

Introduction

Existing research has noted the impact of foreign-born scientists to high-growth, cutting edge fields such as bio- and information technology. However, little has been done to extend this research into the emergent field of nanotechnology. To this end, our research employs an original data-set to examine the nativity of scientists making significant contributions to nanotechnology research and innovation.

Much stands to be gained from our research. In addition to extending current knowledge as previously mentioned, our research has applications to a wide variety of areas. For instance, our research contributes information to debates on immigration policy. More specifically, our research will help examine the possible impacts of changing current immigration policy. Also, our original, comprehensive data-set will identify who is driving nano-innovation and information concerning their education.

Methods

The first part of our research was to collect all the articles of the years 1999-2009 concerning nanotechnology and nanoscience. As shown in the Venn diagram, this task is complex due to the great diversity of fields that are classified as related to nanotechnology and nanoscience. The way we overcame this challenge was by using bibliometric methods. Our bibliometric method utilized a set of Boolean search strings¹ to refine the articles on Web of Science to those concerning the nanoworld. These articles were ranked by number of citations and the top 1% were included in our study. We recorded the names of both corresponding and non-corresponding authors.

There are multiple reasons for including such a small percentage of articles into our study. Mainly, existing research has shown that: 6% of publishing scientists publish over 50% of all papers, 25% of published work is never published and the average citations for those that are published is 1.7.² Since our articles have been cited well over 500 times, they provide a great representation of the work of scientists that make high-impact contributions.

To determine the nativity of our population of scientists, we used sources such as the biographical reference *American Men and Women of Science*, department and faculty web pages, and Linked-In. Aggregate and yearly figures were benchmarked against the prevalence of the foreign-born in both the American scientific labor force and general population. We used the chi-square and two-tailed binomial test to determine statistical significance.

Results

Our research examined 362 highly cited articles relating to nanotechnology and nanoscience. For our results to date, we examined only corresponding authors of articles. We were able to gather biographical information on 60% of all these authors as a whole, with a variable collection rate when the authors are sorted by year.

Shown below are the benchmark data-sets that we used to compare our data with. To the right is a graph that compares the observed number of foreign-born contributions with the expected number that is based on the percentage foreign-born from the benchmark data.

As is shown, the number of observed foreign-born contributions for each year far exceeds the number expected based on either benchmark. Several trends are also apparent. Firstly, both the number of nanotechnology related articles and the number of foreign-born contributions have increased each year. This demonstrates both an increasing importance of nanotechnology and the increasing internal globalization of the US nanotechnology community.

