Preliminary – Please Do Not Cite

Is Innovation a Good Thing? The Innovation Gap in Pink and Black

April 2014

Lisa D. Cook
Michigan State University
lisacook@msu.edu

Abstract

Innovation, the commercialization of invention, is both desirable and necessary for growth and higher living standards in modern economies. Innovation's contribution to the economy is being measured increasingly more precisely, and its contribution has been assessed as economically important and growing. Yet, participation in the innovation economy is not evenly distributed. Women and African Americans participate at each stage of the innovation process – from education to patent activity to startups – at lower rates than their counterparts. These distributional issues provide further evidence of the wide income and wealth gaps in the United States and of their potential for widening.

Innovation, the commercialization of invention, is both desirable and necessary for growth in modern economies. Innovation's contribution to the economy is being measured increasingly more precisely, and its contribution has been assessed as economically important and growing, e.g., Bryjolfsson and McAfee (2011), Oliner and Sichel (2000), and Oliner, Sichel, and Stiroh (2007). Incomes in the innovation economy are more than double the median income for all workers, employment is increasing faster than in other sectors, and unemployment rates are lower relative to other sectors. Fundamentally, economists and the public care about innovation, because it is a source of wealth generation and higher living standards.

Yet, participation in the innovation economy is not evenly distributed. Women and African Americans participate at each stage of the innovation process at lower rates than their counterparts. These distributional issues provide further evidence of the wide income and wealth gaps in the United States and of their potential for widening.

I. Innovation is Good

From a number of economic perspectives, innovation is a good thing. From the perspective of macroeconomic theory, Romer (1986) demonstrates how ideas can support unbounded economic growth. The seminal work of Griliches (1957) shows how the contribution of ideas, as measured by patents, affects economic growth.

Economic historians have also made important contributions to our understanding of the relation between innovative activity, industrialization, and economic activity. Sokoloff and Khan (1993) examined the seminal role that prolific inventors of the early 19th century played not only as idea-generators but also as entrepreneurs who responded to market signals. Mokyr's (2005) foundational investigation of the patent system showed how it enhanced the market for science. Thomson (2009) studied various aspects of the early American innovation system and found that it was a critical component of industrialization in the U.S.

Current employment and income data provide further evidence of the importance of the innovation economy to the broader economy.[1]

The innovation economy has contributed positively to the size of the labor force. In 2010, the innovation economy was estimated to comprise roughly five to 19 million workers, depending on the definition used.[2] In the U.S. in 2010, roughly 5.4 million college graduates were employed in S&E occupations, and roughly 19.5 million college graduates had a bachelor's or higher-level degree in an S&E field. From 1960 to 2011, the number of workers in the innovation economy grew 3.3 percent annually, on average. In contrast, the annual growth rate was 1.5 percent for the broader workforce, on average. During the recent recession and

[1] In this paper the terms "innovation economy," "science and engineering (S&E) economy," and "S&E occupations" will be used interchangeably.

[2] The National Science Foundation (NSF) uses three measures of the S&E workforce: workers in S&E occupations, holders of S&E degrees, and use of S&E technical expertise on the job.

period of slow economic activity, the U.S. workforce contracted, while the S&E workforce expanded slightly.[3]

NSF (2014) reports that employment rates are higher in the innovation economy than in other sectors of the economy. In October 2010, the unemployment rate for scientists and engineers was 4.3 percent. This was lower than the 5.1 percent for all college-educated workers and the 9.0 percent for the entire U.S. labor force.

Incomes in the innovation economy also exceed incomes in other sectors of the U.S. economy. In 2012, earnings in the innovation economy were more than double those of other workers. The median worker in the innovation economy earned $70,270, compared to $34,750 for all workers.[4]

II. Who Participates in the Innovation Economy?

Three stages or components are required to produce innovation: preparation and education, invention, and innovation or the commercialization of invention. Participation rates in innovative activity vary greatly from one stage to another, from one type of innovation to another, from one gender to the other, and from one racial or ethnic group to another.

