

NBER WORKING PAPER SERIES

IMMIGRATION AND THE RISE OF AMERICAN INGENUITY

Ufuk Akcigit
John Grigsby
Tom Nicholas

Working Paper 23137
<http://www.nber.org/papers/w23137>

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
February 2017

We thank the Minnesota Population Center for access to the Census data. Akcigit gratefully acknowledges the National Science Foundation, the Alfred P. Sloan Foundation, and the Ewing Marion Kauffman Foundation for financial support. Nicholas received funding from the Division of Research and Faculty Development at Harvard Business School. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

NBER working papers are circulated for discussion and comment purposes. They have not been peer-reviewed or been subject to the review by the NBER Board of Directors that accompanies official NBER publications.

© 2017 by Ufuk Akcigit, John Grigsby, and Tom Nicholas. All rights reserved. Short sections of text, not to exceed two paragraphs, may be quoted without explicit permission provided that full credit, including © notice, is given to the source.

Immigration and the Rise of American Ingenuity
Ufuk Akcigit, John Grigsby, and Tom Nicholas
NBER Working Paper No. 23137
February 2017
JEL No. N11,N12,O31,O40

ABSTRACT

This paper builds on the analysis in Akcigit, Grigsby, and Nicholas (2017) by using U.S. patent and Census data to examine macro and micro-level aspects of the relationship between immigration and innovation. We construct a measure of "foreign born expertise" and show that technology areas where immigrant inventors were prevalent between 1880 and 1940 experienced more patenting and citations between 1940 and 2000. We also show that immigrant inventors were more productive during their life cycle than native born inventors, although they received significantly lower levels of labor income than their native born counterparts. Overall, the contribution of foreign born inventors to US innovation was substantial, but we also find evidence of an immigrant inventor wage-gap that cannot be explained by differentials in productivity.

Ufuk Akcigit
Department of Economics
University of Chicago
1126 East 59th Street
Saieh Hall, Office 403
Chicago, IL 60637
and NBER
uakcigit@uchicago.edu

Tom Nicholas
Harvard Business School
Soldiers Field
Boston, MA 02163
tnicholas@hbs.edu

John Grigsby
Department of Economics
University of Chicago
1160 East 58th Street
Chicago, IL 60637
jgrigsby@uchicago.edu

“That part of America which has encouraged them (the foreigners) most, has advanced most rapidly in population, agriculture and the arts.”

– James Madison, Constitutional Convention, 1787

1 INTRODUCTION

From the founding of the US nation up to the recent Presidential election, the impact of immigrants has been a focal point of debate. The relationship between immigration and innovation is especially contentious. High-skilled immigrant flows can improve human capital and the stock of ideas in the host country (Kerr and Lincoln (2010); Hunt and Gauthier-Loiselle (2010)), but these flows can also lead to the displacement of domestic knowledge producers (Borjas and Doran (2012)). While the recent literature on this topic is growing, Abramitzky and Boustan (2016) note there is very little evidence connecting immigrants to US innovation over longer horizons. Moser et al. (2014) find a large boost from immigrants from the 1930s to the 1960s, but their evidence comes from a sub-group of particularly high-skilled inventors—German-Jewish émigré chemists who fled from the Nazi regime—for whom we might expect the effect to be large.

Using patent records and Federal Census data we provide broad evidence of the impact of immigrants on US innovation and document labor market outcomes for migrant inventors. We construct a measure of *foreign born expertise* and show that technology areas where immigrant inventors were more prevalent between 1880 and 1940 experienced faster growth between 1940 and 2000. We also show that immigrant inventors were more productive during their life cycle than native born inventors, although they received significantly lower wage levels than their native born counterparts. Overall, our results suggest the contribution of foreign born inventors to US innovation was substantial, but we also find evidence of assimilation frictions in the labor market.

Our analysis is part of a much larger project where we examine the golden age of US innovation by linking US patents to state and county-level data and to information in Federal Censuses between 1880 and 1940 (Akcigit et al. (2017)). We aim to complement modern studies such as Aghion et al. (2015) and Bell et al. (2015) to provide a more complete picture of inventor profiles over time and space. In our main paper we document a fundamental relationship between innovation and long run economic growth and then develop a number of facts about the environment in which inventors functioned, their life cycle and the further link between innovation, inequality and social mobility. One of our findings relates to immigration. We show that in the top 10 most inventive states in terms of the average number of patents per capita between 1880 and 1940, 20.6% of the population were international migrants, compared to just 1.7% of the population of the least inventive states. In the remainder of this paper we explore the underlying relationship between immigrant inventors and innovation.

