Number 13-1

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# *The Federal Role in Technology Cluster Formation*

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Technology clusters are regional concentrations of private and public R&D and production capabilities, including pools of skilled labor, research facilities, and partnership mechanisms for research and production scale-up. To understand the role of regional clusters as a key element of technology-based economic growth policy, three questions must be answered:

- What drives cluster formation?
- What are the economic impacts of clusters?
- What policies can be implemented at the federal level to promote and leverage cluster formation and growth?

Both theory and empirical evidence indicate that several forces drive cluster formation. Local costs and localized endowments of specific economic assets play a key role in cluster formation and development.[1] In addition to these initial conditions, industry participants co-locate to gain access to specialized supply networks, concentrations of specialized and skilled labor, and, perhaps most important from a federal perspective, absorb knowledge spillovers.[2]

Moreover, substantial evidence exists that indicates limits to the geographic spread of such spillovers. This evidence focuses on the key distinction between information that is easily written down (i.e., codified) and vital new *technical knowledge*

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that is the result of breakthrough research. The latter is "tacit" in nature, which means such knowledge is in the heads of scientists that performed the breakthrough research. Tacit knowledge is therefore costly to transfer because it requires person-to-person contact. This fact imposes a geographic limit to the extent of knowledge spillovers and creates an incentive to invest in research clusters. Within these clusters the cost of transferring knowledge from one researcher to another or from laboratory to commercialization will be lower. Research even indicates that distance matters for the transfer of codified information embodied in, for example, patents,[3,4] although the role of distance in the diffusion of codified information may be diminishing.[5] Finally, novel clusters develop in regions that are geographically distinct centers of breakthrough patenting and subsequent innovations in a specific technological area.[6]

Once formed, clusters have a strong positive impact on regional economic and business performance. Clusters increase new business formation and employment and increase the chances that start-up businesses will survive.[7] Further, regions with strong clusters experience faster wage growth and higher levels of patenting.[8] Diversity within clusters creates broader opportunities for multiple categories of talented workers.[9] These lower entry barriers provide incentives for talent to cluster, which in turn drives future location choice for high-tech industry needing diversified talent pools. The result for the local economy is a higher average income level.

Just as pools of highly skilled labor creates demand for multiple categories of talented workers, they also lower the cost of applying new knowledge for the development and commercialization of new products. Regions that attract "star scientists" experience more business start-ups than in traditional industry structures. The firms that are affiliated with "star scientists" have a positive impact on other firms in regions where they are located and create higher-value patents, produce more innovative products, create more jobs,[10] and undergo more frequent and successful initial public stock offerings (IPOs).[11]

While there is substantial evidence that clusters have a strong and positive impact on innovation and economic performance, there are a number of significant concerns about current cluster development strategies, particularly when viewed from a federal perspective. Perhaps most significant is the policy objective to create new clusters through direct development

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assistance. Evidence indicates that "most large-scale place-oriented policies have had little discernible impact."[12] This can be attributed to the fact that there are significant barriers to overcome when attempting to create a new cluster. One policy implication is that important federal investments in traditional infrastructure such as transportation should be undertaken for the inherent value of the infrastructure rather than as a specific instrument for cluster formation.

However, this does not mean that there is no role for the federal government in cluster formation. As discussed above, there is extensive evidence that demonstrates the local nature of knowledge spillovers and the role of knowledge formation and human capital development in driving cluster formation. Policies that implement the widely recognized federal role in supporting research, knowledge creation, and human capital development can be an essential instrument for cluster formation by enhancing innovation and economic performance. When these activities are clearly tied to industry's research needs, the potential for benefit is substantial. Public-private partnerships in general and government/industry/university cooperation in particular have demonstrated the capability of delivering these positive economic impacts.[13]

Even so, evidence indicates that there are a number of challenges that these partnerships must confront in order to deliver upon their promise. Key challenges include research project selection, research portfolio management, and efficient transfer of scientific and technical knowledge the scientific research enterprise to industry. Public-private partnerships must overcome the disconnect between academic scientists who are the recipients of the majority of Federal R&D funding and industry that creates novel products and services based on scientific advances and then commercializes them. Partnerships must also integrate traditionally separate scientific disciplines to address the challenges in creating modern complex technology systems such as nanomanufacturing, biotechnology, or other cross-disciplinary technologies.

