Research and Development Laboratories in the Production Process

A large body of evidence points to relationships between investment in research and development (R&D), productivity, and economic growth. This study aims to advance the understanding of precisely how R&D investments contribute to the productivity of firms--both the firms that undertake the investments directly as well as neighboring firms that benefit from spillover effects.

Combining a unique data set of geocoded R&D labs with firm-level data from Compustat and restricted-use Census data at the firm- and establishment-level, this project will first answer a series of descriptive questions about how R&D labs in the U.S. are embedded in the production structure of firms. Are locations devoted to innovation dispersed or concentrated relative to the rest of firms' establishments? Does this vary by industry or domestic ownership status? In which industries do firms tend to locate labs near their own headquarters versus their production facilities or other firms' labs?

Buzard et al. (2017a)[1] establishes that private R&D labs are agglomerated to a very significant extent relative to economic activity as a whole. Buzard et al. (2017b)[2] further shows that there is significant evidence of knowledge spillovers within the agglomerations of R&D activity.[3]

In this project, we will use this data on R&D agglomerations and the strength of knowledge spillovers within them from these earlier projects to both understand more deeply how firms are organized in relationship to innovative activities *and* how this impacts firm productivity.

That is, we would like to know not only the pattern of firm and lab co-location, but whether and how it matters for firm productivity. Thus we will focus on firm-level analysis that uses the characteristics of, and relationships between, different types of establishments both within and between firms. Using firm-level panel regressions, this project will study the impact on firm productivity of R&D labs, the characteristics of those labs and the agglomerations in which the labs are located, and the position of labs within the production structure of the firm.

The results of this project will be broadly applicable because of the breadth of the sample we will examine. Our lab data covers the top 1000 publicly traded firms in the U.S. in terms of expenditure on research and development--accounting for over 95% of R&D expenditure in Compustat. It is based primarily on the 1989 and 1998 vintages of the *Directory of American Research and Technology*,[4] which includes virtually all nongovernment facilities engaged in any commercially applicable basic and applied research.

Each lab in our data set is associated with its Compustat parent firm, information on its street address, employment, and a text description of its research specialization(s) to which we have assigned the corresponding four-digit SIC code(s). Using the address information for each private R&D establishment, we have geocoded the locations of virtually all the labs in the dataset--more than 3,000 for each vintage. The vintages are connected by the Compustat identifier to form an unbalanced panel, with the interesting feature that some labs change ownership between vintages of the data.

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[1] Buzard, K., Carlino, G., Carr, J., Hunt, B. and Smith, T., (2017a). The Agglomeration of American R&D Labs, *Journal of Urban Economics*, 101, 14-26.

[2] Buzard, K., Carlino, G., Carr, J., Hunt, B. and Smith, T., (2017b). Localized Knowledge Spillovers: Evidence from the Agglomeration of American R&D Labs and Patent Data, *Federal Reserve Bank of Philadelphia Research Department Working Paper 17-32*.

[3] Note that it is not possible to rule out other forces for agglomeration such as labor market pooling; however, the fact that these agglomerations of labs exhibit localization of patent citations is a strong indication that knowledge spillovers are indeed taking place.

[4] *Directory of American Research and Technology*, 23rd ed. New York: R.R. Bowker (1999) / 14th ed. (1990).

Because we have connected the R&D labs to their parent company financial data through Compustat and have also matched them to their patenting output in the NBER patent file, we can use the Compustat-SSEL bridge as well as the bridge from the NBER patent file to the SSEL to connect our data to the detailed micro data in the Economic Census.[5]

After linking to the Census data, we will be able to determine whether each of the R&D labs is a stand-alone facility or part of a larger operation. We hope to be able to verify and potentially complete the employment data we have from our Directories once we have access to the Census files; this is one of the avenues for determining whether a lab is a stand-alone entity.

The next step is to place these laboratories in the context of the production structure of their parent companies to understand how innovation that takes place in labs contributes to the productivity of firms. Although most of the data we need is available at the establishment level, individual establishments are not likely the profit-maximizing decision-makers with regard to the research and development investments of the firm. Even if they were, we would have a problem of identifying which labs correspond to which production facilities: although there are a significant number of single-lab firms in the data, an upper tail of large firms has more than a dozen R&D laboratories each.