2 HISTORICAL BACKGROUND

In 1947 the lobby group, the National Committee on Immigration Policy in the US published a volume on *Economic Aspects of Immigration*. It contains numerous anecdotes to support their argument that economic growth benefitted from invention by foreigners. The Scottish-born Alexander Graham Bell was pivotal in the development of the telephone; David Lindquist, the Swedish inventor who became chief engineer at Otis, developed the electric elevator; the pioneering German-born chemist, Herman Frasch, worked in Philadelphia and Cleveland on refining processes analogous to modern-day fracking. If this volume were to be re-written today, it would be replete with examples of high-skilled immigrants in Silicon Valley.

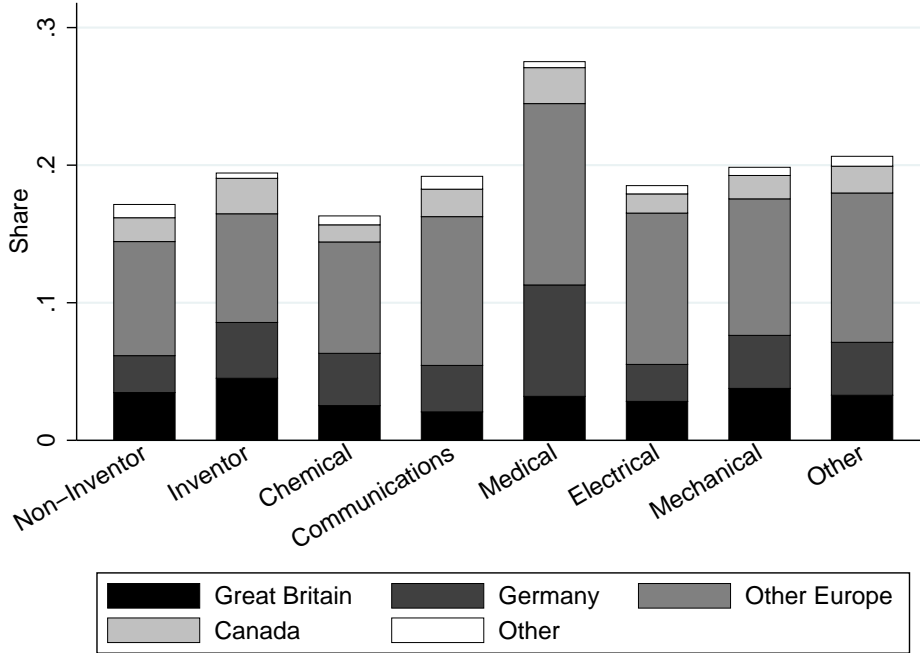
Beyond their own knowledge, high-skilled inventors can create spillovers. Effective collaboration revolves around access to the very best minds (Iaria and Waldinger (2016)). The French engineer Octave Chanute, who settled in Chicago in 1889, acted as an information hub providing Wilbur and Orville Wright with crucial technical information in their search for manned flight. There is also evidence that immigrants worked in teams, which can increase creativity through the combination of specialized insights (Jones (2009)). James Hillier, a Canadian immigrant developed the first commercially viable electron microscope at Radio Corporation of America (e.g., patent 2,354,263, 1944). There he worked with other foreign-born scientists including Ladislaus Marton, a Belgian inventor and Vladimir Zworykin, a Russian immigrant and leading television technology innovator, as well as native-born engineers.

These individuals were superstar inventors creating what Mokyr (2005) describes as “upper tail” knowledge. Yet, it is also important to go beyond such notable examples to examine the overall distribution of foreign-born inventors. During the Age of Mass Migration (1850-1913) almost 30 million European immigrants arrived in the United States. Although the national-origins quota system limited entry between the 1920s and the mid-1960s, high-skilled inventors periodically entered the country, such as those who fled Nazi Europe (Moser et al. (2014)). Our extensive time period coverage is useful for studying the effect of immigration on innovation. In keeping with the focus in Akcigit et al. (2017) on the relationship between innovation and long run growth, it allows us to explore the potential benefits created by knowledge production and externalities long after these immigrants arrived.

3 THE DATA

The data for our analysis are described fully in Akcigit et al. (2017). Here we briefly sketch out the main components. First, we use nearly the universe of patents granted by the USPTO covering the geographic location of inventors, their technology area (i.e.,

Figure 2: FOREIGN INVENTOR SHARE



Notes. Figure shows the share of non-inventors and inventors who were born abroad in our six decennial census years (1880, 1900-1940). The inventor share is also broken down by NBER patent category.

to a lesser extent electricity during the late nineteenth and early twentieth centuries has been well-documented, these sectors actually accounted for the smallest shares. Medical technology stands out. However, in aggregate this sector accounted for 1.0% of US patents between 1880 and 1940 compared to 13.9% for chemicals and 12.6% for electricity.