[3] NSF (2014).
[4] NSF (2014).

A. Preparation and Education

Women and African Americans have increasingly been involved at the beginning of the innovative process. In 1970, nine percent of all Ph.D.'s in S&E fields were awarded to women. By 2005, the share going to women was 40 percent. In 1970, one percent of all S&E Ph.D.'s went to African Americans. By 2005, the share going to African Americans was four percent. The trends are similar for master's and bachelor's degrees and are comparable through 2010.[5]

Figures 1 and 2 show that these increases among women and African Americans have not been uniform across fields of study. Women have traditionally received the highest share of degrees in the life sciences and the lowest share in engineering. African Americans have also traditionally received the highest share in the life sciences and the lowest share in the physical sciences.

B. Invention

Following (or during) preparation and education, workers in the innovation economy participate in actual invention.

[5] NSF, various years.

Women are also increasing their participation at this stage of innovative activity. Between 1993 and 2010, the share of workers in an S&E field who are women rose from 31 percent to 37 percent. Over the same period, women in S&E occupations rose from 23 percent to 28 percent. Specialization in S&E occupations is similar to degree specialization. Women are more concentrated in life sciences relative to men, 48 percent, and less concentrated in computer and mathematical sciences, 25 percent, and engineering, 13 percent, relative to men.[6]

Roughly 70 percent of workers in the innovation economy are non-Hispanic whites. This is approximately similar to their share in the U.S. population of individuals age 21 and older.[7] It is well known that data on race are difficult to obtain from firms in the innovation economy. Nonetheless, to the extent there is reporting by private-sector firms, their data are broadly consistent with data obtained from NSF surveys of individuals. Figure 3 shows results from reporting by three firms – Dell, Intel, and Ingram Micro. Among these firms, African Americans constitute six percent of the workforce, compared to 11 percent in the workforce overall and compared to 64 percent who are white, 20 percent who are Asian, and nine percent who are Hispanic.[8]

Just as incomes vary between the innovation economy and the rest of the economy, they vary among those within the innovation economy. Among other things, they differ by gender and race. While the median salary for men in the innovation economy in 2010 was $80,000, it was

[6] NSF (2014).
[7] NSF (2014).
[8] Money (2011).

only $53,000 for women. The gap between the median salary for African Americans and whites is not as large as it is between the sexes. In 2010, the median salary for whites was $72,000, and for African Americans, it was $56,000.[9]

Participation in inventive activity, as measured by patents, also differs by gender and race. Cook (2007), Cook and Kongchareon (2010), Cook (2011), and Cook (2014) examine patent activity among women and African American inventors. Cook and Kongchareon (2011) show that women and African Americans lag behind and far behind other U.S. inventors with respect to patent activity. Using data from the U.S. Patent and Trademark Office (USPTO) from 1970 to 2006, we calculate that patent output for all U.S. inventors is 235 patents per million; for women, 40 patents per million; and for African Americans, 6 patents per million.

C. Innovation

The final stage of the innovative process, the development and sale of invention, also displays variation in participation by group. The income gap within and relative to the innovation economy is related to income inequality in the U.S. Likewise, the wealth gap within and relative to the innovation economy is related to wealth inequality. Commercialization, including entrepreneurship, is the part of the innovative process where the largest pecuniary gains are found. Any recent example could demonstrate the type of large transactions that often transpire. For example, Google recently purchased Motorola's 17,000 patents for $5.5 billion.

[9] NSF (2014). Salary data are for full-time workers with the highest degree in S&E field. If using the measure of S&E occupations, men's median salary is 19 percent higher than women's.

This stage is also where diverse groups are most scarce. For example, venture capital firms often seriously consider startup proposals with patents pending. This is increasingly the case as patents become the preferred means of intellectual property rights protection. Given the gap in patent activity, it is reasonable to assume the commercialization gap is wide from the start.