Thus we take a generally agnostic approach at the firm level. R&D happening in any of a firm's labs should have an equal chance to impact productivity, all else equal. But all is not equal. A lab may focus on a narrow range of research questions, or it may be quite diversified. It might be located in an R&D agglomeration; the agglomeration may be particularly large or small, particularly homogeneous in terms of research focus or diversified, or it may evidence particularly strong knowledge spillovers. It may be located near the firm's headquarters, near its marketing offices, near production facilities or none of the above.

There is no overarching theory that says any one of these organizational or locational patterns should necessarily be uniformly more conducive to productivity, at least not across all industries. The one exception is that firms should benefit in tangible ways from positive externalities and thus be more productive in areas where knowledge spillovers are stronger. We therefore predict a positive impact on productivity of having a lab in an R&D agglomeration with strong localization of patent citations as identified in Buzard et al. (2017b).

Although our lab data is restricted to publicly traded firms, by covering the top thousand R&D performers and accounting for 95% of R&D expenditures by public firms, the results of this project will be broadly applicable. In terms of research areas identified by the labs themselves, the labs in our dataset represent 440 three-digit SIC codes, with 160 three-digit codes having at least ten labs. This combination of industrial detail and breadth of coverage will allow us to draw conclusions that inform a wide swath of both public and private decision-making.

This project is particularly exciting because this combination of data can be linked together to form a much more complete picture of national innovation ecosystems and allows a detailed examination of the mechanisms underlying innovation's contribution to productivity. We have put forward a set of questions we would very much like to answer with this data, but perhaps its largest contribution will be showing us new sets of questions that we do not yet know to ask.

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[5] The SSEL is the Standard Statistical Establishment List and is also known as the Business Register. It is a comprehensive database of U.S. business establishments and companies that records the name, address, legal form of organization, essential economic data and unique Census-assigned identification numbers. It is the central database from which we will link to other Census data.

Budget Estimate

Research assistance: there is work to be done both inside the Census RDC and outside the RDC. We anticipate final approval from the Census and IRS by early fall (Census approval for the project was given in mid-May 2018). The only costs are research assistance and travel to the Research Data Center in Ithaca, NY (Cornell University).

One semester graduate student stipend and fringe: $11,543 (Syracuse University 2018/2019 rate)

Mileage reimbursement: $1030 (18 trips of 105 per round trip, 54.5 center per mile)

Hotel in Ithaca: $1980 (18 hotel nights at Best Western University Inn in Ithaca at $110 per night)

Hourly research assistance over holiday: $5000 (200 hours at $25/hour)

Total: $19553

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ACADEMIC POSITIONS:

Associate Professor of Economics (with Tenure), Syracuse University, 2018-Present
Assistant Professor of Economics, Syracuse University, Syracuse, New York, 2012-2018
Postdoctoral Associate, Wallis Institute of Political Economy, University of Rochester, Rochester, NY, January-June 2016

EDUCATION:

Ph.D., Economics, University of California, San Diego, June 2012
Dissertation: Essays on International Trade Agreements and Contracts under Renegotiation
Dissertation Committee: James Rauch (Co-Chair), Joel Watson (Co-Chair), Lawrence Broz, Peter Cowhey, Mark Muendler
Masters of European Economic Studies, College of Europe, Bruges, Belgium, 2002
B. A., International Area Studies, Drexel University, *summa cum laude*, 2001

OTHER PROFESSIONAL ACTIVITIES:

Visiting Scholar, Federal Reserve Bank of Philadelphia, Philadelphia, PA, 2012-2018
Instructor, University of California San Diego, San Diego, CA, 2011
Teaching Assistant, University of California San Diego, San Diego, CA, 2007-2012
Economic Analyst**,** Research Dept., Federal Reserve Bank of Philadelphia, Philadelphia, PA, 2002-2007
Business Attraction Specialist, Mayor's Business Action Team, Philadelphia Department of Commerce, Philadelphia, PA, 2000
Intern, European Parliament, Brussels, Belgium, 1999

RESEARCH INTERESTS:

Contract Theory, International Trade, Political Economy, Urban/Regional

CITIZENSHIP: United States of America

JOURNAL PUBLICATIONS:

Self-enforcing Trade Agreements and Lobbying, *Journal of International Economics*, 108, 226-242 (2017). Available at https://authors.elsevier.com/a/1VR9n5330JQa4

The Agglomeration of American R&D Labs (with Gerald Carlino, Robert Hunt, Jake Carr and Tony Smith), *Journal of Urban Economics*, 101, 14-26 (2017). Available at https://authors.elsevier.com/a/1VAPvLPdAby7Z

Unrecognized States: A Theory of Self-Determination and Foreign Influence (with Ben Horne and Benjamin A.T. Graham), *Journal of Law, Economics and Organization*, 33(3), 578-611 (2017).

