Quotations from References on Research

From the National Bureau of Economic Research, USA

Note: The scope of many of these studies depend upon available data. The specific Working Paper should be reviewed before using these quotations in a particular context.

We show that university autonomy and competition are positively correlated with university output, both among European countries and among U.S. public universities. We then identity a (political) source of exogenous shocks to funding of U.S. universities. We demonstrate that, when a state's universities receive a positive funding shock, they produce more patents if they are more autonomous and face more competition from private research universities. Finally, we show that during periods when merit-based competitions for federal research funding have been most prominent, universities produce more patents when they receive an exogenous funding shock, suggesting that routine participation in such competitions hones research skill.

…

The most natural overall interpretation of our results is that frontier research is a complex thing that a university can only pursue effectively if it has the discretion to direct resources and researchers towards what it believes are the most promising paths. Universities will put more effort into directing resources well if they know that rewards are allocated based on competition, especially competition that is strictly merit-based.

> Philippe Aghion, Mathias Dewatripont, Caroline M. Hoxby, Andre Mas-Colell and Andre Sapir, *The Governance and Performance of Research Universities; Evidence from Europe and the U.S.*, April 2009

This study documents the rapid spread of higher education around the world and the consequent reduced share of the US in the world's university students and graduates. It shows that the proportion of young persons who go to college has risen in many advanced countries to exceed that in the US while human capital leapfrogging in the huge populous developing countries has produced massive increases in their university educated work forces. One result of the expansion of higher education overseas is that the US has come to rely extensively on the immigration of highly educated persons to maintain a lead position in science and technology. International students make up roughly half of university graduate immigrants to the US, which makes policies toward those students a key determinant in the country's success in attracting immigrant talent.

> Richard B. Freeman, *What Does Global Expansion of higher Education Mean for the US*? May 2009

In addition we explore some efficiency aspects of the university system. Our findings suggest that leading schools have lower average and marginal costs of performing research than lesser

institutions, and that leading institutions have a comparative advantage t generating higher quality, more cited research. In our comparisons of private and public institutions the results re not as one-sided, yet they suggest once again that private schools have a comparative advantage at generating more highly cited research.

Many of the difficulties [of drawing distinctions] that hinder our measurements of research productivity begin with distinctions between fields that are continuously blurred by spillovers and by collaborative ventures, and with distinctions between schools that are in reality connected by mutual exchange of students and ideas.

> James D. Adams and Zvi Griliches, *Research Productivity in a System of Universities*, November 1996.

In this paper, we estimate the impact of receiving an NIH grant on subsequent publications and citations. Our sample consists of all applications (unsuccessful as well as successful) to the NIH from 1980 to 2000 for postdoctoral training grants (F32s) and standard research grants (R01s). Both OLS and regression discontinuity estimates show that receipt of either an NIH postdoctoral fellowship or research grant leads to about one additional publication over the next five years. The estimates represent about 20 and 7 percent increases in research productivity for F32 and R01 recipients respectively. The limited research impact of NIH grants may be explained in part by a model in which the market for research funding is competitive, so that the loss of an NIH grant simply causes researchers to shift to another source of funding.

…

our estimates will not capture any spillover benefits of research funding, nor will they capture what some have referred to as the transformational impact of R&D expenditures – i.e., the notion that public support for science may change the nature of the research infrastructure which, in turn, may have a much more dramatic impact on future productivity (see, for example, Jaffe 1998, 2002 and Popper 1999).

> Brian Jacob and Lars Lefgren, *The Impact of Research Grant Funding on Scientific Productivity,* October 2007.

Contrary to conventional wisdom, knowledge spillovers (inter-industry spillovers and learning-by-using) did not have a great influence on the diffusion of the newly developed electrical technology. They played a limited role in raising the ability of the population to generate crossover inventions. Nor did spillovers significantly accelerate inventors in the creation of their first crossover invention or increase their productivity at making crossover inventions over their career.