Table 1 provides estimates of the impact of immigrant inventors on the technology area in which they were active. We construct a measure of *foreign born expertise* by multiplying the share of country c 's patents granted in class k between 1880 and 1940 by the number of immigrant inventors from c in the 1940 Census, and then summing across all c :

$$\text{Expertise}_k = \sum_c \frac{\# \text{ Pat}(k, c)}{\# \text{ Pat}(c)} \times \# \text{ Mig-Inv}(c)$$

The intuition behind this measure is that the US technology area in which country c patents captures its frontier innovation advantage, while the physical movement of an inventor from that country to the US magnifies the impact in that area through the transmission of codified or tacit knowledge. In endogenous growth models, innovation leads to economic growth as inventors build on prior generations of frontier ideas (e.g., Romer (1990), Aghion and Howitt (1992)).

We use this measure of *foreign born expertise* between 1880 and 1940 in a regression framework at the USPTO patent class level to predict the change in patenting between

Table 1: The relationship between patent class growth and expertise of foreign migrants

Innovation Definition:	Patents		Citations	
	(1)	(2)	(3)	(4)
Foreign Expertise	0.461*** (0.044)	0.408*** (0.055)	0.396*** (0.043)	0.160*** (0.040)
Log Innovation 1880-1940		0.094 (0.067)		0.417*** (0.083)
Observations	399	399	399	399

Notes. Table reports estimates from regressing log patents (columns 1 and 2) or $\log(1+\text{citations})$ (columns 3 and 4) granted in a patent technology class k between 1940 and 2000 on foreign expertise in class k . Foreign expertise is defined as follows: multiply the share of country c 's patents granted in class k between 1880 and 1940 by the number of migrant inventors from c in the 1940 Census, then sum across all c . All variables are standardized to have 0 mean and unit standard deviation. White heteroskedasticity robust standard errors reported in parentheses. *, **, and *** indicate coefficient statistically different from 0 at the 10%, 5%, and 1% levels, respectively.

1940 and 2000. Columns 1 and 3 show that foreign expertise in a technology area is strongly related to both the level of patents and citations over the following six decades. A one standard deviation increase in *foreign born expertise* is associated with an increase in patents that is 40.8% of its standard deviation (for citations the effect is 16.0% of its standard deviation). These results are robust to controlling for the long-run effects of initial patents and citations in columns 2 and 4. Interestingly, the economic magnitude of these estimates is similar to the 30% increase in innovation Moser et al. (2014) find for the impact of German-Jewish émigrés on patents in the US chemicals industry. Our results suggest immigrants had a broad long-run macroeconomic impact on US invention.

Next we turn to the micro-level. Given the richness of our data we can observe inventors longitudinally, and so measure their career patents and citations to determine productivity. We also observe wage income in the 1940 Census (subject to the caveat that enumerators top-coded high incomes at \$5,000 and income derived from, say patent sales, would not be included in reported income). Hence, we can approximate the financial returns to invention by immigrants relative to other groups, conditioning on productivity. Column 1 of Table 2 show that the career patents of immigrant inventors were $(e^{0.088} - 1 \times 100) = 9\%$ higher than native born inventors. We also find that black inventors were about 67% more productive, and male inventors 111% more productive, than their non-black and female counterparts respectively. In column 2, although the coefficient on international migrants loses statistical significance, the magnitude of these differences holds when we consider career citations.

Now turn to the wage results in columns 3 and 4.¹ We see that despite their higher productivity, labor income for immigrant inventors was about 5% lower than for native

¹We have fewer observations in the wage income regression in columns 3 and 4 compared to the productivity regressions in columns 1 and 2 due to missing information on this variable in the 1940 Census. As a robustness check, we restricted the regressions in columns 1 and 2 to only those individuals for whom we observe wage income. The results remained substantively the same.

Table 2: Career Productivity, Log Wages, and Migrant Status

Dependent Variable: Productivity Measure:	Log(Productivity)		Log(Wage Income)	
	Patents (1)	1+Citations (2)	Patents (3)	1+Citations (4)
International Migrant	0.088** (0.040)	0.066 (0.050)	-0.055** (0.024)	-0.049** (0.024)
Black	0.514*** (0.152)	0.518*** (0.184)	-0.384*** (0.101)	-0.348*** (0.102)
Male	0.746*** (0.138)	0.891*** (0.176)	0.415*** (0.111)	0.447*** (0.109)
Log Productivity			0.084*** (0.009)	0.008 (0.008)
Observations	8209	8209	5831	5831
Mean Dep. Var.	1.581	3.746	7.629	7.629
S.D. Dep. Var.	1.363	1.683	0.840	0.840

