Engines of Productivity Growth:
Railroads, Reallocation, and the Rise of American Manufacturing

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Technological innovation is a fundamental driver of economic growth, and it is natural to consider the degree to which technological innovation responds to greater market integration. Beyond increasing incentives for technological innovation, greater market integration may improve economic efficiency by reallocating resources to more productive uses.

We are exploring these issues by drawing lessons from manufacturing productivity growth in the United States, from 1850 to 1900, as the American economy was rising to global prominence and increasingly pushing the world technological frontier. We begin by decomposing aggregate productivity growth into gains in technical efficiency (counties becoming more productive) and gains in reallocative efficiency (more resources becoming allocated to counties that are more productive on the margin).

We then turn to analyzing contributions to productivity growth from the expansion of the railroad network over this era. Drawing on previous research analyzing changes in market access and agricultural growth (Donaldson and Hornbeck, QJE 2016), we calculate variation in counties' access to markets for manufactured goods. Preliminary estimates using county-by-industry data indicate that increased market access generates substantial increases in county manufacturing productivity.

These preliminary empirical specifications regress a particular county outcome on: county market access, county fixed effects, state-by-year fixed effects, and year-interacted cubic polynomials in county latitude and longitude. One of the notable benefits from analyzing changes in county market access, rather than directly estimating impacts of local railroad construction, is that much variation in counties' market access is due to more distant changes in the railroad network. As in earlier work (Donaldson and Hornbeck), which estimated the impact of market access on agricultural land value, we can estimate specifications that control for local changes in county railroads. Indeed, our preliminary estimates are robust to controlling flexibly for changes in local railroad density.

We are now seeking to digitize plant-level records from the Census of Manufacturers from 1850, 1860, 1870, and 1880. These records include detailed data on plant inputs and outputs, including both quantities and values of outputs and materials inputs (for 1850, 1860, and 1870). These data will permit further analysis of cross-firm input reallocation, and firm-level innovation responses to increased market integration.

We are requesting research funds ($20,000) to finish collecting and processing scans of Census microfilm and to support initial data entry expenses prior to obtaining larger grant support. This project is a substantial undertaking, and we have already processed considerable microfilm that form a near complete set of what was originally collected by the Census. We are now beginning data entry of firm-level records for a few states (NE, KS, MN, IA, MO) that represent a contiguous geographic area that experienced substantial within-region variation in railroad construction and changes in market access between 1850 and 1880. These states also have relatively few establishments, which limit the preliminary data entry costs. Our baseline county-level estimates are similar when limiting the sample to these five states, though the precision declines and the estimates are only marginally statistically significant.

This initial wave of establishment-level data will allow us to illustrate the feasibility of the data entry project and prepare preliminary analysis using these firm-level data. Given this preliminary work, we would then be in a strong position to obtain further substantial funding from the NSF and other various sources to complete entry of the full Census.

Budget

$5,000	Indexing and cleaning scanned plant-level Census survey images (by part-time undergraduate research assistants)
$15,000	Entry of plant-level records for an initial subset of states and decades (by DDD, a data entry firm)

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Current Positions

2015- Professor of Economics, Booth School of Business, UChicago
2015- Neubauer Family Faculty Fellow, Booth School of Business, UChicago

Previous Positions

Spring 2015 George Tolley Fellow, Becker Friedman Institute, UChicago
Winter 2015 Visiting Associate Professor of Economics, Economics Department, UChicago
Fall 2014 Visiting Associate Professor of Economics, Booth School of Business, UChicago
2013-2015 Dunwalke Associate Professor of American History, Economics Dept., Harvard
2011-2012 Visiting Assistant Professor of Economics, SIEPR, Stanford University
2009-2013 Assistant Professor of Economics, Economics Department, Harvard University

Current Affiliations

2016- Research Associate, Center for History and Economics, Harvard
2015- Research Associate, NBER (Development of the American Economy)
2015- Research Associate, NBER (Environmental and Energy Economics)
2015- Research Associate, NBER (Development)
2011- Faculty Affiliate, BREAD

Previous Affiliations

2014-2015 Faculty Research Fellow, NBER (Environmental and Energy Economics)
2013-2015 Faculty Research Fellow, NBER (Development)
2013-2015 Faculty Associate, Center for History and Economics, Harvard
2010-2015 Faculty Associate, Weatherhead Center for International Affairs, Harvard
2009-2015 Faculty Affiliate, Center for International Development, Harvard
2009-2015 Faculty Fellow, Harvard Environmental Economics Program
2009-2015 Faculty Associate, Harvard University Center for the Environment
2009-2015 Faculty Research Fellow, NBER (Development of the American Economy)

Education

2004-2009 Massachusetts Institute of Technology, Ph.D. in Economics
2002-2003 London School of Economics, General Course in Mathematics
2000-2004 University of Chicago, B.A. in Economics

Work in Progress

"Engines of Productivity Growth: Railroads, Reallocation, and the Rise of American Manufacturing," with Martin Rotemberg.

