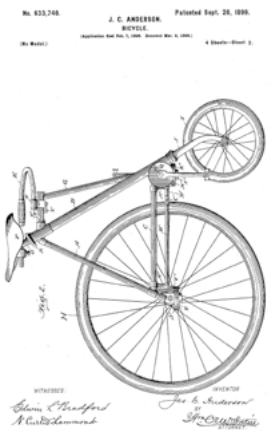
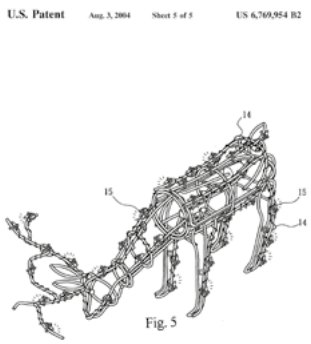
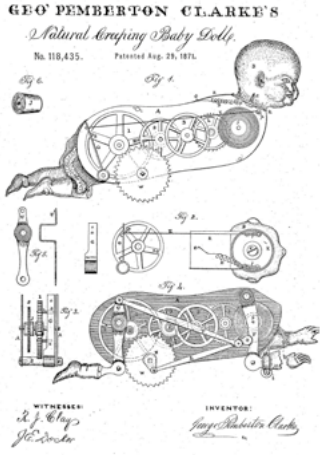
Who are America's most successful inventors – and what can we learn from their experiences in designing policies to stimulate innovation? To answer these questions, former CEP director **John Van Reenen** and his colleagues have analysed data on the lives of more than one million inventors.

Lost Einsteins: who becomes an inventor in America?







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 educational investments in STEM (science, technology, engineering and mathematics).

Unfortunately, the effectiveness of such policies is unclear because we know relatively little about the factors that induce people to become inventors. Who are the most successful inventors? And what can we learn from their experiences when designing policies to stimulate innovation?

To answer these questions, 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 onwards, we identify the key factors that determine who becomes an inventor, as measured by filing a patent.

Our results shed light on what policies can be most effective in increasing innovation. In particular, we show 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 cutting tax rates.

Exposure to innovation substantially increases the chances that children become inventors

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 (see 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.

Differences in ability, as measured by test scores in early childhood, explain very little of these disparities. Children at the top of their third grade (ages 8-9) mathematics class are much more likely to become inventors if they come from high-income families than if they come from poorer families (see Figure 2). High-scoring children from low-income or minority families are unlikely to become inventors. Put differently, becoming an inventor relies on two things in the United States: excelling in mathematics and science *and* having a rich family.

The gap in innovation explained by test scores grows in later grades; by eighth grade (ages 13-14), 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 analyse what specific environmental factors contribute to these disparities.

