THE CONTRIBUTION OF UNIVERSITIES TO REGIONAL ECONOMIES

A Report from the Productivity and Prosperity Project (P3), Supported by the Office of the University Economist

May 2009

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TABLE OF CONTENTS

LIST OF FIGURES

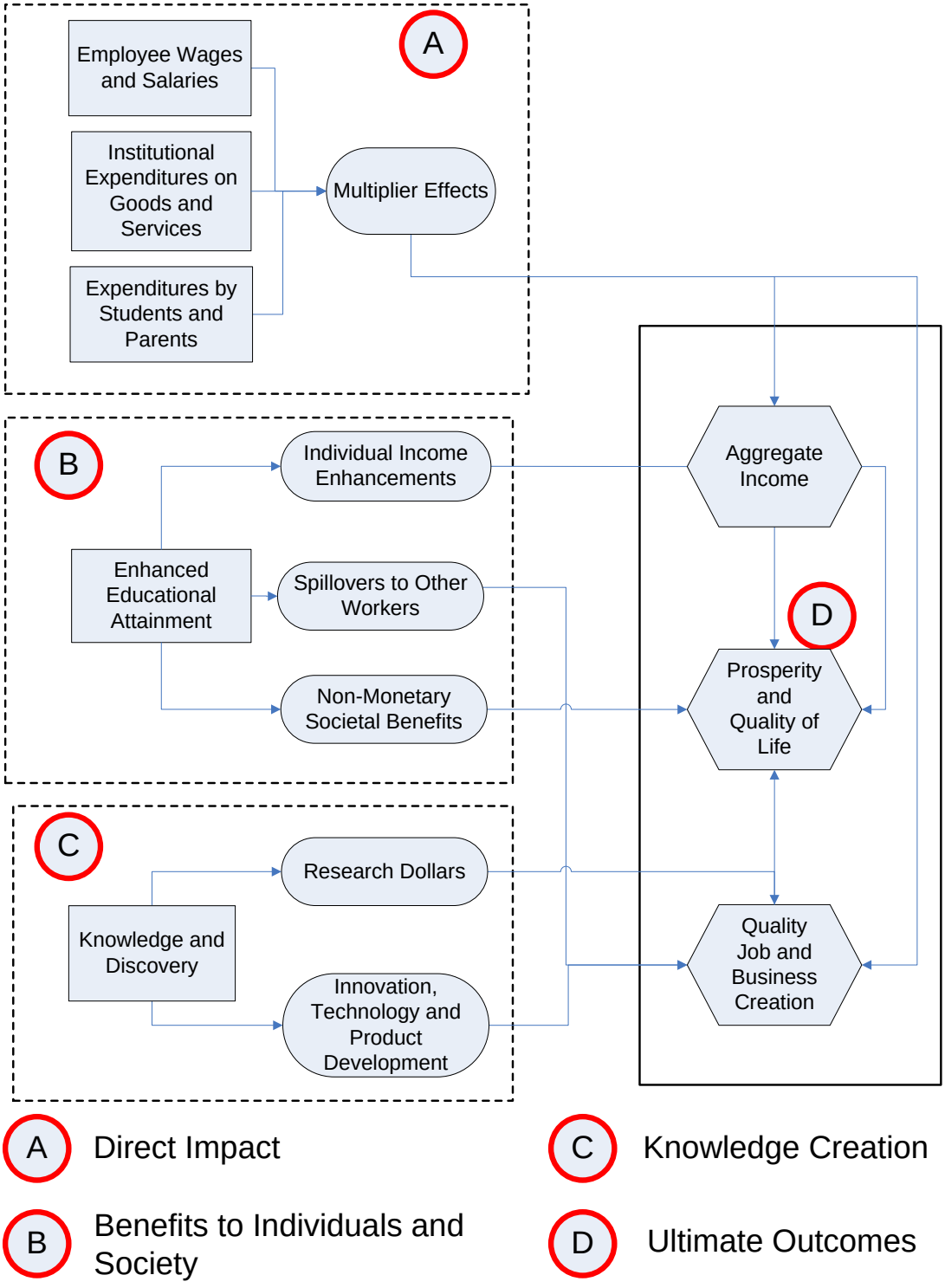
SUMMARY

Universities contribute to the local community in three distinct ways, shown schematically in Figure 1:

- **Traditional Economic Impact: Universities as an Economic Base Industry**. Universities economically impact their communities through their spending for goods and services, and by the expenditures of their employees, students and visitors.
- **Benefits to Individuals and Society: Universities as Institutions of Higher Education**. Universities improve the stock of human capital, which results in higher wages — of those who attended the universities and of other workers in the community. The heightened educational attainment results in other societal benefits, including enhancing the ability of the community to compete for economic development.
- **Creation of Knowledge: Universities as Research Institutions**. The research activities of universities produce knowledge that advances science and technology and results in innovation. New products and processes are created. This too enhances the ability of the community to compete for economic development, particularly related to the knowledge economy. Increased funding from the federal government and other nonlocal sources also benefits the community.

