

Sociology, Science Policy, and Context

Jason Owen-Smith
University of Michigan
jdos@umich.edu

Two theoretical questions that confront sociology also raise important practical issues for science policy. The abstract issues center on (1) the means by which action and constraint articulate in practice and (2) the mechanisms that allow social arrangements to simultaneously reproduce themselves and innovate.

Why do some actors seem able to sculpt their worlds into favorable configurations while others labor under constraints they cannot control? Views that emphasize agency of various sorts are evidenced in studies of ‘genius’ and in Latour’s now famous phrase ‘give me a laboratory and I will raise the world.’ Approaches that highlight constraint, in the form, for instance, of stratification orders that systematically limit the life chances of some, advocate a worldview that more closely approximates Marx’s dictum: ‘men make history but do so under conditions not of their own choosing.’ Understanding the interplay of agency and constraint in the context of scientific and technological innovation can offer science policy new insights into how to systematically improve access and facilitate discovery.¹

How can conservative social arrangements generate novelty? Social systems are conservative when they reproduce themselves over time with little change. Conservative arrangements that also produce considerable novelty are theoretically interesting. The institutional characteristics of American academic science offer a case in point. There is almost no social institution more conservative than the combination of a single blind peer review process with an up or out tenure vote. Yet American science and engineering has been phenomenally innovative in the years since World War II. That success may depend on a mix of responsiveness to and organized skepticism about radical discoveries.

The benefits of bringing sociology and science policy into closer contact, I suspect, will be dramatically increased by finding questions and settings that address practical issues as well as more abstract concerns. Both of these needs can be served by close attention to the types and effects of contexts that constrain and enable scientific work. Consider three.

Organizations translate features of macro-social orders into greater or lesser degrees of constraint on the daily actions of individuals. People at work in organizations differ in their abilities to navigate their environments. Social structures (such as networks and stratification orders) emerge from patterned behavior to shape future possibilities for action. Emergent structures direct flows of information and resources to differently positioned actors at different rates.

Institutions are the rules, regulations, and conventions that guide action in a recognizable area of social life. Those rules are simultaneously constraining and generative. They often describe what is forbidden but not all that might be permitted. When rules and regulations mandate certain

¹ While I dispense with citations and bibliography in this informal essay, most of the ideas I present here draw upon the work of others. Should anyone care to ask, I will enthusiastically detail my intellectual debts.

actions they are often ambiguous about implementation. As a result, even rules intended to set limits on behavior may (at least for a brief time) create broad possibilities for action.

How do networks, organizations, and institutions interact to create contexts that might be of interest to science policy? I sketch an example drawn from my work with Woody Powell and Kjersten Bunker Whittington before turning to a brief discussion of the ways this view of context might contribute to policy debates. I hope to raise more questions than I answer.

Innovative regions in biotechnology

Human therapeutic and diagnostic biotechnology translates often basic life science discoveries into commercially and clinically valuable products. In the U.S. and around the world, successful biotechnology companies are clustered in geographic regions such as Cambridge and Boston, MA or the San Francisco Bay Area. Those regions are home to large numbers of firms in the industry, diverse public science organizations (universities, hospitals, research institutes) and sources of private venture financing.

In addition to scale (many organizations in the same industry) and diversity (many types of organizations working to different ends under divergent institutional and resource constraints), successful regions are characterized by dense networks that link organizations and scientists to each other. Networks are the wellsprings of innovation in biotechnology. Much of the work that goes into discovering and developing new drugs occurs outside the boundaries of particular firms in collaborations with titular competitors and public organizations.

Location in a regional cluster characterized by organizational scale, institutional diversity, and dense network structures benefits firms in numerous ways. Biotech firms in such regions patent more than their competitors outside of regions. Fully 60% of patents owned by U.S. biotechnology firms are assigned to companies located in just three regions. Firms located in the country's most densely populated and networked regions also account for the lion's share of the industry's best-selling products. Six biotech companies produced the industry's ten best selling drugs in 2001. Five of those firms are located in Boston, the San Francisco Bay Area, or San Diego. Dense, diverse, connected regions provide a beneficial context for biotechnology.

Understanding how high technology regions germinate, grow, and sustain themselves could contribute to economic development efforts around the country. My own state, Michigan, is home to an ambitious attempt to create just such a region with the aid of large influxes of tobacco settlement money. Michigan's efforts are far from unique. I suspect that many governors covet the political and economic benefits that would accompany a 'new' Silicon Valley in their state. Yet the components that are necessary for regional economic development are far from clear and, to date, no one has determined if there are sufficient conditions for the birth of high-tech clusters.

I can't answer the sufficiency question, but I do suggest that the benefits of regional agglomeration can be explained by the peculiar contexts overlapping networks, organizations, and institutions create. This view offers interesting insights to sociological theory and science policy alike.

