

This PDF is a selection from a published volume from the National Bureau of Economic Research

Volume Title: Innovation Policy and the Economy, Volume 10

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Volume Publisher: University of Chicago Press

Volume ISBN: 0-226-47333-3 (cloth); 0-226-47334-1 (paper)

Volume URL: <http://www.nber.org/books/lern09-1>

Conference Date: April 14, 2009

Publication Date: February 2010

Chapter Title: Introduction to "Innovation Policy and the Economy, Volume 10"

Chapter Authors: Josh Lerner, Scott Stern

Chapter URL: <http://www.nber.org/chapters/c11762>

Chapter pages in book: (xi - xvi)

Innovation Policy and the Economy: Introduction to Volume 10

This volume is the tenth annual volume of the National Bureau of Economic Research (NBER) Innovation Policy and the Economy (IPE) group. The appreciation of the importance of innovation to the economy has increased over the past decade. There is an active debate regarding the implications of rapid technological change for economic policy and the appropriate policies and programs regarding research, innovation, and the commercialization of new technology. This debate has only intensified as policy makers focus on new sources of innovation and growth in light of the economic downturn and the arrival of a new administration.

The IPE group seeks to provide an accessible forum to bring the work of leading academic researchers to an audience of policy makers and those interested in the interaction between public policy and innovation. Our goals are as follows:

- To provide an ongoing forum for the presentation of research on the impact of public policy on the innovative process
- To stimulate such research by exposing potentially interested researchers to the issues that policy makers consider important
- To increase the awareness of policy makers (and the public policy community more generally) concerning contemporary research in economics and the other social sciences that usefully informs the evaluation of current or prospective proposals relating to innovation policy

This volume contains revised versions of the papers presented at the group's meeting in Washington, DC, in April 2009.

The first two chapters focus on the impact of alternative approaches for offering incentives for innovation. In the first, "Incentivizing Innovation: Adding to the Tool Kit," Michael Kremer and Heidi Williams consider recent initiatives to move beyond traditional intellectual property

instruments, such as patents, and instead to employ alternative incentive systems such as prizes and Advance Market Commitments. Their analysis contrasts the economics of different trigger mechanisms for rewarding innovation: *ex ante* technical specifications that result in a monetary payout when particular design specifications are achieved, *ex post* rewards that reward innovators on the basis of their market impact and the extent of a technology's use, and *ex post* discretion for policy makers to allocate rewards once particular innovations have been developed. Kremer and Williams apply these ideas to evaluate key issues in the design of Advance Market Commitments, focusing in particular on issues that will arise as these incentives move away from near-term innovation challenges (such as the recently announced \$1.5 billion commitment for a pneumococcus vaccine) toward more elusive innovations (e.g., a cost-effective and scalable malaria vaccine). Their analysis suggests that when the ultimate social impact of an innovation depends on its adoption and use (such as in the case of a vaccine), providing rewards based on use (as is done with an Advance Market Commitment) may be more cost-effective than prizes and less distortionary than traditional mechanisms such as patents.

The second chapter turns toward the incentives to create and distribute music (and other creative content). Felix Oberholzer-Gee and Koleman Strumpf evaluate the impact of file-sharing technologies (such as Napster and BitTorrent) on the production and diffusion of music. While the rise of digital file-sharing platforms has reduced the relative strength of copyright protection for creative musical works, Oberholzer-Gee and Strumpf emphasize that the impact of these technologies on the incentives to create music is complex. To conclude that file sharing has had a significant impact on the creation of new music, one must first demonstrate that file sharing significantly reduces the income that artists receive and that the production of new creative work is highly sensitive to (expected) income. Synthesizing a rapidly growing body of empirical evidence, their analysis suggests that the incentive consequences of file-sharing platforms may be relatively benign. First, there is considerable variation across different studies as to whether file-sharing technologies indeed reduce record sales. While some studies do find that file sharing displaces sales, Oberholzer-Gee and Strumpf highlight that their own empirical studies—which are relatively unique in both measuring file-sharing activity and sales at the level of individual albums and accounting for the endogeneity of the level of file sharing through the use of a differences-in-differences approach—show that file-sharing activity and record sales are essentially unrelated. Moreover, while there has

been an overall decline in the level of sales for recorded music, this has essentially been balanced by a significant increase in revenue arising from concerts and other sources of complementary income. Since this shift in revenue away from recordings and toward concerts might benefit artists relative to distributors, it is arguable that the monetary incentives to produce new music have actually increased over the past decade. Finally, while the measurement of creative output of time is challenging, the total amount of new music being created may actually be increasing (perhaps because of the dramatic reductions in the costs of distributing and popularizing music through digital channels). Creative artists may be relatively insensitive to the income potential from creative activities, particularly since the distribution of financial returns to musical artists is so skewed. More generally, Oberholzer-Gee and Strumpf highlight the fact that file-sharing platforms not only alter the relative strength of formal intellectual property protection but also affect the opportunities and costs for mass distribution of creative works.