Among the results are higher incomes of individuals and the community as a whole, higher-quality jobs, enhanced economic development, and improvements in prosperity and quality of life.

FIGURE 1
THE EFFECTS OF UNIVERSITIES ON THE LOCAL COMMUNITY



TRADITIONAL ECONOMIC IMPACT: UNIVERSITIES AS AN ECONOMIC BASE INDUSTRY

Based on a survey of the literature, most "impact" reports circulated by universities have concentrated on the traditional economic impacts resulting from university spending for goods and services and from the expenditures of their employees, students and visitors (section A in Figure 1).

In trying to understand the growth and decline of regions, economists find it useful to divide a region's economic activities into two groups. *Basic* activities satisfy demands from outside the region and generate export income that can be used to pay for the region's imports. *Nonbasic* activities exist to supply goods and services to local residents. Basic activities are a region's economic raison d'être, i.e., its *economic base*. Nonbasic activities are derived from that base and grow or shrink depending on the performance of basic industries.

Autos are a basic industry for the state of Michigan; the entertainment industry is basic to the city of Los Angeles and the state of California; the semiconductor industry is basic to Maricopa County and the state of Arizona. Activities that are nonbasic include dentists and elementary schools.

As a provider of education services to students from outside the local area, colleges and universities may be considered basic activities. The clearest examples are so-called "college towns." The operations of the University of North Carolina are vital to the economy of the town of Chapel Hill, North Carolina. From the perspective of an entire state, a university such as Arizona State University is basic to the extent that it serves out-of-state students. A university's research functions also serve to make the university a basic activity, especially when that research is funded from out-of-state sources.

The full contribution an economic base activity makes to the local economy can be measured using input-output models, or what is more commonly referred to as economic impact analysis. Included in this kind of analysis are the direct contributions the basic activity makes through its own payroll and employment. In addition, a university produces indirect or so-called multiplier effects that derive from its purchases of goods and services from other local businesses and from the jobs and incomes that are supported by the consumer spending of all employees directly or indirectly connected to the basic activity. The contributions of a university are distinct from and somewhat broader than those of, say, a semiconductor manufacturer in that, unlike the buyers of semiconductors, customers of the university (i.e., the students) typically reside in the local area, spend money, and further support jobs in the local economy.

Issues

A requirement of economic base analysis is that the contribution of a basic activity to the local economy be limited to impacts that derive from export income or income from outside the local area. Alternatively stated, the measured contributions should be based on activity that would not exist without the given business. In the case of a university, the basic activities are those supported by tuition from out-of-state students or by research funds from out-of-state sources. The share of university operations supported by state appropriations should not be included in

the economic impact calculations as these tax dollars may have been spent locally (either by governments or the private sector) even if they had not been used to support the university.

A conservative approach to identifying the contribution of a university to the state's economy would be to consider only that share of university operations that is funded by either out-of-state tuition or out-of-state research funds. There are also some gray areas here. For example, one might consider including operations funded by the tuition payments of in-state students if it is believed that most of these students would have attended college outside of the state if the local university did not exist.

A common mistake in the interpretation of findings from an economic impact study is to express them as being the result of a benefit-cost calculation, or as representing a rate of return on investment, analogous to the return on a financial investment. Suppose that a university is found to have a total impact (including multiplier effects) on state income of $3 billion, while state appropriations used to support the university are $500 million. It is commonly reported that the university provides economic benefits to the state economy that are six times the costs, yielding a return on the state's investment of 500 percent. A proper interpretation of the economic impact finding is to simply say that the presence of the university serves to increase employment and economic activity in the state in an amount equal to $3 billion of total state income.

Whether the economic benefits of the services provided by the university exceed their costs depends on whether the additional incomes students are able to earn because of their education exceed the total costs of obtaining the education. This kind of calculation can be made, but it is not the one made in economic impact analysis.