Figure 1:
Patent rates versus parent income

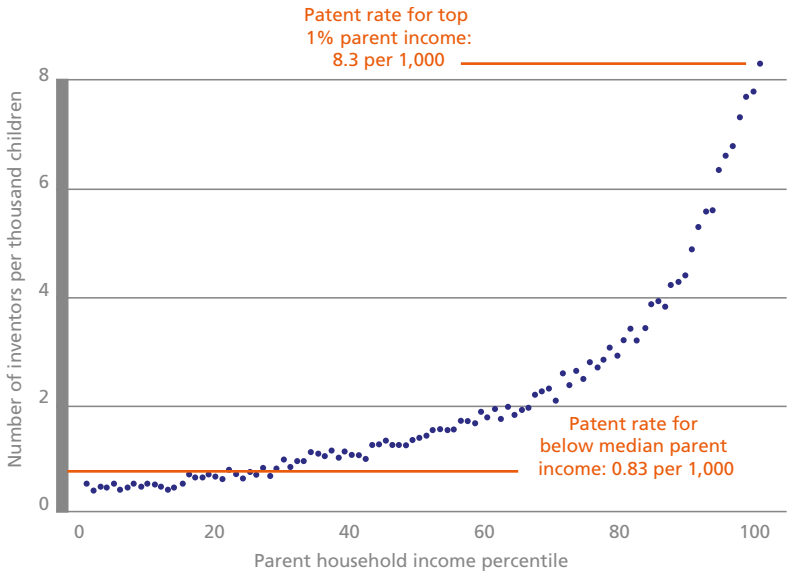
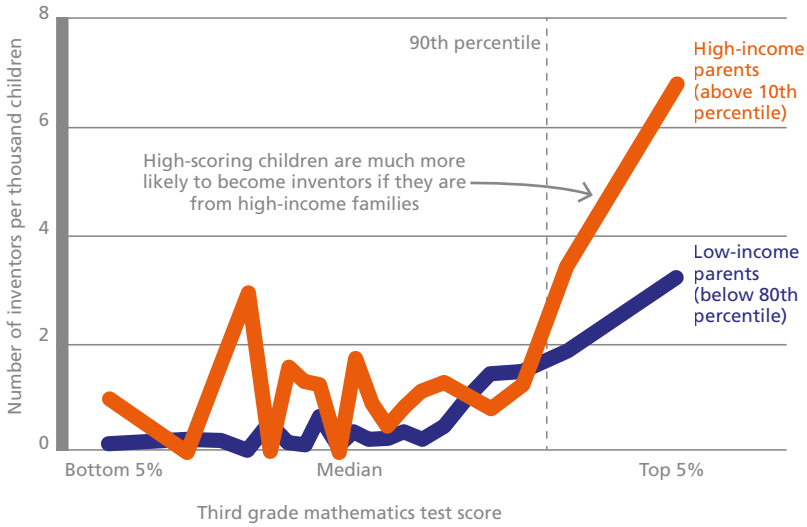
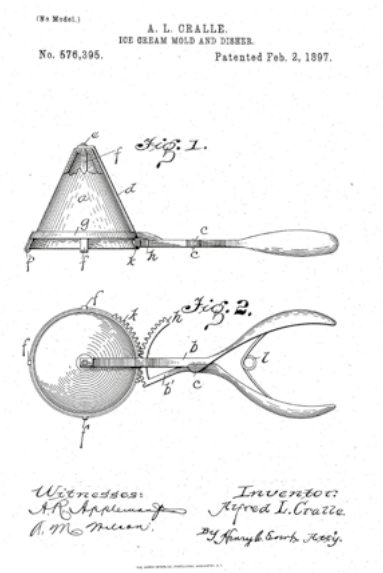


Figure 2:
Patent rates versus third grade (age 8-9) mathematics test scores for children of low- versus high-income parents





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

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 (see Figure 3). 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 (amplifiers, for example) are more likely to patent in exactly that field themselves rather than in other closely related fields (antennas, for example).

Exposure also 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 neighbourhoods in childhood improves children's life outcomes. Neighbourhood effects have typically been attributed to factors such as school quality or residential segregation. Since it is implausible that some neighbourhoods 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, networks and transmission of information.

Children from low-income families, minorities and women are less likely to have such exposure through their families and neighbourhoods, helping to 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.

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

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 – that is, those who produce the most highly cited patents – earn more than $1 million on average per year (see Figure 4). Scientific progress is largely driven by a few star inventors who are highly compensated for their work by the market.

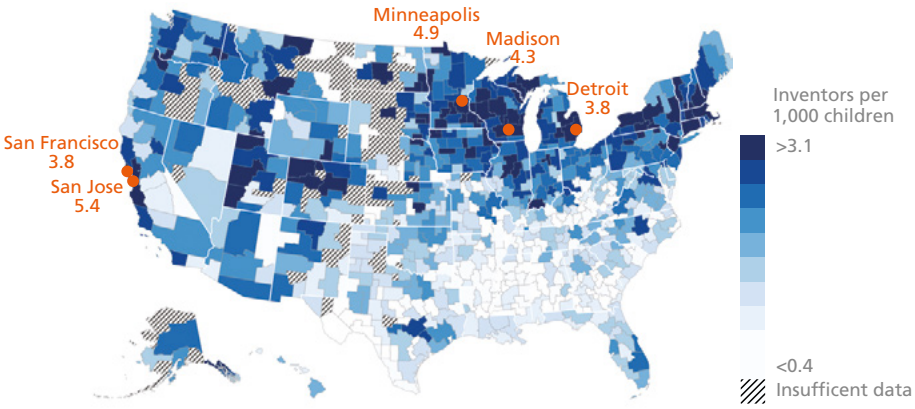
Women, minorities and individuals from low-income families are as under-represented among star inventors as they are among inventors as a whole. Given our finding that innovation ability does not vary substantially across these groups, this result implies there are many 'lost Einsteins' – people who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

