

U.S. Ethnic Scientists and Entrepreneurs

by William R. Kerr

Immigrants are critical to the formation of U.S. technology. While they account for around 10 percent of the U.S. working population, immigrants represent 25 percent of the U.S. science and engineering workforce and almost 50 percent of those with doctorates.

In addition to the number of scientists immigrants add to the U.S. workforce, star immigrant researchers make an exceptional contribution in quality to the nation's science as measured by Nobel Prizes, election to the National Academy of Sciences, patent citations, and so on. The contributions of immigrants extend well beyond the laboratory, too. Ethnic entrepreneurs are also prominent in commercializing new technologies, especially in areas where high-technology firms are clustered, such as Silicon Valley.

The magnitudes of these ethnic entrepreneurial and scientific contributions raise many research and policy questions on both short-term and long-term horizons. This *Economic Commentary* highlights a new methodology for studying such contributions. The methodology makes use of patent records for the information they contain about ethnic scientific and engineering inventors.

The data confirm the growing scientific contributions that ethnic inventors have been making in the United States, especially in high-technology fields. In addition, related research using the same dataset finds that the benefits of immigration run in more than one direction: U.S. ethnic researchers make important contributions to the international diffusion of technology as well.

■ Ethnic Patenting Data

Empirical studies of immigrant scientists and engineers face substantial data constraints. One source of potentially useful information that has not been exploited in such studies is the patent records of the U.S. Patent and Trademark Office (USPTO). Each patent filed with the USPTO contains the name of at least one inventor, and multiple inventors are allowed. In total, 4.3 million inventor names are associated with the 2.9 million patents that have been granted from 1975 to 1999.

I was able to map these inventor names into an ethnic-name database that is typically used for commercial marketing campaigns. This approach exploits the idea that inventors with the surnames Ming or Yu are likely of Chinese ethnicity, Agrawal or Banerjee have a greater probability of being Indian, and Rodriguez or Martinez are likely of Hispanic descent. In cases

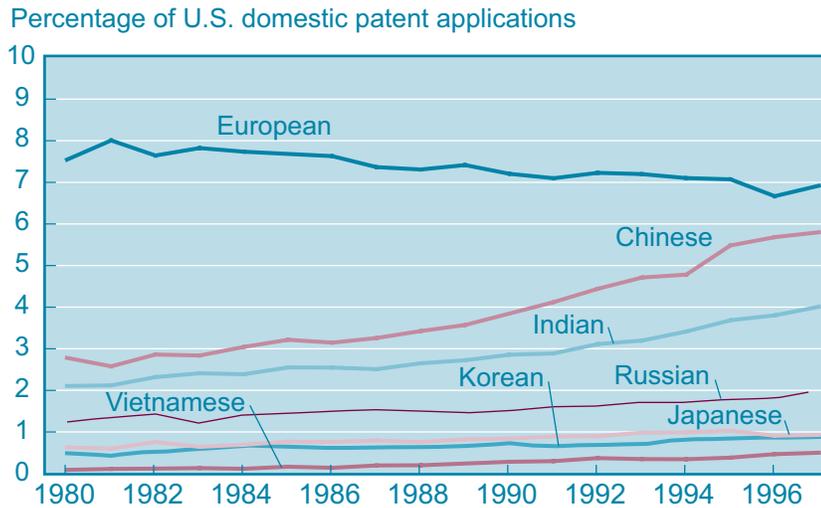
Immigrants are exceptionally important for U.S. technology development, accounting for almost half of the country's Ph.D. workforce in science and engineering. Most notably, the contribution of Chinese and Indian scientists and entrepreneurs in U.S. high-technology sectors increased dramatically in the 1990s. These ethnic scientific communities in the United States also help transfer new technologies back to their home countries.

of overlapping surnames (such as Lee), Census records are used to apportion ties.

The match rate is 98 percent for inventors residing in the United States, and nine ethnicities can be distinguished: Chinese, English, European, Hispanic/Filipino, Indian/Hindi, Japanese, Korean, Russian, and Vietnamese.

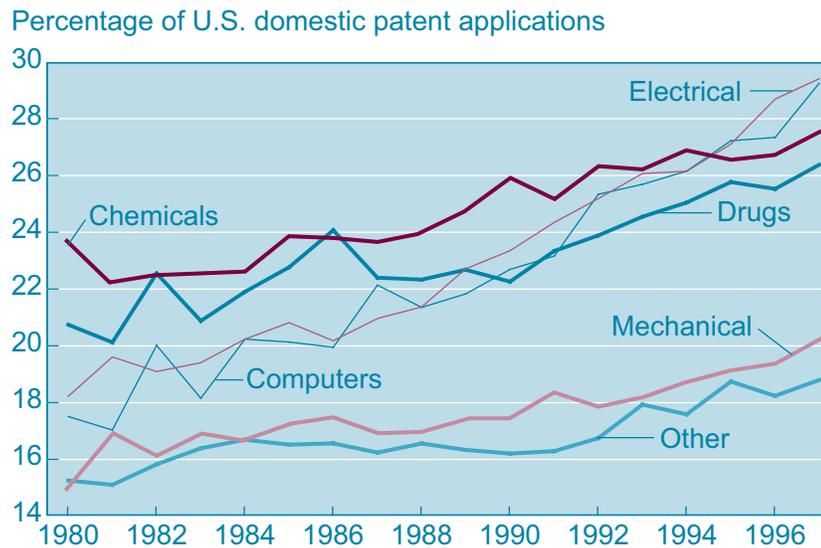
The USPTO grants patents to inventors living within and outside of the United States, with the latter accounting for just under half of all patents issued. Quality assurance exercises using the inventor records for those filing USPTO patents from abroad confirm the approach works well. For example, 99 percent of the inventors filing from Japan are found to be Japanese.