Thus, many of the economic impact studies produced by and for universities have overstated the effects of universities. Siegfried et al. (2007) illustrate how some of these reports have produced misleading estimates:

- Specification of the counterfactual. According to Siegfried et al., "that portion of an institution's economic activity that would remain in the local area even if the institution were not there is not a contribution to the local economy. Few studies of the local economic impact of colleges and universities explicitly articulate such a counterfactual."
- Definition of the "local area." While a campus of higher education has a significant economic impact on the immediate community, that impact becomes diluted as the geographic area is broadened. For state universities, state government funding generally should not be counted when the local area is defined as the state, and only a portion should be counted if the local area is defined more narrowly.
- Identification of "new" expenditures. New funding, and the expenditures that result from it, generally should be limited to funds coming from outside the local area, for example, from the federal government, a nonlocal philanthropist, or an out-of-state student. In contrast, spending originating with local funding — for example, spending by in-state students and by employees paid from state government tax dollars — generally should not be counted or only a portion should be included, depending on the geographic definition of the local area.
- Estimate of multiplier effects. New expenditures, e.g. of out-of-state visitors to the university, circulate through the local economy before escaping, but the number of times

the initial expenditure circulates through the local economy before leaving frequently is overstated. Further, the multiplier never should be applied to all university expenditures.

- Double counting. Siegfried et al. state that "it is improper to count all spending by students plus expenditures by the college or university, because the majority of student spending usually is made to the college or university for goods and services."
- Local taxes. Most not-for-profit institutions are exempt from local property taxes, thereby placing a burden on the local community, but some make in-lieu payments. Such issues rarely are addressed in impact studies.

While university impact studies generally overstate the magnitude of the traditional economic impact, higher education does have an economic impact that can be cited. Further, Siegfried et al. also note that most studies do not address the spillover benefits from enhanced human capital that can be claimed by educational institutions (section B in Figure 1, discussed below).

While most university impact studies address the overall university impact, the effects of a particular program also can be assessed. An example is a capital construction program. The analysis of such a program is subject to the same limitations as noted above.

If the source of funding for a capital construction program is bonding that will be repaid through state government tax revenues, the full amount of the construction expenditures cannot be cited as being an economic benefit to the state because it ignores the cost of funds. Alternative uses of the funds must be considered, such as spending an equal amount for other purposes or not levying taxes for this amount. Alternative expenditures of the funds, whether by state government (for example, building a highway, a primary or secondary school, or even a prison) or by state residents, would have a similar economic impact. In contrast, if the funds originate from an outside source, such as a gift from an individual who earned the money outside the local area, the construction funding and its multiplier effect can be considered to be an economic benefit to the community.

However, even if the source of funding is local, some economic benefit can be noted from such a construction program. Generations of students will use the new building; many students will benefit from its use in the years after the building has been paid off. If the construction program occurs at a time when the cost of borrowing is low and when building costs are low — for example, during a recession when the construction industry's workforce is not fully utilized — then the net benefits are greater. And in downturns, the near-term injection of economic activity financed by longer-term costs can provide a needed stimulus.

In addition, construction of a needed university building will enhance the positive effects on the local community from enhanced educational attainment and knowledge creation (section B and C effects of Figure 1, discussed below). Among the ways that this can occur is to raise the reputation of the university, which will help it attract federal funding, faculty, and out-of-state students. Further, new university facilities may improve the synergy between the university and the private sector and may improve the productivity of university employees.

The Wall Street Journal reported that the University of Pennsylvania, Maryland and Case Western have embarked on capital projects designed to align the economic development efforts

of the region with expansion plans of the universities. Arizona State's recent investments in downtown Phoenix represent another example of this cooperative alignment.

Recommendations

A university should periodically (e.g. every five years) produce an economic impact report to track changes in the contribution of the university to its state or regional economy. Most of the information needed to carry out an economic impact analysis is readily available from accounting data routinely assembled by the Office of the Comptroller and the Office of Institutional Analysis.

One aspect of a university's economic impact that is not easy to estimate involves the spending of students. Students are unusual consumers, with spending patterns that are not well approximated from information collected in the Bureau of Labor Statistics' Consumer Expenditure Survey. To obtain a reasonable level of accuracy in these estimates, a student spending survey should be administered, perhaps every ten years.

In general, universities should be much more careful in their preparation of impact studies; see Siegfried et al. for specifics. While more conservative traditional economic impact estimates generally will result from a more careful analysis, a more comprehensive accounting of the net benefits of universities should be undertaken. This broadening of the studies mostly involves documenting the net positive results from enhancing educational attainment and creating knowledge, as discussed in the following sections.

BENEFITS TO INDIVIDUALS AND SOCIETY: UNIVERSITIES AS INSTITUTIONS OF HIGHER EDUCATION

Universities enhance educational attainment, which confers benefits on individuals and society (see section B of Figure 1). The contributions universities make to a local economy differ fundamentally from those of a typical export-base industry in that the customers (the students) acquire skills and become more productive as a result of their education. The effect of education on productivity is measured by the increase in earnings that the education makes possible. The discounted value of the increase in lifetime earnings measures the private economic benefit of education, against which must be weighed the full cost of education.