Notes. Table reports estimates from a regression of log wages (columns 1 and 2) or log career inventor productivity (columns 3 and 4) for the set of inventors matched to the 1940 census. Columns 1 and 3 define career productivity to be the total number of patents granted to an inventor, while columns 2 and 4 define productivity to be one plus the number of citations received. All regressions include controls for education, age, and state and occupation fixed effects. White heteroskedasticity robust standard errors reported in parentheses. Regression sample is set of inventors matched to the 1940 Decennial Census. We do not include prior inventors due to a lack of suitable controls (e.g. education) and the unavailability of wage data. *, **, and *** indicate coefficient statistically different from 0 at the 10%, 5%, and 1% levels, respectively.

born inventors. Although the mechanism is hard to disentangle, we find a large wage gap for black inventors relative to non-black inventors and for males relative to females when controlling for productivity, both of which are consistent with labor market discrimination. While the limits of our data mean we can not observe lifetime earnings, our evidence implies immigrant inventors who relocated to the United States earned lower labor income than comparable native born inventors.

5 CONCLUSION

The contribution of immigration to US economic growth is an important policy question. [Akcigit et al. \(2016\)](#) show that the top income tax rates affect the international migration of superstar inventors. We have shown that immigrant inventors were especially productive and that the technology areas in which they were active exhibited higher levels of growth over the long run. Our evidence is consistent with the view that immigrant inventors had a substantial positive macroeconomic impact through their influence on US inventiveness. At the same time the micro-level labor market wage-gap we observe implies frictions associated with assimilation. This can have a large effect on economic outcomes. [Hsieh et al. \(2013\)](#) show that labor market barriers in the in the US from 1960 to 2010 severely dampened growth due to the misallocation of talent. The immigrant inventor wage-gap we find cannot be explained by variation in productivity.

REFERENCES

- Abramitzky, Ran and Leah Platt Boustan**, “Immigration in American Economic History,” Working Paper 21882, National Bureau of Economic Research January 2016.
- Aghion, Philippe and Peter Howitt**, “A Model of Growth through Creative Destruction,” *Econometrica*, 1992, 60 (2).
- , **Ufuk Akcigit, Ari Hyytinen, and Otto Toivanen**, “Living the American Dream in Finland: The Social Mobility of Innovators,” 2015. University of Chicago mimeo.
- Akcigit, Ufuk, John Grigsby, and Tom Nicholas**, “The Rise of American Ingenuity: Innovation and Inventors of the Golden Age,” 2017. NBER Working Paper # 23047.
- , **Salome Baslandze, and Stefanie Stantcheva**, “Taxation and the International Migration of Inventors,” *American Economic Review*, 2016, 106 (10), 2930–2981.
- Bell, Alex, Raj Chetty, Xavier Jaravel, Neviana Petkova, and John Van Reenen**, “The Lifecycle of Inventors,” 2015. Harvard mimeo.
- Borjas, George J. and Kirk B. Doran**, “The Collapse of the Soviet Union and the Productivity of American Mathematicians,” *The Quarterly Journal of Economics*, 2012, 127 (3), 1143–1203.
- Hsieh, Chang-Tai, Erik Hurst, Charles I. Jones, and Peter J. Klenow**, “The Allocation Of Talent And U.S. Economic Growth,” 2013. NBER Working Paper # 18693.
- Hunt, Jennifer and Marjolaine Gauthier-Loiselle**, “How Much Does Immigration Boost Innovation?,” *American Economic Journal: Macroeconomics*, 2010, 2 (2), 31–56.
- Iaria, Alessandro and Fabian Waldinger**, “Frontier Knowledge and the Creation of Ideas: Evidence from the Collapse of International Science in the Wake of World War I,” Working Papers, Centre de Recherche en Economie et Statistique August 2016.
- Jones, Benjamin F.**, “The Burden of Knowledge and the Death of the Renaissance Man: Is Innovation Getting Harder?,” *The Review of Economic Studies*, 2009, 76 (1), 283–317.
- Kerr, William R and William F Lincoln**, “The Supply Side of Innovation: H-1B Visa Reforms and US Ethnic Invention,” *Journal of Labor Economics*, 2010, 28 (3), 473–508.

Mokyr, Joel, “Long-Term Economic Growth and the History of Technology,” in Philippe Aghion and Steven Durlauf, eds., *Handbook of Economic Growth*, 1 ed., Vol. 1, Part B, Elsevier, 2005, chapter 17, pp. 1113–1180.

Moser, Petra, Alessandra Voena, and Fabian Waldinger, “German-Jewish Emigres and US Invention,” *American Economic Review*, 2014, *104* (10), 3222–55.

Romer, Paul Michael, “Endogenous Technological Change,” *Journal of Political Economy*, 1990, *98* (5), S71–102.