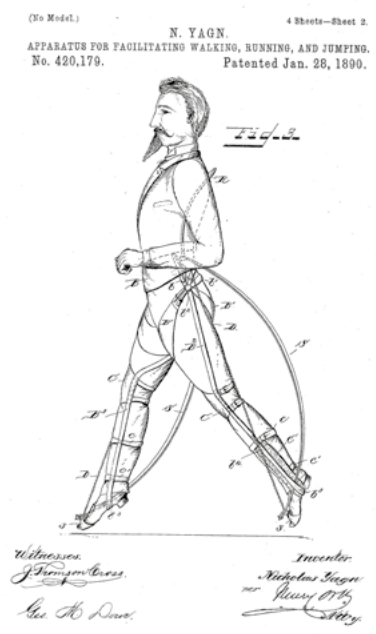
These findings suggest that changes in financial incentives (for example, by reducing tax rates) have limited scope to increase innovation. This is for two reasons:

■ First, changes in incentives affect only the small subset of individuals who have exposure to innovation.

Improving opportunities for upward mobility may spur greater innovation and growth

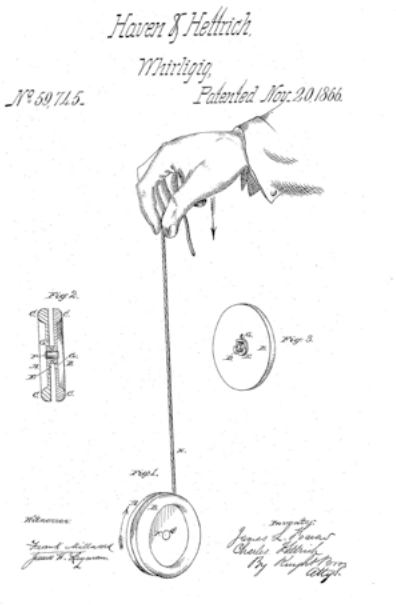
Figure 3:
The origins of inventors: patent rates by area where children grow up





Notes: Darker colours denote areas where more children grow up to become inventors. The five American cities that produce the most inventors per capita are highlighted.

If girls were as exposed to female inventors as boys are to male inventors, the gender gap in innovation would fall by half



■ 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. We caution, however, that these predictions remain to be tested empirically. Taxes could potentially affect economic growth through other channels, for example, by changing the behaviour 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 the United States would quadruple. Our findings therefore call for greater focus on policies that harness the under-used talent in these groups by providing them with greater exposure to innovation. Such policies could range from mentoring programmes to internships to interventions through social networks.

Our analysis does not tell us which programmes are most effective, but it does provide some guidance on how they should be targeted. Targeting exposure programmes to children from under-represented groups who excel in mathematics and science at an early age is likely to maximise their impacts. Furthermore, tailoring programmes to participants' backgrounds may be valuable: for example, women are more influenced by female rather than male inventors.

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.

This article summarises 'Who Becomes an Inventor in America? The Importance of Exposure to Innovation' by Alex Bell, Raj Chetty, Xavier Jaravel, Neviana Petkova and John Van Reenen, CEP Discussion Paper No. 1519 (http://cep.lse.ac.uk/pubs/download/dp1519.pdf).

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There are many 'lost Einsteins' – people who would have had high-impact inventions had they become inventors

Figure 4:
Inventors' annual incomes by scientific impact