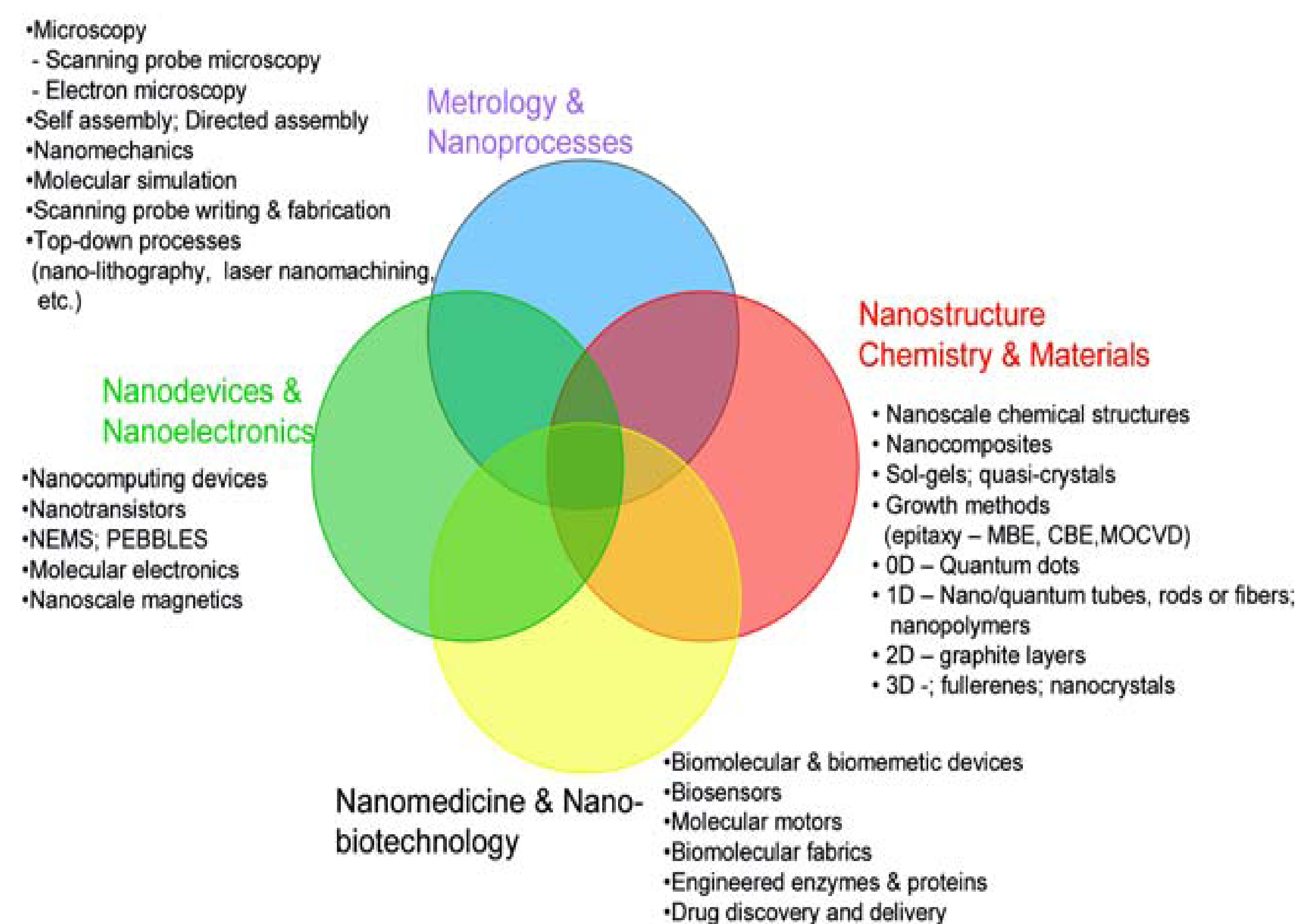
In regards to statistical significance, we find that overall, and for each year after 2005, our results are significant at the $P < 0.0001$ level. However, when benchmarked against the characteristics of the national population we find that the differences observed in 1999 were not statistically significant at the $P < 0.05$ level. As would be expected, when benchmarked against the characteristics of employed doctoral scientists and engineers differences observed in the years 1999, 2000, 2002 and 2003 are not statistically significant at the $P < 0.05$ level.

Characteristics of Employed Doctoral Scientists and Engineers				Characteristics of the Population of the USA			
Year	1999	2003	2006	Year	1999	2003	2006
No. Native US Sci/Engrs	429,070	445,960	468,060	No. Native	247,274,214	255,988,943	262,834,523
No. Foreign Born US Sci/Engrs	124,300	147,340	153,570	No. Foreign Born	29,973,832	34,327,839	37,547,789
% Native US Sci/Engrs	77.5%	75.2%	75.3%	% Native	89.2%	88.2%	87.5%
% Foreign Born US Sci/Engrs	22.5%	24.8%	24.7%	% Foreign Born	10.8%	11.8%	12.5%

