Who Becomes an Inventor in America? The Importance of Exposure to Innovation

Executive Summary

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Innovation is widely viewed as the engine of economic growth. As a result, many policies have been proposed to spur innovation, ranging from tax cuts to investments in STEM (science, technology, engineering, and math) education. Unfortunately, the effectiveness of such policies is unclear because we know relatively little about the factors that induce people to become inventors. Who are America's most successful inventors and what can we learn from their experiences in designing policies to stimulate innovation?

We study the lives of more than one million inventors in the United States using a new de-identified database linking patent records to tax and school district records. Tracking these individuals from birth onward, we identify the key factors that determine who becomes an inventor, as measured by filing a patent.[1] Our results shed light on what policies can be most effective in increasing innovation, showing in particular that increasing exposure to innovation among women, minorities, and children from low-income families may have greater potential to spark innovation and growth than traditional approaches such as reducing tax rates.

Our analysis yields three main lessons.

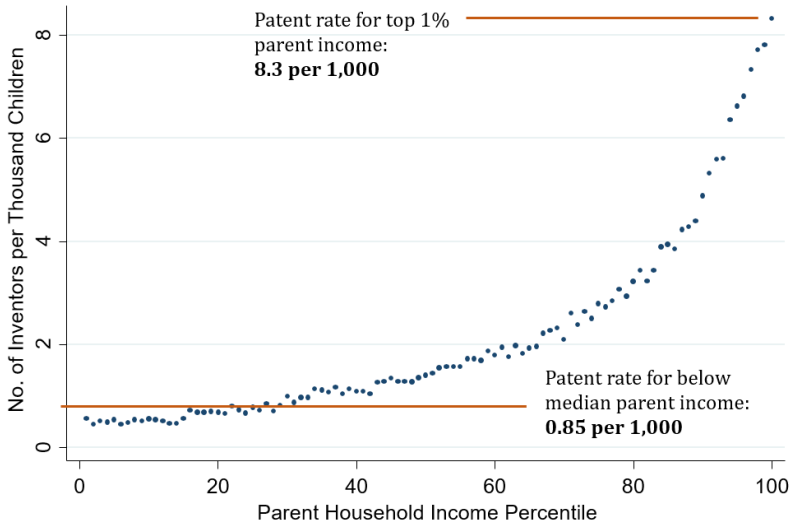
Lesson 1: There are large disparities in innovation rates by socioeconomic class, race, and gender.

Children with parents in the top 1% of the income distribution are ten times more likely to become inventors than children with below-median income parents (Figure 1). There are analogous gaps by race and gender: white children are three times more likely to become inventors than black children and only 18% of inventors are female. The gender gap in innovation is shrinking gradually over time, but at the current rate, it will take another 118 years to reach gender parity.

Children from high-income families are ten times more likely to become inventors than children from low-income families.

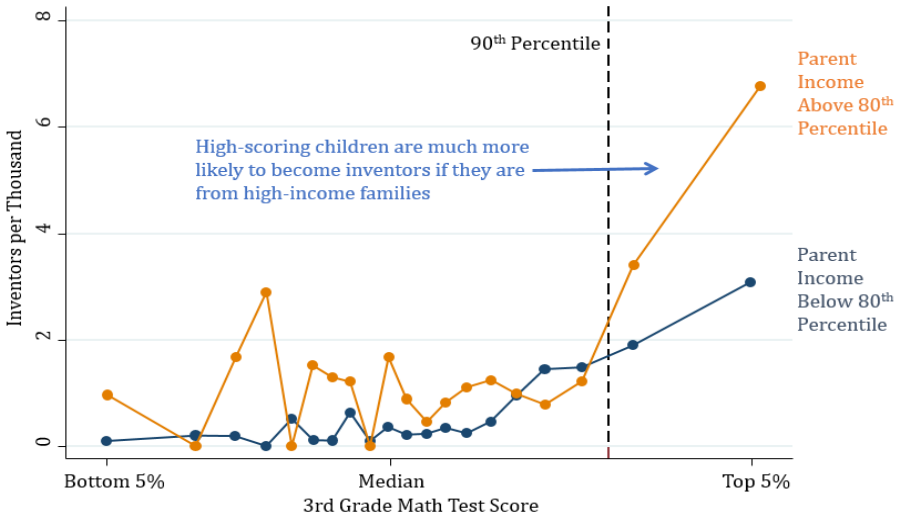
[1] Not all patents are meaningful new inventions; however, we show that focusing on the subset of patents that have the most substantial scientific impact, as measured by future citations, generates very similar results to those discussed below.