On the other hand, conditions that encourage inventive activity in general appeared to have helped in the diffusion of the electrical technology. Such conditions influenced the location of crossover inventions as well as the speed and productivity of individuals in making crossover inventions.

Shih-tse Lo and Dhanoos Suthiphisal, *Crossover Inventions and Knowledge Diffusion of General Purpose Technologies: Evidence from the Electrical Technology*, May 2008

In this paper we provide new insights into how venture capital contributes to building successful companies. Building on the literature about the role of absorptive capacity as a source of competitive advantage, we investigate whether venture capital affects the innovation strategies of portfolio companies.

We find that these appear to benefit from expanded financial resources, which increase their innovation effort. More importantly, we find that venture capitalists selectively push portfolio companies towards choosing innovation activities which result in the accumulation of absorptive capacity, and towards more permanent in-house R&D efforts. Venture backed companies rely more on a Make–and—Buy strategy, rather than on Make—only or Buy—only strategies.

Interestingly, our results hold after accounting for the availability of public funds. Moreover, we find a clear difference in the role of (private) venture financing and public funding, as the latter relaxes financial constraints but does not provide any additional strategic guidance. This provides novel evidence on the special role of venture funding in driving companies towards successful innovation strategies. From a policy perspective, our results suggests that venture capital may be beneficial not only for individual companies, but may also play an important role in fostering economic growth.

Marco Da Rin and Maris Fabiana Penas, *The Effect of Venture Capital on Innovation Strategies,* November 2007.

But along with the educational transformation in China, there is now a major focus on patenting, both in China itself and international patenting. The latter is to be both by Chinese residents and Chinese institutions, including Chinese universities and academies of science.

Yao Li, Yohn Whalley, Shunming Zhang, Xiliang Zhao*, The Higher Educational Transformation of China and Its Global Implications*, March 2008.

These results suggest that risk [avoidance] considerations at the managerial level play an important role in preventing innovation.

Phillippe Aghion, John Van Reenen, and Luigi Zingales*, Innovation and Institutional Ownership,* March 2009.

In this paper we argued that openness of upstream research does not simply encourage higher levels of downstream exploitation: it also raises the incentives for additional upstream research by encouraging the establishment of entirely new research directions. We tested this hypothesis by examining a \natural experiment" in openness within the academic community: NIH agreements during the late 1990s that circumscribed IP restrictions for academics regarding

certain genetically engineered mice. First, we found, not surprisingly, that there is an increased overall level of follow-on research taking place after the NIH-DuPont-JAX openness agreements.

…

Our results highlight that the current literature on intellectual property and innovation has neglected a key potential cost of intellectual property - the limits that IP rights may place on the diversity of research that would otherwise be pursued by follow-on innovators taking a single powerful idea and experimenting across multiple research lines.

> Fiona Murray, Philippe Aghion, Mathias Dewatripont, Julian Kolev and Scott Stern, *Of Mice and Academics: Examining the Effect of Openness on Innovation*, March 2009.

This paper estimates science production functions for R&D-performing firms in the United States using scientific papers as the measure of output, by analogy with patents. The underlying evidence covers 200 top U.S. R&D firms during 1981-1999 as well as 110 top U.S. universities. We find that industrial science builds on past scientific research inside and outside the firm, with most of the returns to scale in production deriving from outside knowledge. In turn, the largest outside contribution derives from universities rather than firms; this is especially true when papers are weighted by citations received, a measure of their importance. Consistent with the role assigned to knowledge spillovers in growth theory, the importance of outside knowledge, especially that of universities, increases from the firm to the industry level.

> James D. Adams and J. Roger Clemmons, *The Origins of Industrial Scientific Discoveries*, February 2008.

I started this paper by pointing out two trends: economists in several highly-regarded departments are publishing fewer papers in the top field journals; and Harvard's economics department is also publishing fewer papers in the top general interest journals. Several pieces of evidence bolster the view that one factor contributing to these trends is that the role of journals in disseminating research has been reduced.