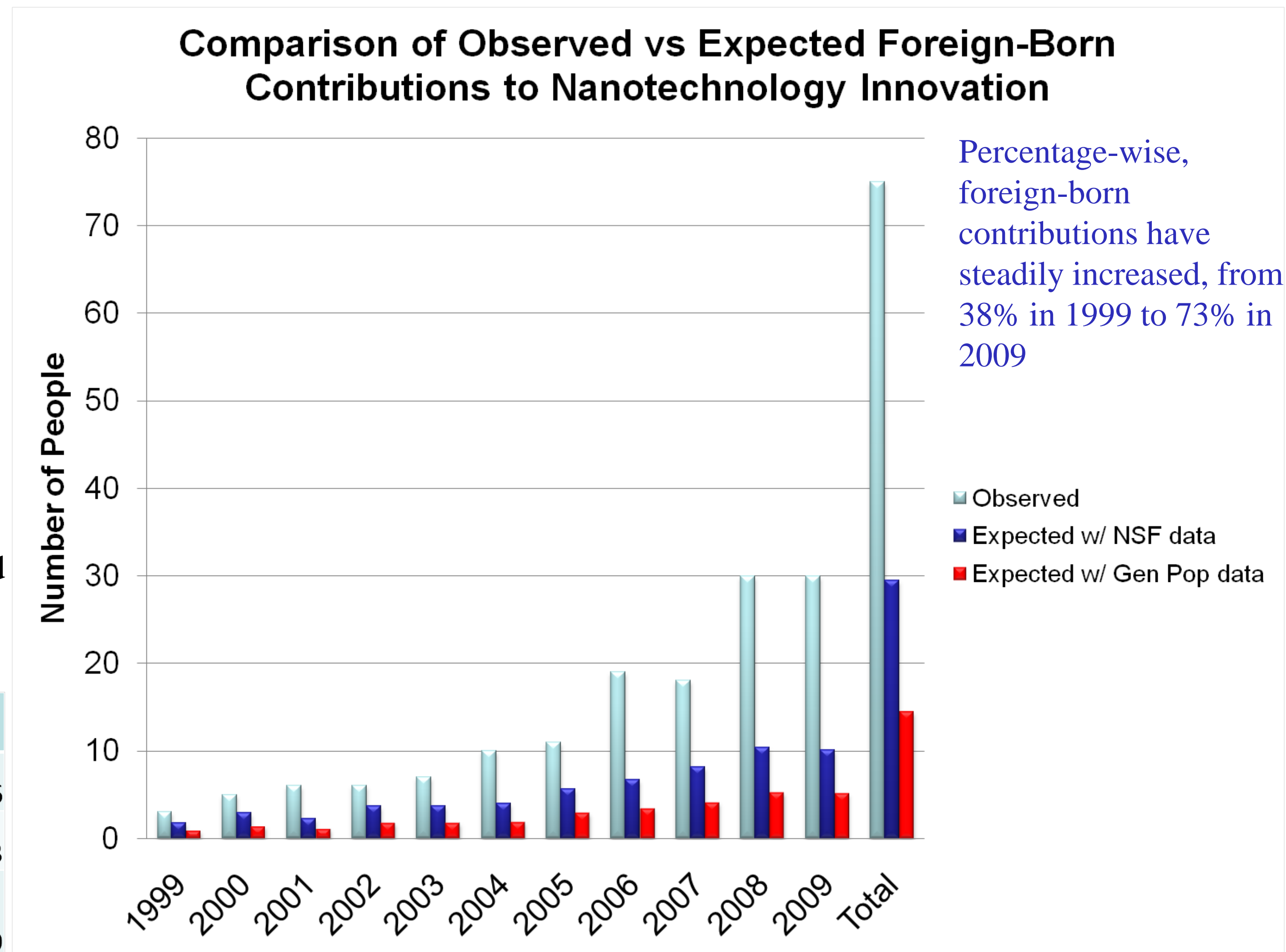
Conclusions/Future Work

In conclusion, we find that foreign-born scientists are disproportionately represented among those making high-impact contributions to the nanotechnology field. Also, the amount of foreign-born contribution and the number of highly-cited articles has increased steadily each year, representing the emergence of the nanotechnology field and the increasing internal globalization of the US nanotechnology community. Our results provide new data on a significant, but largely unstudied phenomenon and promise to contribute to studies on highly-skilled migration and its links to America's economic competitiveness.

In the future, we plan to complete our collection of biographical data with a survey. Also, my working group at the Center for Nanotechnology in Society plans to extend this research by examining patents and PhD production.



Source: Porter, A., Youtie, J., Shapira, P., & Schoeneck, D. (2008, May). Refining search terms for nanotechnology. *Journal of Nanoparticle Research*, 10, 715-728.



Top 4 Countries by Number of Corresponding Authors

United States of America → 47 Scientists
 China → 21 Scientists
 India → 8 Scientists
 Germany → 5 Scientists

References

- Porter, A., Youtie, J., Shapira, P., & Schoeneck, D. (2008, May). Refining search terms for nanotechnology. *Journal of Nanoparticle Research*, 10, 715-728.
- Stephan, Paula, and Sharon Levin, "Exceptional Contributions to US Science by the Foreign-Born and Foreign-Educated," *Population Research and Policy Review* 20:1 (2001), 59-79.

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