The next three chapters consider innovation policy and entrepreneurship from an international perspective. In “The Divide between Subsistence and Transformational Entrepreneurship,” Antoinette Schoar synthesizes cross-cutting findings from a forthcoming NBER volume, *International Differences in Entrepreneurship* (edited with Josh Lerner). Schoar focuses on the dual nature of entrepreneurship in emerging economies. On the one hand, subsistence entrepreneurs—by far the majority—are self-employed individuals with very small-scale businesses that are essentially an alternative employment opportunity for themselves and their family members. By way of contrast, transformational entrepreneurs found businesses that have the potential for significant growth, including the possibility of hiring a significant number of additional employees, and that involve significant capital investments over time. While most policy analysis assumes that subsistence entrepreneurship represents a first step toward transformational entrepreneurship, an emerging body of empirical evidence suggests the opposite: the types of individuals who engage in the two types of entrepreneurship are different from each other (e.g., in terms of education levels), each type responds differently to policy initiatives (e.g., the provision of subsidized financing), and the probability of transitioning from subsistence to transformational entrepreneurship is negligible in most environments. Consequently, policies designed to encourage transformational entrepreneurship—such as reduced entry regulations or enhancements in the ability of entrepreneurs to access credit markets—are likely to have an asymmetric effect on these two types

of populations. While economic growth built on transformational entrepreneurship is a common policy objective in emerging economies, Schoar's analysis suggests that policy makers need to consider the specific conditions supporting transformational entrepreneurship (as opposed to the economywide level of self-employment) and recognize that many of the most influential transformational entrepreneurs will often come from backgrounds in more established companies, particularly those that are directly engaged with the global economy.

In "The 'I's Have It: Immigration and Innovation, the Perspective from Academe," Paula Stephan documents the significant and influential role played by foreign-born researchers in the U.S. university system. As U.S. undergraduates have reduced their propensity to major in and pursue graduate training in science and engineering fields, a significant debate has focused on the impact of the foreign born as graduate students, postdoctoral fellows, faculty, and industrial researchers. While measurement and classification issues make precise quantification of exactly what is meant by an "immigrant" scientist challenging, Stephan provides compelling evidence that foreign-born researchers now make up a very large share of the total population of university researchers: 60% of postdoctoral researchers are employed with a temporary visa status, more than 40% of all doctorates in science and engineering are awarded to individuals with a temporary visa status, and more than 25% of all tenure-track faculty are immigrants (under a number of alternative definitions). Interestingly, Stephan provides evidence that foreign-born researchers are unusually productive researchers, contributing a higher share of "exceptional" contributions (e.g., papers in leading journals). Relative to native-born researchers, foreign-born researchers seem to be associated with a higher marginal productivity. Moreover, foreign-born researchers constitute more than one-third of all newly hired PhDs in U.S. firms. Taken together, this evidence suggests that foreign-born researchers constitute a very significant fraction of the overall U.S. innovation system, measured in terms of raw scale as well as productivity. Whether U.S. universities can continue to "import" foreign-born researchers (as students, postdocs, and faculty) will depend both on immigration policy (such as the rules and conditions governing the H1B visa program) and on whether U.S. universities continue to serve as attractive options for talented students, graduates, and faculty.

While Stephan focuses on the role of foreign-born researchers who stay within the United States (either in academe or industry), her essay raises a broader question regarding the globalization of innovation.

Indeed, over the past several years, a significant policy debate has arisen as to whether the U.S. comparative advantage in innovation is eroding and about the role of specific policies in shaping the global distribution of R&D activity. Drawing in part on a forthcoming NBER volume, *The Location of Biopharmaceutical Activity*, Iain Cockburn and Matthew Slaughter offer novel empirical evidence on these issues in "The Global Location of Biopharmaceutical Knowledge Activity: New Findings, New Questions." Cockburn and Slaughter consider the evolution of biopharmaceutical R&D activity in an international context and the relationship between U.S. and non-U.S. R&D activity by global biopharmaceutical firms. When measures such as R&D investment, patenting, and clinical trial activity are examined, the overwhelming share of R&D activity continues to be conducted within the United States and other traditional locations (e.g., the EU-15). But a number of nontraditional locations have experienced a very high rate of growth (albeit from a low baseline). The authors then move beyond these international comparisons to consider the relationship between activities occurring within the United States and those abroad. While most policy analysis assumes that outsourcing comes at the expense of U.S. activity, Cockburn and Slaughter conclude the opposite: by and large, the global spread of biopharmaceutical R&D is a complement rather than a substitute for home-country activities. Consequently, the emergence of an increasing number of locations supporting biopharmaceutical R&D need not imply a significant reduction in U.S. R&D employment or expenditures.

The final chapter for this year's volume considers the impact of university patenting and licensing activities on university research. In "University Licensing: Harnessing or Tarnishing Research?" Jerry Thursby and Marie Thursby consider whether university patent licensing has moved university researchers away from a basic research orientation. While there has been considerable policy concern that the prospects of commercial returns on the part of university researchers have eroded incentives for pure scientific research, Thursby and Thursby synthesize an emerging body of theoretical and empirical evidence suggesting that such concerns may be overblown. Notably, when investments in research can lead to both publication *and* patenting, the incentives offered through licensing opportunities reinforce incentives to undertake basic research. The chapter illustrates the potential for complementarity across a wide range of specifications for the production of university research and licenses; it is only when investments in applied research that can lead to licensing cannot be published and are

substitutes for publishable basic research that enhanced licensing incentives potentially reduce basic research output. Thursby and Thursby highlight new empirical evidence and case studies suggesting that the most common pattern associated with university patenting is a “flurry” of activity in which a research team makes a significant discovery that yields a burst of papers as well as patents in a particular research area. While the nature of university research raises questions about the ability to nurture and invest in “blue sky” investigations, Thursby and Thursby suggest that, at least so far, the impact of patenting and licensing opportunities on faculty incentives has likely been salutary.

Together, these essays continue to highlight the important of economic theory and empirical analysis in innovation policy analysis. While the issues involved are undoubtedly difficult, the chapters in this year’s volume suggest that contemporary research in economics informs the evaluation of current and prospective innovation policy alternatives.

Josh Lerner and Scott Stern