The changes that have occurred over the past decade are modest in magnitude. Economists at top departments are still spending a great deal of effort publishing in top peer reviewed journals and publishing many papers there. One could imagine, however, that much larger changes will be seen in the near future. Technologies for disseminating papers will continue to improve. More top economists may realize that the publication hassles they have been enduring are not necessary. The peer-review process may also be subject to unravelling: as more top economists withdraw from the process, the signal that publication in a given journal provides is devalued, and this may lead to further withdrawals. Even a partial unravelling could have a significant impact on the course of economic research.

> Glenn Ellison, *Is Peer Review in Decline*, July 2007.

We find that 29 percent of the workforce was required to hold a license in 2006, which is a higher percentage than that found in other studies that rely on state-level occupational licensing data or single states. Workers who have higher levels of education are more likely to work in jobs that require a license.

> Morris M. Kleiner and Alan B. Krueger, *The Prevalence and Effects of Occupational Licensing*, September 2008.

While the theoretical analysis provided here clari.es the conditions under which factor scarcity and wage (factor price) push may induce innovation and technology adoption, these conditions may or may not hold depending on the specific application (time period, institutional framework, the industry in question, etc.). This suggests that empirical evidence is necessary to shed light on when factor scarcities and various regulations affecting factor prices may encourage innovation and technology adoption. Existing evidence suggests that this is a possibility, but is not conclusive. For example, Newell, Jaffee and Stavins (1999) show an effect of changes in energy prices on the direction of innovation and on the energy efficiency of household durables and Popp (2002) provides similar evidence using patents. Acemoglu and Finkelstein (2008) show that the Prospective Payment System reform of Medicare in the United States, which increased the labor costs of hospitals with a significant share of Medicare patients, appears to have induced significant technology adoption in the affected hospitals. In a different context, Lewis (2007) shows that the skill mix in US metropolitan areas appears to have an important effect on the choice of technology of manufacturing .rms. Further research might shed more systematic light on the empirical conditions under which we may expect greater factor prices and factor scarcity to be an inducement, rather than a deterrent, to technology adoption and innovation.

> Daron Acemoglu, *When Does Labor Scarcity Encourage Innovation*? March 2009.

Scientific research has come to dominate many American universities. Even with growing external support, increasingly the costs of scientific research are being funded out of internal university funds. … We find that universities whose own expenditures on research are growing the most rapidly, ceteris paribus, have had the greatest increase in student faculty ratios and, in the private sector, higher tuition increases. Thus, undergraduate students bear part of the cost of increased institutional expenditures on research.

…

Whether these costs are more than offset by the benefits the students receive from being educated in proximity to scientific researchers who are at the cutting edge of their disciplines is an open question that deserves serious study.

…

It is possible, of course, that the increasing costs of research that are borne by universities may be eventually at least partially offset by revenues that the universities receive from increased commercialization of their faculty members' research. The Association of University Technology Managers (AUTM) reported in their fiscal year 2000 survey of their members that American colleges and universities received more than $1 billion dollars in licensing income and other forms of royalties relating to patents that year. While this figure seems large, it was concentrated in a few large "winners"; 90% of the universities in their sample received less than $2 million and almost half received less than $1 million.

Licensing income received in one year depends upon the flow of investments in research that universities have made in the past. If we ignore this and the fact that the return on any particular research project may occur for a number of years in the future, a simple way of looking at the commercial returns that universities receive from their faculty members' research is to ask how the licensing income received by a university in one year relates to its own expenditures on research in that year. Licensing income received in fiscal year 2000 averaged 3.23% of total research expenditures in the year across the institutions in the AUTM sample. As we have noted, universities fund about 20% of their research expenditures out of their own resources, which suggests that licensing income averaged about 16% of institutions' research expenditures out of internal university funds in the year.

…

The median institution in the sample licensing income was 0.83% of its total research revenue, which is about 4.2% of its internal volume of research expenditures.