Figure 1. Patent Rates vs. Parent Income



Differences in ability, as measured by test scores in early childhood, explain very little of these disparities. Children at the top of their 3rd grade math class are much more likely to become inventors, but only if they come from high-income families (Figure 2). High-scoring children from low-income or minority families are unlikely to become inventors. Put differently, becoming an inventor relies upon two things in America: excelling in math and science *and* having a rich family.

Figure 2. Patent Rates vs. 3rd Grade Math Test Scores for Children of Low- vs. High-Income Parents

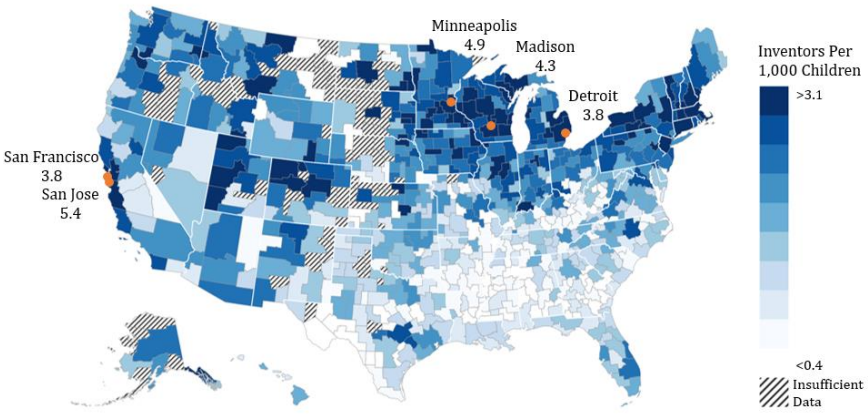


The gap in innovation explained by test scores grows in later grades; by 8th grade, half of the gap in innovation by income can be explained by differences in test scores. This is because low-income children steadily fall behind their high-income peers over time, perhaps because of differences in their schools and childhood environments. We next turn to analyze what specific environmental factors contribute to these disparities.

Lesson 2: Exposure to innovation substantially increases the chances that children become inventors.

Children who grow up in areas with more inventors – and are thereby more exposed to innovation while growing up – are much more likely to become inventors themselves. Exposure influences not just whether a child grows up to become an inventor but also the *type* of inventions he or she produces. For example, among people living in Boston, those who grew up in Silicon Valley are especially likely to patent in computers, while those who grew up in Minneapolis – which has many medical device manufacturers – are especially likely to patent in medical devices. Similarly, children whose parents hold patents in a certain technology class (e.g., amplifiers) are more likely to patent in *exactly* that field themselves rather than in other closely related fields (e.g., antennas).

Figure 3. The Origins of Inventors: Patent Rates by Area Where Children Grow up



Darker colors denote areas where more children grow up to become inventors. The five cities that produce the most inventors per capita in America are highlighted.

Exposure matters in a gender-specific manner. Women are more likely to invent in a given technology class if they grew up in an area with many female inventors in that technology class. Growing up around male inventors has no impact on women's propensity to innovate. Conversely, men's innovation rates are influenced by male rather than female inventors in their area.

Our findings are consistent with recent evidence that exposure to better neighborhoods in childhood improves children's life outcomes. Neighborhood effects have typically been attributed to factors such as school quality or

residential segregation. Since it is implausible that some neighborhoods or schools prepare children to innovate in a single field, such as amplifiers, the exposure effects here are more likely to be driven by mechanisms such as mentoring, transmission of information, and networks.

Children from low-income families, minorities, and women are less likely to have such exposure through their families and neighborhoods, helping explain why they have significantly lower rates of innovation. For example, our estimates imply that if girls were as exposed to female inventors as boys are to male inventors, the gender gap in innovation would fall by half.