The private returns to individuals furthering their educational attainment are significant (see Hill et al. (2005)):

- Individual earnings are strongly related to educational attainment. People who have completed high school earn more than those who have not; people with a bachelor's degree earn more than those with only a high school diploma; and those with a graduate education earn more than those with only an undergraduate education.
- Average annual earnings of individuals with a bachelor's degree are more than 75 percent higher than the earnings of high school graduates. These additional earnings sum to over $1 million over a lifetime.
- The differential in earnings based on educational attainment has increased over time. For example, for full-time male workers between the ages of 35 and 44, the earnings premium associated with having a bachelor's degree versus a high school diploma rose from 38 percent in the 1980-84 period to 94 percent in 2000-03.
- To properly assess the economic value of a college education, the benefits realized in terms of higher future earnings must be discounted to adjust for the time value of money. The discounted earnings must then be weighed against the full costs of acquiring a college education including not only the tuition paid by the student, but the earnings foregone while the student is in college and the appropriations of state and local governments. When these calculations are made, the benefits of a college education are seen to be more than three times as large as the costs.
- If the value of a college education is expressed on the same basis as the return on a financial investment, the net return is on the order of 12 percent per year, over and above inflation. This compares favorably with annual returns on stocks that historically have averaged 7 percent.

The benefits of education go well beyond the increase in earnings enjoyed by the educated individual. Significant societal benefits also are noted by Hill et al.:

- Social benefits of a workforce with greater educational attainment and skills can be traced to the enhanced worker productivity associated with greater educational attainment. These productivity gains translate into higher output and incomes for the economy.
- Nonmonetary societal benefits in regions with high proportions of college graduates include lower crime rates, greater and more informed civic participation, and improved performance across a host of socioeconomic measures.
- Intergenerational social benefits may be very large as degree attainment today translates into higher probabilities of degree attainment in future generations.

- Empirical work in econometrics (see Moretti) suggests that after controlling for differences in amenities and individual wages, an increase in the share of college graduates in the labor force leads to significant increases in productivity and wages for all workers.
- A portion of this significant wage effect is attributable to spillovers that result from productivity gains. Simulations for Arizona using conservative estimates of these spillovers suggest that combining spillovers and individual benefits realized from a four-year college degree, degreed workers account for gross lifetime earnings that total $1.6 to $1.9 million more than workers with only a high school diploma.
- Accounting for costs of education and the time value of money, discounted lifetime net benefits from a university degree — including combined individual and societal benefits — exceed $600,000 per worker, a combined internal rate of return of about 16 percent.

Issues

Simple comparisons of earnings between individuals with different education backgrounds can be misleading if earnings differentials are due to other factors which also correlate with educational attainment. What is known as the issue of "ability bias" is the possibility that the earnings premium observed for college graduates is partly a reflection of the fact that people who are successful in school are those with high innate abilities and that these abilities also help them to be successful in the job market. They go on to earn high incomes not because of what they learned in college, but because they are smart.

The issue of ability bias remains an active area of research among labor economists. The current consensus among scholars is that the true average return to education probably is not much below the estimate suggested by simple education-earnings correlations.

When state appropriations are used to subsidize higher education, it is important to know whether and for how long graduates remain employed in the local economy. Graduates who leave the state will no longer pay state taxes to defray the costs of the education subsidies. If there are spillovers from education to other workers, these will not be realized locally if the graduate moves out of state. Potential mobility of graduates is a major issue for universities, especially for those in states without large urban areas, markets for skilled labor, or natural amenities that graduates find attractive.

While societal benefits are significant, evidence does not exist that local production of graduates, in isolation, will be an effective economic development strategy. A portfolio approach — that incorporates higher education and that is aimed at quality workforce development, quality public infrastructure, an emphasis on quality of life and amenities, and efforts to attain and maintain business climate conducive to attracting quality employment opportunities — may yield the highest returns.

A local area cannot emphasize the production of college graduates exclusively because labor force participants with university degrees are highly mobile in terms of their residence. Thus, the number of university graduates from local institutions of higher education is not necessarily highly related to the number of college graduates living in a community. National studies indicate that a statistically significant relationship exists between the number of new college

graduates in a state and average educational attainment in the state's adult population. But the strength of this relationship appears modest. Studies find that if an additional 100 college-bound students choose to attend college in a given state, the long-run effect of raising the college-educated workforce in that state will be only 5-to-10 workers.