> Ronald G. Ehrenberg, Michael J. Rizzon, and George H. Jakubson, Who Bears the Growing Cost of Science at Universities? April 2003.

The empirical and theoretical literature that examines the economic effects of information and communication technologies (ICT) generally aggregates together the information technology (IT) and communication technology (CT) into a single homogeneous mass. We argue that this is a serious error because the impact of IT and CT on the organization of firms, and ultimately income inequality, will be quite different depending on the type of technology. Falls in communication costs will tend to reduce employee autonomy, as decisions will be passed up to the centre of the firm. Falls in information acquisition costs will have the opposite effect, facilitating more effective employee decisions making.

> Nicholas Bloom, Luis Garicano, Raffaella Sadun, John Van Reenen, *The District Effects of Information Technology and Communication Technology on Firm Organization*, May 2009.

Other Sources

This paper has presented evidence on patterns of research collaboration in U.S. universities over the final two decades of the 20th century. The evidence on the size of scientific teams, as measured by authors per paper, suggests that specialization and the division of labor have increased markedly over this period, especially during the 1990s. Our findings on collaboration between institutions suggest a similar pattern of developments, but with some new twists. Collaboration with foreign universities increases more rapidly over time than team size, while domestic collaboration increases less rapidly. We take this as evidence that the location of team members is shifting and is becoming more geographically dispersed, perhaps because of funding advantages coupled with telecommunications improvements. However, we lack complete information on the causal factors directing this dispersion. It seems plausible to say that domestic collaboration has for a long time been more feasible than international collaboration, and that only recently have modern communications technologies made international science viable for researchers on projects of normal size. This interpretation receives support from Figs. 7 and 8 where it is the *smaller* teams that are becoming internationalized at a faster rate. But in addition, an increasing emphasis on large databases, as in biology and medicine, and on massive instrumentation, as in astronomy and physics, may have also played important roles in these trends towards greater internationalization.

The growth of collaboration as observed in this article could be viewed as consistent with the increasing efficiency of the research enterprise. Collaboration at a distance permits a combination of complementary capabilities that leads to the execution of more and hopefully better research.

> James D. Adams, Grant C. Black, J. Roger Clemmons, and Paula E. Stephan, "Scientific teams and institutional collaborations: Evidence from U.S. universities, 1981–1999," *Science Direct*, 23 March 2005. (Research Policy, v. 34 no. 3, pp. 259 Date: 2005).

We have used 19.9 million papers over 5 decades and 2.1 million patents to demonstrate that teams increasingly dominate solo authors in the production of knowledge. Research is increasingly done in teams across virtually all fields. Teams typically produce more highly cited research than individuals do, and this advantage is increasing over time. Teams now also produce the exceptionally high impact research, even where that distinction was once the domain of solo authors. These results are detailed for the sciences and engineering, social sciences, arts and humanities, and patents, suggesting that the process of knowledge creation has fundamentally changed.

> Stefan Wuchty, Benjamin F. Jones, and Brian Uzzi, "The Increasing Dominance of Teams in Production of Knowledge," *Science Magazine*, 18 May 2007, pp. 1038-1039 and supplementary materials.

Although the rewards of science, from grants to the Nobel Prize, go to individuals, there is evidence that graduate students and postdoctoral fellows who find themselves in the right kind of work setting may have a leg up in their trajectory toward becoming successful scientists.
…

A second over finding is that work group size is positively associated with early productivity.
…
There is, however, also a tendency for larger laboratories to be more secretive, both in terms of their climate and the individual respondents' willingness to share.
…
The findings present new grit for ongoing discussions about the desirability of more entrepreneurial universities. While we hope for scholars who are driven by both the objective of discovery and by the norm of openness, we may find that these coexist as ideals rather than realities.

> Karen Seashore Louis, Melissa S. Anderson and Eric G. Campbell, Becoming a Scientist: the Effects of Work-Group Size and Organizational Climate, *The Journal of Higher Education,* May/June 2007 (78:3), pp. 311-336.