FIGURE 1 ETHNIC SHARES OF U.S. DOMESTIC PATENTS



SOURCE: U.S. Patent and Trademark Office; and author's calculations.

FIGURE 2 TOTAL ETHNIC SHARE BY MAJOR TECHNOLOGIES



SOURCE: U.S. Patent and Trademark Office; and author's calculations.

The primary limitation of the ethnic-name approach is that first-generation cannot be distinguished from later-generation immigrants.

But the approach yields quantifiable data in previously unavailable detail on the ethnic composition of U.S. inventors. Because the ethnic assignment is done at the micro-

level, greater detail on the ethnic composition of inventors is available annually on multiple dimensions. Each patent contains very detailed technology categories, so that differences in ethnic contributions across sectors can be analyzed (for example, semiconductors and biotechnology).

Likewise, ethnic populations can be described annually for each city or state. Finally, most patents are assigned to a corporation, university, or government body (for example, IBM, MIT, or the U.S. Army). The ethnic composition of each institution's inventors, by city and line of business, can be similarly described.

U.S. Ethnic Inventors

Figure 1 illustrates the evolving ethnic composition of U.S. inventors from 1980 to 1997. This graph includes only inventors who resided within the United States at the time of their patent filing. The USPTO issues many more patents today than in previous years, and it is difficult to interpret changes in the levels of patents granted.

The trends are presented as annual shares of ethnic inventors to abstract from these issues. The English share, omitted from the graph, declines from 82 percent in 1980 to 75 percent in 1997. The European ethnicity represents the largest foreign contributor to U.S. technology development. Like the English ethnicity, however, the European share of U.S. domestic inventors declines steadily over the period.

These declining English and European shares are partly due to the exceptional growth of the Chinese and Indian ethnicities, which increase from 3 percent to 6 percent and 2 percent to 4 percent, respectively, over the 17-year period. Recent data suggest that these upward trends have continued through at least 2002, and work on collecting data that continue through 2006 is ongoing. Growth in Chinese and Indian patenting activity is particularly concentrated in high-technology sectors, where Chinese inventors have supplanted European researchers as the largest ethnic contributor to U.S. technology formation beside the English.

Figure 2 explores the technology dimension of the contributions made by ethnic inventors. Patents are separated into six broad technology areas: chemicals, computers and communications, drugs and medical, electrical and electronic, mechanical, and miscellaneous (labeled “other” on the graph). The miscellaneous group includes patents for agriculture, textiles, furniture, and the like. Growth in ethnic patenting is clearly stronger in high-technology sectors than in more traditional industries.

■ International Technology Diffusion

Ethnic scientists and engineers are an important and growing contributor to U.S. technology development. Chinese and Indian ethnicities, in particular, are now an integral part of the country’s invention and commercialization activities in high-technology sectors.

The dataset developed through patent records is useful for studying several important policy questions. Examples include the appropriate immigration quotas for high-skilled workers and the impact of foreign-born workers on native workers and students.

But the contributions of immigrants do not run in just one direction; there is a special relationship that exists between U.S. ethnic scientific communities and their home countries. Immigrants in the United States often retain a special interest in their native lands, which they still influence in ways ranging from financial transfers to political inputs.

Quantifying these flows is important for evaluating whether the emigration of top talent to the United States is a gain or loss to the sending nation (sometimes referred to as the “brain drain” versus “brain circulation” debate). The extent to which technologies

diffuse faster to countries through ethnic scientific channels is very important for achieving the positive gains from these expatriates.

Empirical work finds that U.S. ethnic scientific communities do aid the transfer of technologies developed in the United States to their native countries. This work moves beyond case studies by examining more than 40 countries and 20 manufacturing industries over the 1980–1997 period. This technology transfer boosts the economic development of the home countries as measured by output and productivity growth. Moreover, countries are found to increase exports—to countries other than the United States—in the industries in which they receive technology stimulants, signifying the development of comparative trade advantages.

Current research is also evaluating the channels through which this technology transfer operates. Scientific collaboration certainly plays a role, with ethnic inventors outside of the United States being found to cite ethnic inventors within the United States at a higher rate, even after controlling for specific technological fields. This effect is most prominent immediately after new inventions are developed, with the special ethnic collaborations promoting both greater awareness of new technologies and greater tacit understanding of how they work.

More recent projects with Fritz Foley of Harvard Business School are looking within the firm. We have gathered data on firm-level foreign direct investment (FDI) and trading patterns. On the FDI front, we have found evidence that a stronger U.S. ethnic research presence with multinationals facilitates greater FDI into the scientists’ home countries. We are further exploring how the organizational forms of FDI change—

for example, entry through fully owned facilities versus joint ventures—and how within-firm trade is shaped.

Immigrants have a disproportionate influence on U.S. technology formation and diffusion. Understanding these ethnic contributions and the scientific networks through which they operate is essential for crafting appropriate U.S. immigration and innovation policies. With increasing globalization of research and development and innovative efforts, and the rapid development of China and India, these topics will continue to grow in importance.

■ Recommended Reading

William R. Kerr. 2006. “Ethnic Scientific Communities and International Technology Diffusion,” Harvard Business School Working Paper 06-022.

William R. Kerr. 2006. “The Ethnic Composition of U.S. Inventors,” unpublished manuscript.

A.L. Saxenian, Y. Motoyama, and X. Quan. 2002. *Local and Global Networks of Immigrant Professionals in Silicon Valley*. San Francisco, CA: Public Policy Institute of California.

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William R. Kerr was a participant at the Federal Reserve Bank of Cleveland's Conference on Universities, Innovation and Economic Growth, held in November 2006. Dr. Kerr is an assistant professor at the Harvard Business School and a research associate at the Center for Economic Studies.

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