Patent assignment is one simple measure of (potential) commercialization contained in USPTO data. Cook and Kongchareon (2010) examine patent-assignment data to calculate the odds of assigning a patent to a COMPUSTAT (public) firm. The multinomial logit regressions show that women inventors' odds of assigning a patent at issue to a COMPUSTAT firm are 51 percent lower than men's odds. African American inventors' odds of assigning a patent at issues to a COMPUSTAT firm are 46 percent lower than other U.S. inventors' odds.[10]

In general, it is difficult to find women and African Americans among the ranks of entrepreneurs, (senior) management teams, and boards in the innovation economy. It is estimated that female entrepreneurs account for three to five percent of tech startups.[11] African Americans accounted for one percent of entrepreneurs obtaining venture funding.[12] Women and African Americans are sometimes found in legal and marketing departments but are largely missing among executives and boards otherwise.

III. Conclusion: Innovation is Not as Good as It Could Be

[10] Cook and Kongchareon (2010). Odds are calculated relative to assignment to an individual.
[11] Wadwha, Women 2.0
[12] CB Insights. Data are for the first half of 2010.

Taken together, these findings from the innovation economy and their implications raise fundamental questions related to income inequality and wealth inequality. In the economics literature, there is mounting evidence of both. For example, Picketty and Saez (2003, 2011) study income-tax data and provide evidence that levels of income inequality are higher now than they were during the Gilded Age. In just the period of 1993 to 2011, they find that real income growth was nearly 10 times higher for the top one percent compared to the bottom 99 percent – 57.5 percent compared to 5.8 percent.[13] Picketty (2014) uses evidence from over 200 years of data and 20 countries to focus on the sources of wealth accumulation and concentration – returns to capital that are greater than the growth rate of the economy.

Why would economists and the public care about these distributional issues? First, with respect to well-being, individuals assess their incomes, or economic well-being, in relative rather than absolute terms. Large and sustained divergence in income may result in discontent and social unrest, which in turn may lead to lower growth rates. Second, earners at the top may increasingly be able to influence the political process, which may also lead to social unrest. Groups of people not participating in the gains experienced in the innovation economy for prolonged periods may contribute to such divergence in income and wealth and to these undesirable outcomes.

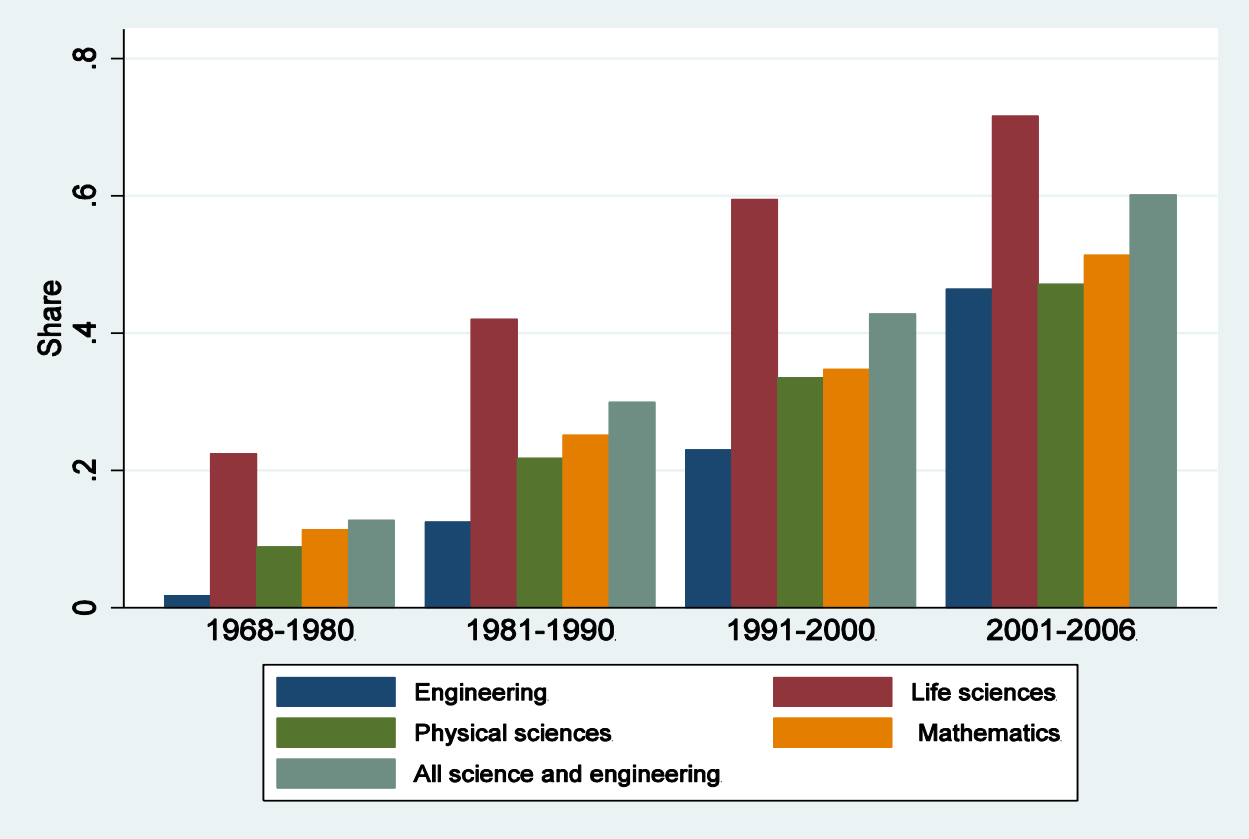
How might the issue of participation or exclusion be addressed? How would one affect the process at each stage of innovation? Input and outcomes? Demand and supply? Is there a role