In any community, the retention of locally educated individuals and the attraction of highly educated people from other regions are heavily dependent on the availability of job opportunities appropriate for those with college degrees. Urban and natural amenities also are important to the attraction and retention of college graduates.

No single university legitimately can claim responsibility for these societal benefits since they result from private individuals who could acquire knowledge and skills from any university. But in the aggregate, universities are responsible for providing opportunities that are pursued by these private individuals. And in the aggregate, universities can make legitimate arguments that they are responsible for the incremental income that is accrued due to this acquisition of human capital.

Recommendations

Accurate, current estimates of the return that accrues to people who acquire higher education degrees need to be developed. These estimates should be segmented by chosen degree, by major, and by individual characteristics such as ethic background and gender. The U.S. Census Bureau is a source of earnings data that can be crosstabulated by other characteristics.

The Census Bureau figures can be augmented with detailed survey data from university alumni. The survey should include questions on location, earnings, industry, occupation, and a variety of other characteristics.

Together, the Census Bureau and alumni data can provide estimates of the return on human capital that accrue to graduates as well as the location of graduates. While the individuals who earn degrees and the businesses that hire them are directly responsible for their earnings stream, it seems reasonable that the university can claim responsibility for a portion of the net benefits that accrue.

CREATION OF KNOWLEDGE: UNIVERSITIES AS RESEARCH INSTITUTIONS

Universities, particularly research universities, create knowledge (section C of Figure 1). Contributions to the stock of knowledge add value to a region apart from the human capital considerations discussed in the previous sections. Hill, in two papers from 2006, discusses the role of universities in the national innovation system and the relationship between university research and local economic development.

Salter and Martin (2001) note six forms of benefits from publicly funded research:

- Increasing the stock of knowledge. Basic research is a source of new useful knowledge.
- Training skilled graduates. Skills developed, particularly by graduate students, in the production of basic research can lead to economic benefits as individuals move from basic research to working in private companies.
- Creating new instrumentation and methodologies. The transfer of new instruments and methods from basic research to industry can open technological opportunities or alter the pace of technological advance. The tacit knowledge and skills generated during basic research are especially important in emerging areas of science and technology.
- Forming networks and stimulating social interaction. Participation in basic research is essential if one is to obtain access to international networks of experts and information.
- Increasing the capacity for scientific and technological problem solving. Basic research may be especially useful in developing the ability to solve complex problems confronted by firms.
- Creating new firms. Basic research may lead to the creation of spin-off companies to which academics can transfer their skills, tacit knowledge, and problem-solving abilities.

The relative importance of these forms varies with scientific field, technology, and industrial sector. The rationale for government funding of basic research needs to be extended from the traditional market-failure justification to include these various forms of benefits.

A report by Lester of MIT (2005) corresponds in many ways to Salter and Martin, noting that universities contribute to local innovation processes in a variety of ways: technology transfer; attracting human, knowledge, and financial resources; adapting knowledge originating elsewhere to local conditions; integrating separate areas of technological activity; redirecting knowledge already present but not being put to productive use; providing education; and serving as a public space for ongoing local conversations about the future direction of technologies and markets. Lester found that the university role depends on the type of industrial transformation occurring in the local economy. Thus, rather than the standard focus of most universities on patenting, licensing, and new business formation, he recommends “a more comprehensive, more differentiated view of the university role.”

In a report produced for Science Foundation Arizona, economists from the University of Arizona and Arizona State University (see Charney et al. 2007) applied empirical estimates from Jaffe et al. (1989, 1993, 2002) to estimate that the rate of return — measured in induced private-sector research and development (R&D) activity — to an investment in publicly supported research activity was on the order of 4 to 1. Zucker and Darby (2007), in an extensive analysis of the linkages between highly regarded scientists and regional economic impact, found that it is the physical presence of the star scientists, rather than the embodied knowledge of their work, that is

the catalyst for economic activity. Abramovsky et al. (2007) report results in the *Economic Journal* that identify a correlation between the location of research facilities in Britain and the location of quality academic research departments. The British evidence is interesting since it is based on detailed establishment-level data rather than aggregate information or survey data on the location of private-sector R&D.

The Washington Advisory Group (2007) concludes that public R&D investments are an important economic driver. "Public investments in regional science and engineering capacity — as well as in a cluster of complementary human resource and business assets — have emerged as the dominant form of regional economic competition for high-growth, high-wage industries…The economic development competition among states, regions, and even nations using investments in science and technology — usually closely linked to institutions of higher education — is nothing less than a global race."