History has shown that research agendas and project selection have been frequent sources of tension in university/industry consortia;[14] specifically, the negotiation of intellectual property rights has been a costly and significant barrier to cooperation.[15] Within these partnerships there have

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remained significant costs and barriers to the transfer of academic research results to the industrial environment.[16] Beyond the funding of research, a key federal role in supporting public-private consortia will be to act as an honest broker to ensure the integrity of the research agenda.

Research consortia—particularly when guided by agreed upon technology roadmaps—have been an effective means to channel industry resources into universities without changing the fundamental quality of university research. These technology roadmaps serve as a highly valuable tools to leverage investments, yet leave the "maximum freedom and intellectual initiative with individual academic researchers." [17] Those partnerships that also leverage location scale and scope economies and facilitate the transfer of tacit knowledge by bringing together government, academic, and industry scientists to work together in a common research center will increase the efficiency of subsequent technology transfer. In summary, federally-sponsored and industry-led consortia act as vital "buffer institutions" between academic and industrial research, and can overcome incompatibilities between industry and academia and thereby leverage the capabilities of each.

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**Endnotes**

[1] Edward L. Glaeser & William R. Kerr (2009). "Local Industrial Conditions and Entrepreneurship: How Much of the Spatial Distribution Can We Explain?," Journal of Economics & Management Strategy, Blackwell Publishing, vol. 18(3), pages 623-663.

[2] Glenn Ellison, Edward L. Glaeser & William R. Kerr, 2010. "What Causes Industry Agglomeration? Evidence from Coagglomeration Patterns," American Economic Review, American Economic Association, vol. 100(3), pages 1195-1213.

[3] Jaffe, Adam, Manuel Trajtenberg and Rebecca Henderson (1993), "Geographic localization of knowledge spillovers as evidenced by patent citations", Quarterly Journal of Economics 108 (3), pp 577-598

[4] Griffith, Rachel, Harrison, Rupert and John Van Reenen (2006) "How special is the special relationship: Using the impact of US R&D spillovers on British firms as a test of technology sourcing" American Economic Review (2006) 96(5) 1859-1875.

[5] Griffith, Rachel, Sokbae Lee and John Van Reenen (2007) "Is distance dying at last? Falling home bias in fixed effects models of patent citations" CEPR Discussion Paper 6435.

[6] William R. Kerr (2010), "Breakthrough Inventions and Migrating Clusters of Innovation," Journal of Urban Economics, Elsevier, vol. 67(1), pages 46-60.

[7] Mercedes Delgado, Michael E. Porter, and Scott Stern (2010). "Clusters and Entrepreneurship," Journal of Economic Geography, 10(4): 495-518.

[8] Mercedes Delgado, Michael E. Porter, and Scott Stern (2012). "Clusters, Convergence, and Economic Performance," NBER Working Paper No. 18250.

[9] Richard Florida, "The Economic Geography of Talent," *Annals of the American Association of Geographers,* 92.4(2002): 743-755

[10] Zucker, Lynne G., Michael R. Darby, and Jeff S. Armstrong, 2001, Commercializing Knowledge: University Science, Knowledge Capture, and Firm Performance in Biotechnology," NBER Working Paper No. 8499

[11] Michael R. Darby, Lynne G. Zucker , 2002, "Going Public When You Can in Biotechnology," NBER Working Paper No. 8954

[12] Edward L. Glaeser, Joshua D. Gottlieb (2008). "The Economics of Place-Making Policies," NBER Working Paper No. 14373.

[13] For example, federal Labs through CRADAs increase industry knowledge production and research (Adams et al (2003), Industry/Government research consortia increase profitability and reduce duplicative R&D (Irwin and Klennow (1996), Link et al (1996), and industry/university Cooperative Research Centers increase industry patenting (Adams 2001).

[14] See for example Feller, et al (2002), Grindley, et al (1994).

[15] Hall et al. (2001), NSF (2006)

[16] Grindley, et al (1994), Adams (2001)

[17] Harvey Brooks and Lucien P. Randazzese (1998). University-Industry Realtions: The Next Four Years and Beyond," in Lewis Branscomb and James Keller (1998). Investing in Innovation. The MIT Press, Cambridge, MA.