

Assessing the High-Impact Contributions of Foreign-Born Scientists to Nanotechnology Innovation

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Research Goals

- Determine whether leading nanotechnology scientists are disproportionately foreign-born
- Benchmark our original data set against NSF data concerning Sci/Eng in general and general US population
- Utilize results to assess the internal globalization of the US science community

The Importance of Our Research

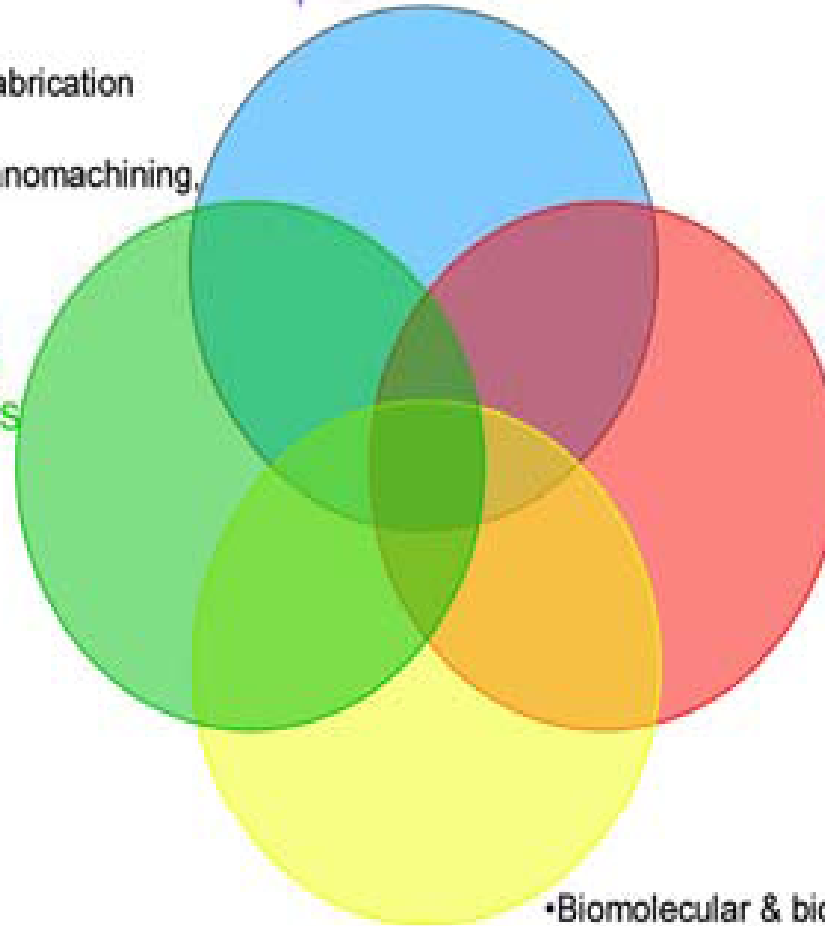
- Narrows the focus of current research to include the emerging field of nanoscience
- Contributes information to debates on immigration policy
- Gain information on who is driving nano-innovation by creating an original, comprehensive data set
- Provides information on the education and nationality of leading, high-impact scientists

- Microscopy
 - Scanning probe microscopy
 - Electron microscopy
- Self assembly; Directed assembly
- Nanomechanics
- Molecular simulation
- Scanning probe writing & fabrication
- Top-down processes
(nano-lithography, laser nanomachining, etc.)

Metrology & Nanoprocesses

Nanodevices & Nanoelectronics

- Nanocomputing devices
- Nanotransistors
- NEMS; PEBBLES
- Molecular electronics
- Nanoscale magnetics



Nanostructure Chemistry & Materials

- Nanoscale chemical structures
- Nanocomposites
- Sol-gels; quasi-crystals
- Growth methods
(epitaxy – MBE, CBE, MOCVD)
- 0D – Quantum dots
- 1D – Nano/quantum tubes, rods or fibers; nanopolymers
- 2D – graphite layers
- 3D -; fullerenes; nanocrystals

Nanomedicine & Nanobiotechnology

- Biomolecular & biomimetic devices
- Biosensors
- Molecular motors
- Biomolecular fabrics
- Engineered enzymes & proteins
- Drug discovery and delivery



Collection of Biographical Data and Survey Research

- American Men & Women of Science
 - Missing Data
- Biographical internet sources (Linked-In, Dept Websites, etc.)
- Gathered contact info for mail/e-mail surveys
- Recorded nativity information
- Statistical analysis using Chi-square test or two-tailed binomial test

Population Information

- 362 Highly Cited Articles
- Only included scientists with at least one corresponding authorship
- 209 unique first authors
 - Biographical information on 60% overall, variable by year



Benchmark Data

Characteristics of the Population of the USA

Year	1999	2003	2006
No. Native	247,274,214	255,988,943	262,834,523
No. Foreign Born	29,973,832	34,327,839	37,547,789
% Native	89.2%	88.2%	87.5%
% Foreign Born	10.8%	11.8%	12.5%