- See a related column in the Washington Post.

Trade Agreements in the Shadow of Lobbying, *Review of International Economics*, 25(1), 21-43 (2017).

Contract, Renegotiation, and Hold Up: Results on the Technology of Trade and Investment (with Joel Watson), *Theoretical Economics*, 7(2), 283–322, May 2012.

OTHER PUBLICATIONS:

Unrecognized States: Theory and Cases (with Benjamin A.T. Graham), chapter in "Transforming Intractable Conflicts: Restructuring and Reframing," eds. Catherine Gerard, Galia Golan, Louis Kriesberg and Miriam Elmam (Forthcoming).

The Geography of Research and Development Activity in the U. S., (with Gerald A. Carlino), In *Handbook of Industry Studies and Economic Geography*, F. Giarratani, G. Hewings, and P. McCann, eds. Cheltenham: Edward Elgar Publishing, 2013.

The Geography of Research and Development Activity in the U.S., (with Gerald A. Carlino), *Business Review*, Third Quarter 2008, Federal Reserve Bank of Philadelphia.

WORKING PAPERS:

Localized Knowledge Spillovers: Evidence from the Agglomeration of American R&D Labs and Patent Data (with Gerald Carlino, Robert Hunt, Jake Carr and Tony Smith), Revision requested from *Regional Science and Urban Economics*, November 2017.

Temporary Trade Barriers: When Will They End? November 2017

Inefficient Concessions and Mediation (with Benjamin C. Horne), at *European Journal of Political Economy*, September 2017.

Endogenous Politics and the Design of Trade Institutions, August 2017.

Lobbying and Legislative Uncertainty (with Sebastian Saiegh), May 2016.

WORK IN PROGRESS:

Research and Development Laboratories in the Production Process (with Gerald A. Carlino, Robert M. Hunt, Jake K. Carr, Tony E. Smith), May 2018

Explaining Gradualism in Trade Agreements: A Political Economy Approach, May 2018

Informal norms and the optimal design of a formal dispute settlement mechanism (with Mostafa Beshkar), August 2017

CONFERENCE AND SEMINAR PRESENTATIONS:

2018 University of Nebraska-Lincoln, Midwest International Trade Meetings (Philadelphia)

2017	American Economic Association Meetings (Chicago), University of Iowa (Ames), Workshop on the Economics of International Trade Agreements (Villars-sur-Ollon, Switzerland); University of Nottingham (Nottingham, UK), 4th InsTED Workshop on Advances in the Theory and Empirics of Institutions, Trade and Economic Development (Sao Paolo, Brazil), CESifo Venice Summer Institute 2017: Dynamics of Conflict - Results from Theory and Experiments (Venice, Italy), Great Lakes Political Economy Theory (London, Ontario), Southern Economic Association Meetings (Tampa, FL)
2016	Political Economy of International Organizations (University of Utah), Villanova University, University of Rochester Trade Workshop, Spring Midwest Economic Theory Meetings (University of Rochester), Wallis Institute Workshop (University of Rochester), 3rd Annual InsTED Workshop (Indiana University), SITE International Trade Policy (Stanford University), Transforming Intractable Conflicts: Restructuring and Reframing (Syracuse University), Midwest Economic Theory Conference (Purdue)
2015	Wesleyan University (Middletown, CT), Spring Midwest Trade Meetings and Spring Midwest Economic Theory Meetings (Ohio State University), Canadian Economic Association Meetings (Toronto, ON), Econometric Society World Congress (Montreal, QC), Fall Midwest Trade Meetings (Pennsylvania State University)
2014	Political Economy of International Organizations (Princeton, NJ), Midwest International Economics Conference (Indianapolis), InsTED Network 2nd Annual Workshop (Eugene, OR), European Trade Study Group (Munich, Planned) McGill University, Ryerson University
2013	European Trade Study Group (University of Birmingham, England); International Society for New Institutional Economics Annual Conference (Florence, Italy); Econometric Society North American Summer Meeting (University of Southern California); Midwest Economic Theory Meetings (Michigan State University); Political Economy of International Organizations (Mannheim/Heidelberg)
2012	University of Massachusetts Amherst; Florida International University; Syracuse University; Georgetown University; State University of New York, Oswego; Brandeis University; Bowling Green State University; Kenyon College; Swarthmore College
2010	Southwest Economic Theory Conference (Lake Arrowhead, CA)
2008	International Conference on Game Theory (Stony Brook, NY)