Consider organizations. It may only be a slight exaggeration to say that all cutting edge life science is anchored in formal organizations such as firms, universities, government agencies, research institutes and hospitals. Such organizations share a few common features. They coordinate complex work, channel necessary inputs (human capital, information, raw materials of various sorts), and produce outputs (patents, publications, new drugs, skilled scientists, cured patients etc.). A dense cluster of organizations undertaking the same types of work will create (or attract) concentrations of necessary inputs. Labor markets for life scientists in Boston, the Bay Area or San Diego, for instance, are deeper and more fluid than anywhere else in the nation. Venture capital, too, concentrates in these regions. Such concentrations, which economic geographers sometimes call scale externalities, limit the amount organizations must search for, in this example, talent or capital, thus allowing them to economize on the costs of some inputs without necessarily sacrificing quality.

But the organizations undertaking scientific work in biotechnology regions also differ in consequential ways. Science-based firms and public research organizations do similar kinds of work under disparate institutional conditions. Take research universities. Such campuses are distinguished by influxes of federal (and state) funding, by a mandate to discover and disseminate fundamental knowledge, train students and serve the public good. While universities vary in their reliance on public funds and their commitments to research, teaching, and service, these institutional characteristics add important dimensions to high technology regions. Universities broadcast knowledge into a region (and beyond), but they also add stability.

Large, research intensive universities rarely go out of business. Public funding insures some degree of insulation from the vagaries of the market. Small, science-focused biotechnology firms are very different creatures. They are subject to dramatic market pressures and often die. While many receive public support (in the form of, for instance, SBIR grants or subsidized clinical trials for orphan drugs), most depend on private equity or public capital markets. While they contribute little stability to a region, their relative independence from the time tables of granting agencies and the conservative features of theory-driven academic science makes them highly responsive to discoveries on a fast-moving research frontier.

In some cases the institutional arrangements that characterize public and private research efforts can be highly complementary, matching stability with responsiveness and deliberate, longer term research endeavors with more flexible, discovery oriented science. When that happens, institutionally diverse regions will be more stable and productive than those that are densely populated by as single type of organization.

Organizational scale and institutional diversity seem to me to be likely candidates for the list of conditions that are necessary for the development and maintenance of successful high technology regions. Research in this area though, has demonstrated time and time again that neither scale nor diversity are sufficient. The failure of areas like Chicago, Philadelphia and the Tri-State region to develop biotechnology communities akin to those I have been describing offers a case in point. Simply adding institutions and organizations and stirring is unlikely to be enough.

Which brings me to the third dimension of context, networks. Let me be clear. I do not contend that networks are a sufficient condition for the development and maintenance of high tech

regions, but I do believe they are necessary. ‘Formal,’ contractual networks that connect organizations and more ‘informal’ ties based in the mobility of scientists and engineers from organization to organization within a region forge dense, institutionally diverse clusters into self-aware communities.

Networks make regions into communities in several ways. First, formal and informal ties facilitate the flow of resources from position to position within a regionally bounded social structure. When multiplex networks connect firms with public science organizations they facilitate thick, rich flows of information, allowing cutting edge basic science and the tacit knowledge necessary to its implementation to diffuse into the region. When ties connect titular competitors they introduce a degree of forbearance into hotly contested winner-take-most innovation races. Co-located firms that collaborate on one therapeutic candidate while competing on another indication and scientists whose social connections cross firm boundaries compete. Ferociously. Victors, though, will be loath to destroy the vanquished if some portion of their research effort is mutually dependent. When information and resource flows as well as mutual awareness and restraint emerge from cohesive networks, self-aware communities result.

Where scale helps to create accessible local pools of important resources and diversity contributes to the stability and innovative potential of a region, cohesive networks are the skeleton that defines a region’s shape and character. The benefits of location in a regional cluster defined by scale, diversity and cohesion are benefits of a particular social context. Understanding that context is interesting to me as a sociologist because it speaks to the two theoretical questions that opened this essay. Successful regions are conservative in the sense that they stably reproduce themselves over time (even as firms in the region die). They are also hugely innovative in organizational and technological terms.

To a certain extent, regional communities raise all boats. Location in a region confers benefits relative to those outside it. Outcomes vary dramatically within regions, however. Some organizations and individuals seem much better positioned to benefit from their membership in a regional community. For others, the networks that create community are ties that bind. As a result, examining the creation and dynamics of regional clusters and particularly the interplay of organizations, institutions, and networks seems to me to have real theoretical potential.

Such an examination, though, could also have immediate practical payoffs by providing systematic advice to policy-makers intent on creating new regions. Broader, more interesting, questions relevant to policy could also be addressed. If we learn how economic competitors develop and maintain practices that also allow them to be scientific collaborators, we will have taken an important step toward understanding the organizational capacities necessary to the sorts of mega-projects that may become commonplace in the age of genomics. If we determine how universities and firms can collaborate without impeding the ability of firms to compete in the market or forcing universities to, we will have taken a step toward unraveling the changes that increased research commercialization is wreaking on academe. Answers to both of those questions, could provide new insights into the ways that federal (and other public) investments in fundamental science can percolate out into the market without placing onerous requirements on the investigators and organizations that perform basic research.

The list could go on, but my point (I hope) is simple. Context matters, but it's complicated. Unpacking the theoretical and practical nuances of context requires rich, strategic research sites. I believe that the concerns of science policy point to numerous possible locations for that research. I also hold that the theoretical concerns of sociologists can lead them to raise and answer questions about those settings in a fashion that has much to offer policy-makers.