"Dust Bowl Migrants: Selection and Migration Patterns of Environmental Refugees"

"Who Benefits From Productivity Growth? The Local and Aggregate Impacts of Local TFP Shocks on Wages, Rents, and Inequality," with Enrico Moretti, May 2015.

"(Measured) Profit is Not Welfare: Evidence from an Experiment on Bundling Microcredit and Insurance," with Abhijit Banerjee and Esther Duflo, NBER Working Paper #20477, September 2014.

Published and Forthcoming Papers

"Creative Destruction: Barriers to Urban Growth and the Great Boston Fire of 1872," with Daniel Keniston, *American Economic Review*, forthcoming.

"Economic Dynamics in the Malthusian Era: Evidence from the 1609 Spanish Expulsion of the Moriscos," with Eric Chaney, *Economic Journal*, 126(594)1404-1440, August 2016.

"Railroads and American Economic Growth: A "Market Access" Approach," with Dave Donaldson, *Quarterly Journal of Economics*, 131(2)799-858, May 2016.

"Does Agriculture Generate Local Economic Spillovers? Short-run and Long-run Evidence from the Ogallala Aquifer," with Pinar Keskin, *American Economic Journal: Economic Policy*, 7(2)192-213, May 2015.

"Bundling Health Insurance and Microfinance in India: There Cannot be Adverse Selection if There is No Demand," with Abhijit Banerjee and Esther Duflo, *American Economic Review: Papers and Proceedings*, 104(5)291-297, May 2014.

"When the Levee Breaks: Black Migration and Economic Development in the American South," with Suresh Naidu, *American Economic Review*, 104(3)963-990, March 2014.

"The Historically Evolving Impact of the Ogallala Aquifer: Agricultural Adaptation to Groundwater and Drought," with Pinar Keskin, *American Economic Journal: Applied Economics*, 6(1)190-219, January 2014.

"The Enduring Impact of the American Dust Bowl: Short- and Long-run Adjustments to Environmental Catastrophe," *American Economic Review*, 102(4)1477-1507, June 2012.

"Nature versus Nurture: The Environment's Persistent Influence through the Modernization of American Agriculture," *American Economic Review: Papers and Proceedings*, 102(3)245-249, May 2012.

"Being surveyed can change later behavior and related parameter estimates," with Alix Zwane, Jonathan Zinman, Eric Van Dusen, William Pariente, Clair Null, Edward Miguel, Michael Kremer, Dean Karlan, Xavier Gine, Esther Duflo, Florencia Devoto, Bruno Crepon, and Abhijit Banerjee, *Proceedings of the National Academy of Sciences*, 108(5)1821-1826, February 2011.

"Identifying Agglomeration Spillovers: Evidence from Winners and Losers of Large Plant Openings," with Michael Greenstone and Enrico Moretti, *Journal of Political Economy*, 118(3)536-598, June 2010.

"Barbed Wire: Property Rights and Agricultural Development," *Quarterly Journal of Economics*, 125(2)767-810, May 2010.

Other Publications

"Review of The Republic of Nature: An Environmental History of the United States by Mark Fiege," *Journal of Economic History*, Vol. 72, No. 4, pp. 1120-1121, December 2012.

"Microfinance and Unexpected Consumption Expenditures," IFPRI 2020 Focus 17, Innovations in Insuring the Poor, Brief 12, December 2009.

"Price Discrimination and Smuggling of AIDS Drugs," *Topics in Economic Analysis & Policy*, 5(1) Article 16, September 2005. (Undergraduate Thesis)

Fellowships and Honors

2014-2016	Sloan Research Fellowship
2014	Excellence Award in Global Economic Affairs, Kiel Institute
2013-2016	Furer Fellow, Harvard University
2013	Clark Award, Harvard University
2012	Excellence in Refereeing Award, *American Economic Review*
2012	Excellence in Refereeing Award, *Quarterly Journal of Economics*
2009	Review of Economic Studies Tour

Grants

2016	IGM, Chicago Booth
2013	Lab for Economic Applications and Policy (LEAP), Harvard University
2013	Warburg Fund, Harvard University
2012-2016	NSF (Co-PI: Dave Donaldson)
2012	Warburg Fund, Harvard University
2010-2014	NIH (PI: Esther Duflo)
2010	Harvard University Center for the Environment
2010	Sustainability Science Program, Harvard University
2010	Project on Justice, Welfare, and Economics, Harvard University
2010	Lab for Economic Applications and Policy (LEAP), Harvard University
2010	Taubman Center for State and Local Government, Harvard University
2009	Warburg Fund, Harvard University