Source: US Census Bureau and American Community Surveys



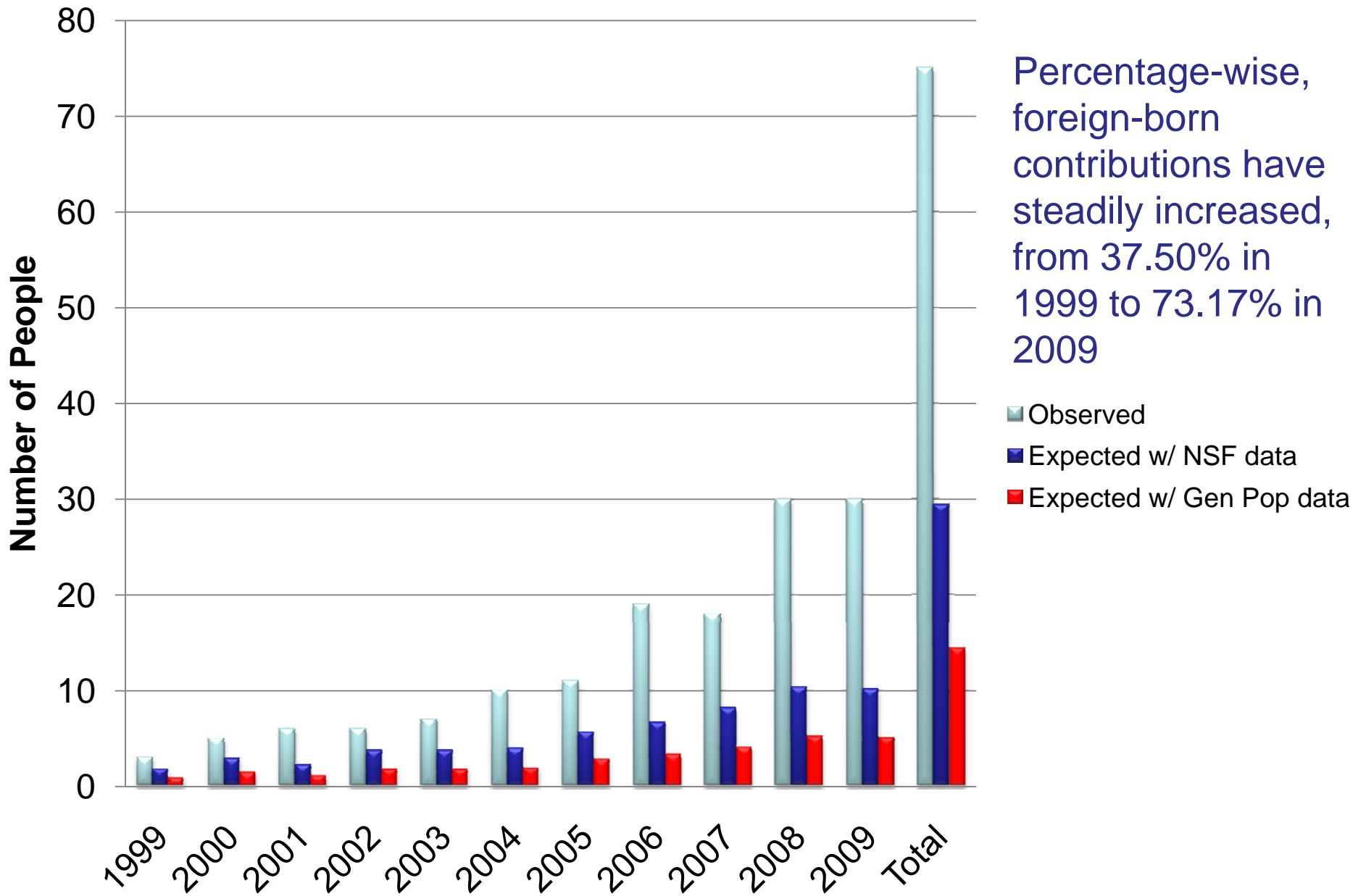
Benchmark Data

Characteristics of Employed Doctoral Scientists and Engineers

Year	1999	2003	2006
No. Native US Sci/Engrs	429,070	445,960	468,060
No. Foreign Born US Sci/Engrs	124,300	147,340	153,570
% Native US Sci/Engrs	77.5%	75.2%	75.3%
% Foreign Born US Sci/Engrs	22.5%	24.8%	24.7%

Source: NSF

Comparison of Observed vs Expected Foreign-Born Contributions to Nanotechnology Innovation



Statistical Analysis

- When benchmarked against the characteristics of the national population:
 - Only the difference observed in 1999 is not statistically significant at the $P < 0.05$ level
- When benchmarked against the characteristics of employed doctoral scientists and engineers:
 - Differences observed in 1999, 2000, 2002 and 2003 are not statistically significant at the $P < 0.05$ level
- Starting in 2006 differences were extremely significant ($P < 0.0001$)

Country of Birth Information

United States of America → 47 Scientists

China → 21 Scientists

India → 8 Scientists

Germany → 5 Scientists

Other countries

Israel, Taiwan and UK (4); Argentina, Canada, France, Japan, Poland, Russia, Serbia and South Africa (2); Belarus, Belgium, Costa Rica, Cyprus, Egypt, Greece, Hungary, Ireland, Italy, Netherlands, Republic of Korea, Spain and Turkey (1)

Discussion

- Overall, scientists making high-impact contributions were disproportionately foreign-born
- The amount of foreign-born contribution and number of highly-cited articles has increased steadily
- Results promise to contribute to studies on highly-skilled migration and its links to the US economy

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