University Research and Economic Development

The most important source of economic progress over the past two centuries has been industrial innovation. Improvements in industrial technology, in turn, have been driven by advances in basic science, many of which have been made at universities. Over the long run, the economic benefits of industrial innovation and university research accrue largely to consumers throughout the world in the form of lower prices and a greater variety of goods available.

Despite the generally global dispersion of their economic impacts, research at universities can have significant effects on production and employment in the city or region in which the university is located. These local impacts include the attraction of industrial laboratories, the start-up of new high-tech businesses, and competitive advantages enjoyed by local businesses when their technology is advanced by university research.

Prior to WWII much university research in the United States was funded by state governments. In return, universities were expected to train students for employment in local industry and to help local firms solve industrial research problems. The local economic impacts of university research and graduate training were highly visible. After WWII, however, the federal government became the dominant source of university research funding, with goals that were national in scope and unrelated to the needs of local industry. Academic research also became less proprietary and conducted more in an open science format. Research findings were published in journals, presented at seminars, and available to anyone. Without formal ties between a university and local industry, it is less clear that many of the competitive advantages that derive from commercial application of university research accrue locally.

There are two reasons why university research programs generate local economic impacts. First, some research findings, especially those that are revolutionary and have the potential to create new industries, are difficult to transfer to industry without frequent face-to-face contact between university and industrial scientists. Research findings that can be codified, and expressed through formulas or text, can be made available to anyone anywhere. There is no compelling reason for this kind of knowledge to be commercially developed close to the original source. But in many cases of scientific discoveries with revolutionary commercial potential, knowledge is tacit and difficult to communicate without personal interaction. If the pioneering scientist has a university

appointment that he or she wishes to maintain, he/she will serve to determine the location of new firms entering the market to develop the technology.

The period during which discovering scientists play a major role in transferring new knowledge to industry may only last 10-15 years. Eventually, scientific findings become codified and can be learned by graduate students at any major research university. But once an industry has been established in a given location, agglomeration economies associated with the rise of specialized suppliers or markets for specialized labor may serve to lock in an industry's location. In this way, the initial geographic residences of path-breaking researchers have a long-term effect on industry location.

Research universities also generate local economic impacts through their graduate programs. Availability of scientific labor is an important concern for managers of industrial laboratories, and they may choose to site a lab in an area if local universities can provide a steady supply of highly qualified science and engineering graduates. Because of a variety of local attachments people develop while in school, young professionals often prefer to remain in the vicinity of their graduate school, especially if that school is located in a large urban area.

Evidence of local economic impacts from university research comes from a variety of sources: case studies of local industries born from the ideas of university scientists, university records of income earned and new businesses formed from university research findings, and econometric evidence identifying a statistical association between the level of economic activity in an area and the presence of a research university. The evidence shows conclusively that university research programs can have significant local economic impacts.

Issues

Two universities with research programs that are similar in scale and quality may have very different local economic impacts. MIT and Harvard University have had huge documented effects on the Boston area economy. However, Johns Hopkins University, which is routinely among the largest recipients of federal government research funds, has failed to stimulate significant high-tech production in the Baltimore area. High research activity apparently is not a sufficient condition for a university to have large impacts on jobs and incomes in the local economy. Studies of the connection between university research and local economic activity suggest that certain complementary factors may need to be present if a university is to significantly affect the local economy.

High-Quality Research and Graduate Programs

Universities with the greatest local economic impacts are generally those with high quality research programs. The most compelling reason for technology-based firms to locate near universities is to facilitate tacit knowledge transfer from faculty who are on the leading edge of scientific breakthroughs. It is only these star researchers who have the power to determine firm location. University scientists with a national reputation are more likely to be able to attract venture capital, management, and the technical workers necessary to start new companies. In addition, while studies show that availability of science and engineering workers is an important factor in the location of industrial research laboratories, R&D managers are particular about the institutions they hire from and view only the best graduate programs as an attracting factor.

Agglomeration and Research Networks

Agglomeration economies are known to be an important factor in the production of knowledge. Spatial concentration of research activity promotes the development of markets for specialized suppliers of materials, testing equipment, and even legal services. Agglomeration also helps to support informal channels of knowledge transfer. University research will be more productive and more likely to influence local economic activity if it takes place in an area with an existing concentration of corporate research activity and high-tech production. Studies of the biotech industry, for example, have found that university faculty who collaborate with industry in commercial ventures are more likely to do so with local firms if the industry has a significant local presence. Otherwise, faculty involvement will be long-distance.