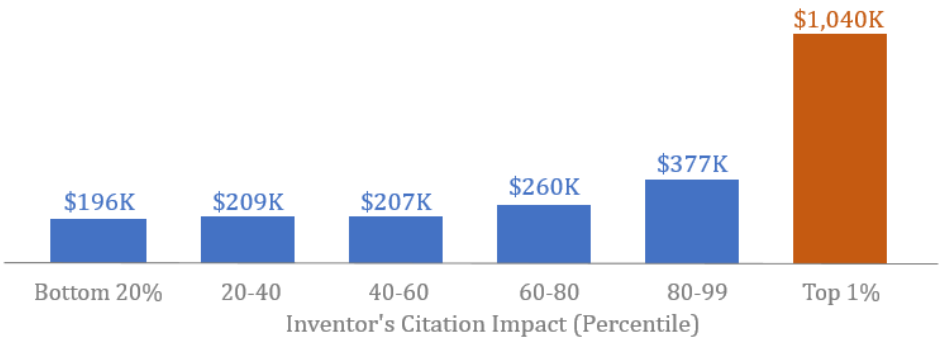
If girls were exposed to female inventors during childhood at the same rate that boys are to male inventors, the gender gap in innovation would fall by half.

Stepping forward in children's lives, we find that innovation rates vary widely across colleges, but students from low- and high-income families at the most innovative colleges (e.g., MIT) patent at relatively similar rates. This finding reinforces the view that factors that affect children *before* they enter the labor market, such as childhood environment and exposure to innovation, drive much of the gaps in innovation we uncovered.[2]

Lesson 3: Star inventors earn more than $1 million per year, suggesting that further increasing financial incentives or reducing tax rates may have small effects on innovation.

The average patent holder earns approximately $256,000 per year in his or her mid-forties. But the individuals who make discoveries that have the greatest scientific impact – i.e., those who produce the most highly-cited patents – earn more than $1 million on average per year (Figure 4). Scientific progress is largely driven by a few star inventors who are highly compensated for their work by the market.

Figure 4. Inventors' Annual Incomes by Scientific Impact



[2] This result also weighs against the hypothesis that a lack of access to funding or an aversion to risk discourage low-income students from pursuing innovation, as those factors would generate gaps in innovation rates even among students attending the same college.

Women, minorities, and individuals from low income families are as under-represented among star inventors as they are among inventors as a whole. Given our finding that innovation ability does not vary substantially across these groups, this result implies there are many "lost Einsteins" – people who would have had high-impact inventions had they become inventors – among the under-represented groups.

There are many "lost Einsteins" – people who would have had highly impactful inventions had they been exposed to careers in innovation as children.

These findings suggest that changes in financial incentives (e.g., by reducing tax rates) have limited scope to increase innovation, for two reasons. First, changes in incentives affect only the small subset of individuals who have exposure to innovation. Second, such policies are unlikely to influence the decisions of star inventors who matter most for economic growth. Star inventors – who typically earn more than $1 million per year – would presumably be happy to work in their field even if they earned say $950,000 instead of $1 million per year.[3] We caution, however, that these predictions remain to be tested empirically and that taxes could potentially affect economic growth through other channels, for instance by changing the behavior of firms or other workers.

Policy Implications

If women, minorities, and children from low-income families were to invent at the same rate as white men from high-income (top 20%) families, the rate of innovation in America would quadruple. Our findings therefore call for greater focus on policies that harness the under-utilized talent in these groups by providing them greater exposure to innovation. Such policies could range from mentoring programs to internships to interventions through social networks. Our analysis does not tell us which programs are most effective, but it does provide some guidance on how they should be targeted. Targeting exposure programs to children from under-represented groups who excel in math and science at early ages is likely to maximize their impacts. Furthermore, tailoring programs to participants' backgrounds may be valuable: for example, women are more influenced by female rather than male inventors.

Improving opportunities for upward mobility may increase innovation and economic growth

More broadly, our results suggest that improving opportunities for disadvantaged children may be valuable not just to reduce disparities but also to spur greater innovation and growth.

[3] Even if people are uncertain about their chances of becoming a star when deciding whether to pursue innovation, tax changes are unlikely to have large effects. The payoffs to innovation are similar to a buying a lottery ticket. Most of the time one doesn't win (in which case tax rates don't matter), but sometimes one hits the jackpot and wins millions (in which case a slightly smaller payout won't reduce interest in buying a ticket by much).

Want to Learn More?

Read the full paper or presentation slides

Download the new data on innovation constructed in this study:

- Origins of inventors: innovation rates by childhood state and commuting zone (CZ), gender, and parental income.
- Careers of inventors: innovation rates by current state and CZ, gender, age, and year of birth.
- Innovation rates by college.
- Income distributions of inventors by age and year.

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