[13] Saez (2013).

for policy? If so, should it begin with engineering programs that are sometimes found to be hostile to women? Is it greater education about arbitrage opportunities that are not being exploited? For instance, Cook and Kongcharoen (2010) find that co-ed patent teams are more productive than single-sex patent teams. There is much data to be collected and much research to be executed to address these questions and to recommend appropriate changes.

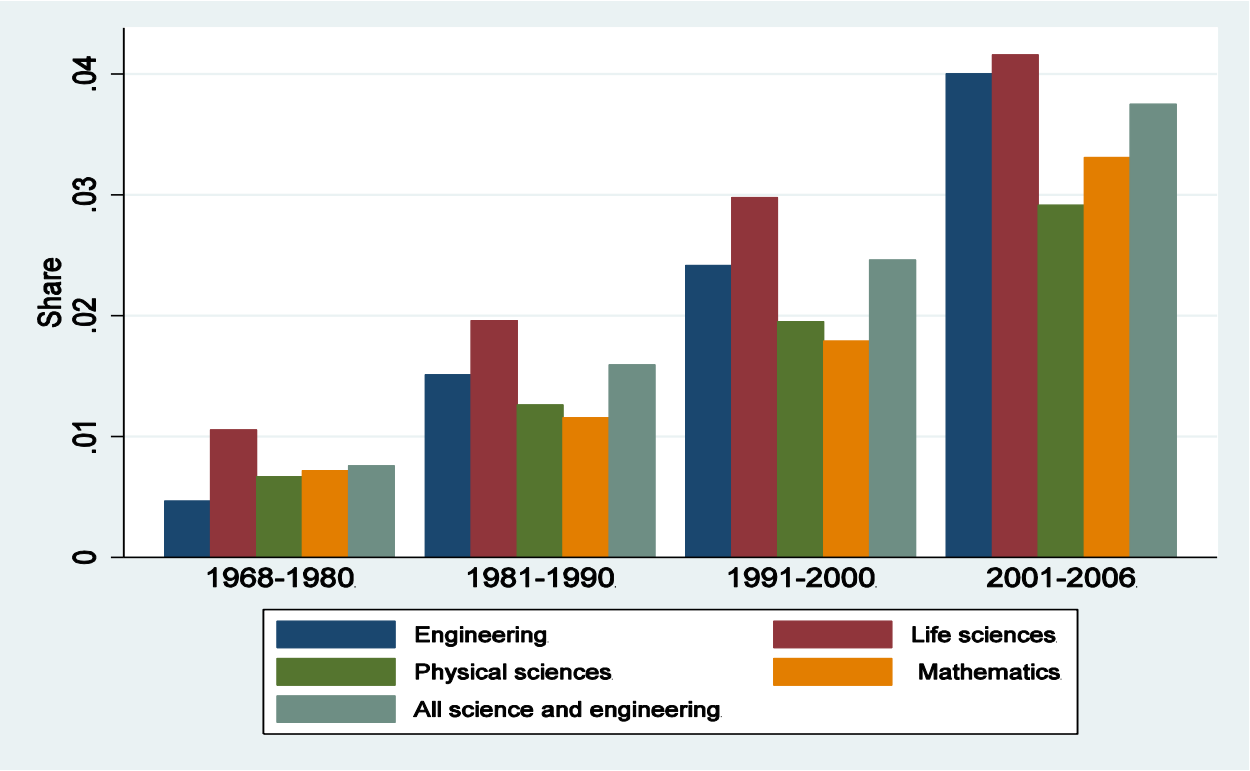
References