Large Metropolitan Areas

Apart from the size of particular industries, the general size of an urban area affects the scale and productivity of local research. Areas with 1-to-4 million people produce twice as many patents per capita as do areas with a population less than 250,000. New product innovations are introduced disproportionately by firms in large metro areas. Studies also show population size to be a more important siting variable for high-tech companies than low taxes or low wages. One reason for these findings may be that large urban areas better promote knowledge spillovers between different industries. Also, population size is thought to be an important locational consideration for science and engineering workers. Large urban areas offer amenities that professional workers value, and they make it easier for spouses to find employment.

University Policy

University culture and policies can have important effects on the extent to which faculty engage in and develop commercially relevant research. In an attempt to raise what are generally considered to be disappointing financial returns from resources used to promote technology transfer, more universities are making use of equity arrangements when licensing university inventions. Many university-owned patents fail to generate significant income because faculty do not take the time to develop their ideas and concepts into a commercially viable product. When faculty have a financial interest in the performance of the firm that licenses their research, they are more likely to assist the firm in product development. Licensing firms also believe that university equity positions confer a kind of halo effect that helps them secure venture capital funding. Data analysis indeed shows that universities that are permitted to take an equity position in companies that license their research have 70 percent more start-ups than universities who cannot.

Recommendations

Universities can take several steps to better understand the role of their research in the economic development of their community:

- Monitor all metrics obtained from Association of University Technology Managers (AUTM) surveys.
- Survey businesses in the local community to understand how they perceive benefits from the local research university. Using inputs from industry, academia, AUTM, and other sources, a standard set of questions could be assembled to form the basis for a regular survey of business representatives.

- Build an understanding of how the benefits of knowledge creation flow to a local economy. To understand these channels, survey academic literature and recent reports by monitoring:
    - Research published in journals
    - Sponsored research
    - Contract research
    - Faculty consulting
    - Student internships and full-time placements
    - Patents, licenses, and start-ups
    - Symposia sponsored by university research centers
    - Executive education
    - Certificate programs
- Establish the relative importance of these factors through primary survey data. Surveys may be conducted in conjunction with site visits and/or regular communication with local business leaders. At a minimum, this effort will help build a mutual understanding of the needs of regional businesses and the ability of research universities to fill these needs.

An Opportunity for Further Analysis of the Relationship Between University Research and Private-Sector Business Activity

Perhaps the most distinctive avenue for identifying university research benefits is to measure the extent to which private-sector activity is catalyzed by the activities of research universities. The hypothesis is that there is more business activity (measured by output or employees in the private sector) in a region as a direct result of the presence of a research university. This is a difficult hypothesis to prove because business activity in a region is affected by many factors. However, proving this hypothesis will go a long way toward establishing the rates of return that prevail on investments in public research universities.

The National Science Foundation is pursuing a program that fits well with these research questions. Following is the synopsis of the solicitation for the current fiscal year (http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=501084&org=SBE):

> The Science of Science & Innovation Policy (SciSIP) program supports research designed to advance the scientific basis of science and innovation policy. Research funded by the program thus develops, improves and expands models, analytical tools, data and metrics that can be applied in the science policy decision making process. For example, research proposals may develop behavioral and analytical conceptualizations, frameworks or models that have applications across a broad array of SciSIP challenges, including the relationship between broader participation and innovation or creativity. Proposals may also develop methodologies to analyze science and technology data, and to convey the information to a variety of audiences. Researchers are also encouraged to create or improve science and engineering data, metrics and indicators reflecting current discovery, particularly proposals that demonstrate the viability of collecting and analyzing data on knowledge generation and innovation in organizations.
>
> Among the many research topics supported are:
> - examinations of the ways in which the contexts, structures and processes of science and engineering research are affected by policy decision,
> - the evaluation of the tangible and intangible returns from investments in science and from investments in research and development,

- the study of structures and processes that facilitate the development of usable knowledge, theories of creative processes and their transformation into social and economic outcomes,
- the collection, analysis and visualization of new data describing the scientific and engineering enterprise.

The SciSIP program invites the participation of researchers from all of the social, behavioral and economic sciences as well as those working in domain-specific applications such as chemistry, biology, physics, or nanotechnology. The program welcomes proposals for individual or multi-investigator research projects, doctoral dissertation improvement awards, conferences, workshops, symposia, experimental research, data collection and dissemination, computer equipment and other instrumentation, and research experience for undergraduates. The program places a high priority on interdisciplinary research as well as international collaboration.

Investigators are encouraged to submit proposals of joint interest to the SciSIP Program and other NSF programs and NSF initiative areas. The program places a high priority on broadening participation and encourages proposals from junior faculty, women, other underrepresented minorities, Research Undergraduate Institutions, and EPSCoR states. The program also supports small grants that are time-critical and small grants that are high-risk and of a potentially transformative nature (see Grants for Rapid Response Research (RAPID) and EArly-concept Grants for Exploratory Research (EAGER).)

