

The Contribution of High-Skilled Immigrants to Innovation in the United States

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Innovation and technological progress are key determinants of economic growth. There is growing evidence that immigrants play a key role in U.S. innovation. For example, immigrants accounted for 23 percent of the total workforce in science, technology, engineering, and mathematics occupations in 2016. They accounted for 26 percent of U.S.-based Nobel Prize winners from 1990 through 2000. Based on a 2003 survey, U.S. immigrants with a four-year college degree were twice as likely to have a patent than U.S.-born college graduates.

Nevertheless, we do not have an aggregate estimate of how immigrants contribute to U.S. innovation. One key reason is the lack of comprehensive data that enable researchers to identify immigrant inventors and determine how their productivity differs from native inventors. We brought to

bear new data and used a unique approach to identify, for the first time, the immigrant status of individuals residing in the United States, which we then linked to patent data. We found that immigrants accounted for 16 percent of all U.S. inventors from 1990 to 2016. However, immigrants produced about 23 percent of total innovation, and we found that the average immigrant is substantially more productive than the average U.S.-born inventor. We also found that immigrants create spillovers onto the innovation of native inventors, thus indirectly contributing to innovation by raising native-inventor productivity more than would collaboration with other native inventors.

Our analysis relied on the Infutor database, which provides the exact address history of more than 300 million adults living in the United States over the past 30 years.



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Beyond the exact address history, these data also include the individuals' names, years of birth, and genders and the first five digits of their Social Security numbers (SSNs). Our methodology inferred immigrant status by combining the first five digits of their SSN together with information on year of birth. The first five digits of the SSN pin down the year in which the SSN was assigned. Since practically all U.S. natives are assigned an SSN at birth or during their youth, individuals who receive an SSN in their 20s or later are highly likely to be immigrants.

Using individual-level address information provided by Infutor and the Patent and Trademark Office, we merged information on an individual's immigrant status with information from the patent database. We found that 16 percent of all U.S.-based inventors between 1990 and 2016 were immigrants that came to the United States when they were 20 years of age or older. The contribution of these immigrants to overall U.S. innovative output, however, was disproportionately large relative to their share of the U.S. inventor population. Immigrant inventors produced roughly 23 percent of all patents during this period, which is 40 percent greater than their share of the U.S.-based inventor population (16 percent). Moreover, these patents do not appear to be of lower quality than those authored by U.S.-born inventors. We weighted patents by how often they are cited by future patents, which captures their quality, and found that the immigrant contribution is even higher at 24 percent of all patents. Finally, we found that immigrants have generated 25 percent of the aggregate economic value, which is more than 50 percent greater than their share of the U.S.-based inventor population.

The contribution of immigrants to U.S. innovative output is not especially concentrated in specific sectors. We found that immigrants generated over 25 percent of innovative output in the computers and communications, drugs and medical, electronics, and chemical sectors and 15 percent in more traditional technology sectors, such as metal working, transportation, and engines.

We next explored how immigrants differ in innovative productivity over their life cycles. Both natives and immigrants exhibit an inverse U-shaped pattern, where inventors are quite unproductive at the beginning of their careers, become most productive in their late 30s and early 40s, and then steadily decline in productivity thereafter. However, while

the two populations follow similar trajectories, immigrants reach a higher peak by producing significantly more patents and citations and by generating more economic value. This gap persists through the rest of inventors' careers.

Though it was not our goal to identify all the reasons immigrants are more productive than natives, we did investigate a few mechanisms. While immigrant inventors in the United States may have high innate ability, we documented them making choices that complement their productivity. For example, we found that immigrants disproportionately choose to live in highly productive counties relative to U.S.-born inventors. Immigrants also disproportionately patent in technology classes that experience more innovation activity. These two forces explain about 30 percent of the patenting gap between immigrants and natives. This suggests that immigrants not only are more productive based on ability but also are more willing to make choices that further improve their innovative output.

We found that immigrant inventors foster the importation of foreign ideas and technologies into the United States and facilitate the diffusion of global knowledge. During their careers, immigrant inventors relied more heavily on foreign technologies, as illustrated by a 10 percent increase in the fraction of new patents citing foreign patents. Immigrants were also about twice as likely to collaborate with foreign inventors relative to native inventors. Finally, foreign technology sectors were about 10 percent more likely to cite the patents of U.S.-based immigrants than those of U.S. natives. While U.S.-based immigrant inventors appear to be more productive than U.S. natives, one potential concern is that immigrant inventors may be less integrated into networks of collaboration due to cultural impediments or lack of assimilation. However, we found that throughout their careers, immigrant inventors tended to have more collaborators than native inventors. Furthermore, while we found that immigrants were more likely to work with other immigrants (as compared with natives), this tendency declined over time, suggesting gradual assimilation.

Team interactions between foreign-born and U.S.-born inventors in the production of patents may be a key mechanism through which an inventor's knowledge spills over onto the knowledge and productivity of collaborators. These knowledge spillovers are exactly why allowing high-skilled immigrants in the United States may improve

the welfare and productivity of U.S.-born workers. We estimated the magnitudes of foreign-born and U.S.-born knowledge spillovers on their collaborators by studying the unexpected termination of these relationships. We exploited the premature deaths of inventors, defined as deaths that occur before the age of 60. We then followed the patenting behavior of inventors who had coauthored a patent with a deceased inventor and compared the change in patenting activity of these coauthors before versus after the inventors' deaths with inventors who did not experience the premature death of a coauthor. We found that premature death gradually led to a 10 percent decline in the patenting activity of coinventors. Most strikingly, we found that an immigrant inventor's death caused a significantly larger decline in the productivity of coinventors than that of a native inventor. The death of an immigrant lowered coinventor productivity by approximately 17 percent, while a U.S.-born inventor's death lowered productivity by approximately 9 percent.

Finally, we quantified the share of aggregate innovation that can be attributed to immigrants, through both their

direct output and indirect knowledge spillovers. We conclude that 36 percent of total U.S. innovative output since 1990 can be ascribed to immigrants even though they make up only 16 percent of the inventor workforce and directly author only 23 percent of patents. The additional 13 percentage points of innovation beyond immigrants' direct output are due to immigrants' substantial collaboration spillovers on native-born inventors. Moreover, we found that over a third of U.S. innovation can be attributed to two-way spillovers between immigrants and natives, highlighting the importance of combining inventors with different knowledge and backgrounds to push the innovation frontier.

NOTE

This research brief is based on Shai Bernstein et al., "The Contribution of High-Skilled Immigrants to Innovation in the United States," National Bureau of Economic Research Working Paper no. 30797, December 2022.



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