Figure 1. Share of Women in Science, Engineering, and Health Doctoral Degrees Awarded, By Field, 1968-2006



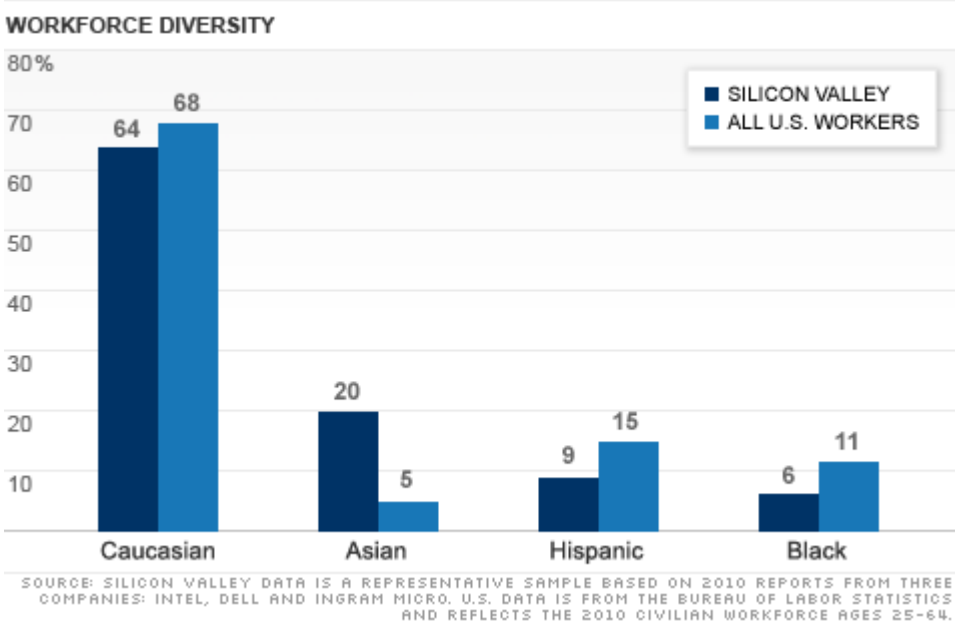
Source: Cook and Kongcharoen (2010); NSF, various issues

Figure 2. Share of African Americans in Science, Engineering, and Health Doctoral Degrees Awarded, by Field, 1968-2006



Source: Cook and Kongcharoen (2010); NSF, various issues

Figure 3. Data on Employment in 3 Silicon Valley Firms



Source: http://money.cnn.com/2011/11/09/technology/diversity_silicon_valley/, 11/9/2011.