Teaching

Fall 2016	Business in Historical Perspective (MBA), University of Chicago
Summer 2016	Business in Historical Perspective (EMBA), University of Chicago
Fall 2015	Business in Historical Perspective (MBA), University of Chicago
Winter 2015	Economic History (Undergraduate), University of Chicago
Fall 2013	Economic History (Undergraduate), Harvard University
Fall 2013	Development (PhD), Harvard University
Fall 2012	Economic History (Undergraduate), Harvard University
Fall 2010	Economic History (Undergraduate), Harvard University
Fall 2010	Development (PhD), Harvard University
Spring 2010	Economic History (PhD), Harvard University
Fall 2009	Development (PhD), Harvard University
Spring 2009	Economic History (PhD), Massachusetts Institute of Technology

Dissertation Committees (and Initial Placement)

2016	James Feigenbaum (BU, Economics Department)
2015	Martin Rotemberg (NYU, Economics Department)
2015	Jamie Lee (Cornerstone Research)
2015	A. Nilesh Fernando (Notre Dame, Economics Department)
2015	Mahnaz Islam (Amazon)
2014	Tyler Goodspeed (Oxford post-doc)
2014	Julia Cage (Sciences Po, Economics Department)
2012	Philip Osafo-Kwaako (Government of Nigeria, Ministry of Finance)

Editorial Positions and Refereeing

2016-	Board of Editors, *Journal of Economic History*
2015-	Board of Editors, *Explorations in Economic History*

Refereeing: *American Economic Journal: Applied Economics; American Economic Journal: Economic Policy; American Economic Journal: Macroeconomics; American Economic Review; Berkeley Electronic Press; Econometrica; Economic Development and Cultural Change; Economic Journal; Economica; Economics of Transition; Explorations in Economic History; Historical Methods; Journal of Comparative Economics; Journal of Development Economics; Journal of Economic History; Journal of Environmental Economics and Management; Journal of the European Economic Association; Journal of Human Resources; Journal of Political Economy; Journal of Public Economics; Journal of Urban Economics; National Science Foundation; Quarterly Journal of Economics; Review of Economics and Statistics; Review of Economic Studies; Review of Environmental Economics and Policy, World Bank Economic Review.*

Conference and Seminar Presentations

2016-2017: ACEGD Delhi, Columbia, FSU, Harvard, Indiana, Sciences Po, Wharton.

2015-2016: ABF, BEA, Chicago Booth, Chicago Harris, NYU, Yale.

2014-2015: Berkeley Haas, Chicago Booth, Chicago Econ, Chicago Harris, Chicago Law, Colorado, EHA, EIEF, Harvard, IGC (Urban), Illinois, MIT, NBER (DAE), Northwestern, PUC-Chile, Wisconsin Ag.

2013-2014: AEA, BU, Brown, Cambridge, Dartmouth, EIEF, George Mason, Harvard, Kiel Institute, LSE, Northwestern, Pittsburgh/CMU, SFU, Toulouse, UBC, UCL, Warwick.

2012-2013: Chicago, GW, NBER (EG), RFF.

2011-2012: AEA, Arizona, BREAD, EHA, Harvard, NBER (DAE), Santa Clara, Stanford, Stanford GSB, UC-Berkeley, UC-Berkeley Ag, UC-Davis, UC-Davis Ag, UC-Irvine, UC-Merced, UC-San Diego, UCLA, Yale.

2010-2011: AEA, Bocconi, Brown, Columbia, EHA, Harvard, IIES, Kansas, Miami-OH, Michigan State, NBER (DAE), NEUDC, PERC, Queen's, Stanford, Toronto, UCLA, UC-Santa Barbara, UPF, Vanderbilt, World Bank, Yale.

2009-2010: AEA, Bank of Mexico, Columbia, EHA, FRB-Minneapolis, FRB-Philadelphia, FRB-Richmond, Hong Kong, ITAM, Michigan, NBER (DAE), Stanford, UC-Berkeley, UC-Davis.

2008-2009: BU, Chicago, Chicago Booth, Harvard, HBS, LSE, Maryland Ag, NBER (DAE, PP), NEUDC, Northwestern, Princeton, Review of Economic Studies Tour (Brussels, Oxford, Munich), SITE, UCLA, Wharton, Yale.

Personal

Citizenship: USA
Date of Birth: May 26, 1982
Family Status: Married, two children (born August 2012 and January 2016)