One approach that has not been used widely is to examine the issue using establishment-level data from the Census Bureau or from a private source. This might be combined with the detailed patent database assembled by a team of researchers at Harvard University. Combining data from these two sources would offer researchers the ability to understand the types of business establishments that locate in particular regions, to identify linkages that prevail between knowledge creation and business activity, and to understand the possible roles played by research universities in the observed economic activity.

Monitoring Ongoing Research

In recent years contributions to the academic literature have shed light on the issues of enhanced educational attainment and the creation of knowledge. Moretti has estimated models that suggest important economic gains accrue to those cities that can increase the labor force share of college graduates. Zucker and Darby estimated the impact that star scientists can have on local economies. Developing an archive of quality academic treatments of this issue can help build understanding of how to measure the value of universities.

Assessing the value of universities would benefit from a general research agenda that focuses on how regional prosperity should be measured and what factors are responsible for the economic growth and prosperity of regions. This is the ongoing research agenda of the *Productivity and Prosperity Project* conducted by the Office of the University Economist at Arizona State University.

REFERENCES

Abramovsky, L., Harrison, R. and Simpson, H. "University Research and the Location of Business R&D" *The Economic Journal* 117 (March 2007): C114-C141.

Beck, R., D. Elliott, J. Meisel, and M. Wagner. "Economic Impact Studies of Regional Public Colleges and Universities," *Growth and Change* 26 (Spring 1995): 245-60.

Card, D. "The Causal Effect of Education on Earnings," *Handbook of Labor Economics 3A* (North-Holland-Elsevier, 1999): 1801-63.

Charney, A., Hill, K., Hoffman, D., Lobo, J. and Nadelhoffer, M. "A Strategic Assessment of the Economic Benefits of Investments in Research in Arizona" (June 2007) http://www.sfaz.org/documents/072044abFullReport-Final.pdf.

Hill, K., Hoffman, D. and Rex, T. "The Value of Higher Education: Individual and Societal Benefits" (October 2005) http://www.asu.edu/president/p3/Reports/EdValue.pdf.

Hill, K. "Universities in the U.S. National Innovation System" (March 2006) http://www.asu.edu/president/p3/Reports/innovation.pdf.

Hill, K. "University Research and Local Economic Development" (August 2006) http://www.asu.edu/president/p3/Reports/univResearch.pdf.

Jaffe, A. "Real Effects of Academic Research" *The American Economic Review* 79 (1989): 957-970.

Jaffe, A., Trajtenberg, M., and Henderson, R. "Geographic Localization of Knowledge Spillovers as Evidenced by Patent Citations" *Quarterly Journal of Economics* 108 (1993): 577-598.

Jaffe, A. and Trajtenberg, M. *Patents, Citations, and Innovations: A Window on the Knowledge Economy* (The MIT Press, 2002).

Lester, R. "Universities, Innovation, and the Competitiveness of Local Economies" (December 2005) http://web.mit.edu/ipc/publications/pdf/05-010.pdf.

Moretti, E. "Workers' Education, Spillovers and Productivity: Evidence from Plant-Level Production Functions" *American Economic Review* 94 (June 2004): 656-690.

Moretti, E. "Estimating the Social Return to Higher Education: Evidence from Longitudinal and Repeated Cross-Sectional Data" *Journal of Econometrics* 121 (July/August 2004): 175-212.

Moretti, E. "Human Capital Externalities in Cities" *Handbook of Regional and Urban Economics 4* (North Holland-Elsevier, 2004).

Salter, A. and Martin, B. "The Economic Benefits of Publicly Funded Basic Research: A Critical Review" *Research Policy* 30 (2001): 509-532.

Siegfried, J., Sanderson, A. and McHenry, P. "The Economic Impact of Colleges and Universities" *Economics of Education Review* 26 (October 2007): 546-558.

The Wall Street Journal. "Colleges Teach Urban Development 101: Involvement in Projects Reflects Need to Upgrade School's Surroundings" (February 27, 2008): B10.

The Washington Advisory Group. "R&D Investments Drive State Economies: A Guide for Arizona" (June 2007) http://www.sfaz.org/documents/072041.FINAL.pdf.

Watson, P., Wilson J., Thilmany, D. and Winter, S. "Determining Economic Contributions and Impacts: What Is the Difference and Why Do We Care?" *The Journal of Regional Analysis & Policy* 37 (2007): 140-146.

Zucker, L. and Darby, M. *Star Scientists, Innovation and Regional and National Immigration*, NBER working paper no. 13547 (October 2007) http://papers.nber.org/papers/w13547.