Conference participation:

2017	Brussels Political Economy Conference, Brussels, Belgium; Wallis Institute of Political Economy Annual Conference, Rochester, NY
2016	NBER Program on Productivity, Innovation and Entrepreneurship, Cambridge, MA; Carnegie-Rochester-NYU Conference, Rochester, NY; Wallis Institute of Political Economy Annual Conference, Rochester, NY
2015	Wallis Institute of Political Economy Annual Conference, Rochester, NY
2014	Dartmouth/SNU Workshop on International Trade Policy and Institutions, Stanford Institute for Theoretical Economics, Session 5: Dynamics of Collective Decision Making
2013	Wallis Institute of Political Economy Annual Conference, Rochester, NY
2012	Southwest Economic Theory Conference (San Diego, CA)
2005, 2010	Allied Social Science Associations Annual Meeting (Philadelphia, PA)
2009-2010	Stanford Institute for Theoretical Economics: The Economic Analysis of Trade Agreements, Stanford University
2008-2009	20th Jerusalem Summer School in Economic Theory: The Economics of Contracts, The Institute for Advanced Studies at The Hebrew University
2003-2005	North American Meetings of the Regional Science Association

GRANTS, HONORS, SCHOLARSHIPS, AND FELLOWSHIPS:

2012-18	Maxwell School of Citizenship and Public Affairs Appleby-Mosher Fund Grant
2013-15, 17	Maxwell Summer Project Assistantship Program
2011	UCSD Clive Granger Research Fellowship
2011	UCSD Summer Graduate Teaching Fellowship
2010	UCSD Economics C. Phil Research Fellowship
2010	UCSD Economics Walter P. Heller Award: Honorable Mention for Third Year Paper
2010	UCSD Economics Teaching Assistance Excellence Award
2009	UCSD Economics Graduate Student Grant
2008-10	UCSD Summer Graduate Research Fellowship
2001-02	Fulbright Fellowship for Study Abroad in Belgium

PROFESSIONAL ACTIVITIES:

Journal Referee: American Economic Journal: Microeconomics, American Economic Review, American Law and Economics Review, B.E. Journal of Theoretical Economics, Canadian Journal of Economics, Economics Bulletin, European Economic Review, Games and Economic Behavior, International Economic Review, Journal of Development Economics, Journal of Economic Behavior and Organization, Journal of Institutional Economics, Journal of Institutional and Theoretical Economics, Journal of International Economics, Journal of Law, Economics and Organization, Journal of Public Economics, Review of International Economics

COURSES TAUGHT:

Graduate: Survey of Microeconomic Theory
Undergraduate: The World Economy, Game Theory

ACADEMIC SERVICE:

2016-2018	Member, Economics Department External Search Committee
2015-2017	Member, Scientific Board, InsTED Network
2015	Co-Organizer, Political Economy Reading Group
2014-2015	Member, Syracuse University Recruitment, Support, Retention, and Success Workgroup
2013-2014	Member, Applied Microeconomic Theory Search Committee
2013-2015	Member, Graduate Admissions Committee
2012-2015	Co-Coordinator, Economics Department Applied Microeconomics Seminar
2012-2013	Member, Macroeconomics Search Committee
2012-2013	Advisor for Undergraduate Economics Majors
2012-2013	Member, Scholarship and Fellowship Preparation Committee, Renee Crown University Honors Program
2009-2011	Graduate Program Committee, UCSD Department of Economics
2007-2009	Graduate Teaching Prize Committee, UCSD Department of Economics

PAST AND PRESENT MEMBERSHIPS OF PROFESSIONAL ASSOCIATIONS:

American Economic Association, Canadian Economics Association / Association canadienne d'économique, Econometric Society, InsTED Network, International Society for New Institutional Economics, Regional Science Association