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RAJ CHETTY ON "THE LOST EINSTEINS"

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Introduction:

TED GAYER
Vice President and Director, Economic Studies
The Brookings Institution

Presentation: The Lost Einsteins

RAJ CHETTY
Professor of Economics
Stanford University

Panel: Increasing Opportunity and Harnessing Talent -- What Works?

RICHARD REEVES, Moderator
Senior Fellow and Co-Director, Center on Children and Families
The Brookings Institution

RAJ CHETTY
Professor of Economics
Stanford University

TONY JACK
Junior Fellow, Harvard Society of Fellows, Assistant Professor of Education
Harvard University

RESHMA SAUJANI
Founder and Chief Executive Officer
Girls Who Code

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P R O C E E D I N G S

MR. GAYER: My name is Ted Gayer. I am the Vice President and Director of Economic Studies here at Brookings. And I'm delighted today that we are hosting Raj Chetty to discuss his most recent paper on “lost Einsteins.”

I actually have a little personal Raj Chetty story; I didn't share with them right before when we were chatting. So, I've been in this role for four years, I like my job I should say, and right after I got the promotion I was invited to a Brookings Board meeting, and one of the co-chairs, then co-chairs of our Board, I later learned has a tendency to do this, I didn't know it at a time, he cold-calls me.

So, it's my first Board Meeting, he cold-calls me, and he says, I'm wondering: What's the most influential economics article in the last few years? So, you know the mind races a little bit under those circumstances, it was a totally fair question, I am vice president of Economic Studies, I should be able to answer that question.

So, what felt like a long delay and then, boom, I came up with Raj Chetty. So, you can imagine the next moment of panic, because then you have to figure out which Raj Chetty Study is the most influential study in the past few years, which is a very, very challenging task. So, I don't remember what I answered that day, I will list some of my favorites and maybe we can have a little, like poll or something to figure out which one wins.

He's got a fantastic paper on absolute mobility, where he shows that over the last half decades the likelihood of a child earning more than their parent at the age of 30 has steadily diminished. I sometimes do these talks on the state of the economy, and I think I labeled this: the most dispiriting slide of the year, sometimes labeled: the fading of the American Dream.

He has a paper or papers on relative mobility showing that the probability

that a child born at the bottom of the distribution, income distribution will rise to the top of the distribution, as that probability has been relatively flat, again, over many, many decades. He's got a few papers on the “Effective Location on Economic Outcomes,” showing that children who moved to better neighborhoods improved their economic outcomes in proportion to the amount of time they spend in their childhood in those better neighborhoods.

He's done path-breaking work on the impact of teachers on later student outcomes on the optimal level and duration of unemployment insurance, a paper that he presented here, which I was just telling him, was one of my favorite presentations, was on the difference between subsidizing savings, versus behavioral elements to promote -- passive behavioral elements to promote savings, the latter being more effective.

And then an oldie but a goodie, Adam Looney is somewhere here, Adam Looney is the co-author -- a colleague of mine, and a co-author of him, of Raj's, on a paper on tax salience, which is just a fantastic paper, I think around 2008, basically showing -- I've written a public finance book -- basically showed my book is wrong. So, thank you.

In that paper looking at the difference between if you levy a tax and you put it on -- you actually include the tax in the ticket price when you go to the shelf, as opposed to you include it when it gets rung up the register, you get very different consumer responses. Again, violating the basic principles we held in public finance.

There are two things in particular I want to point out, that I appreciate about Raj and his work. One is he's disabused me of this long-held notion that I had. In the 1990s and 2000s, in the economics profession, there was this very healthy development. This really meticulous focus on issues of research design, what we called "identification", and it really got us thinking about how best can we try to obtain credible

empirical evidence, how do we know if we are actually presenting evidence that might not be that credible, and it really enhanced a conversation about the empirical validity of what we were arguing.

The claim that I used to make that he's disabused me of is, unfortunately I felt, which I think was true, that the better the research design the narrower the question, and so you often found yourself having really, really, really good research designs, very credible estimates on questions that, you know, some people might care about but aren't of great importance.

Well, he's blown that out of the water combining his dedication to meticulous research design, credible empirical evidence but yet using large enough data sets and fabulous techniques in order to get at really important questions of the day.

The second thing I appreciate about Raj, I alluded to before, is I feel he understands the importance of exposing his work to policy experts and to audiences like this, he's spoken here before at Brookings, he's sharing his work with us today, and I think that's something to be emulated.

So, today I'm grateful that he's here to talk about his latest paper on Lost Einsteins, which, along with his co-authors, they examined the disparities and innovation rates by socioeconomic class, race and gender.

So, the plan is to have Raj talk for about a half hour. Then my colleague, Richard Reeves, will lead a panel discussion up here, and as we do at Brookings, we will welcome your questions and have a Q&A period to follow. So with that, please join me in welcoming Raj Chetty. (Applause)

MR. CHETTY: Thanks so much, Ted, for the really thoughtful and generous introduction. And thank you all for being here. Before I start I just wanted to thank Brookings, as well, for hosting these events, we've done a couple of these at the

Quality of Opportunity Project here at Brookings, and have really felt the impact that these events have on translating the research into the public debate, so I appreciate your doing this.

So, the topic I'm going to talk about today really starts from a very simple motivation, a very simple question: How can we increase innovation and growth in America? Innovation, as you all know, is widely viewed as the engine of economic growth by many people, and so motivated by that there are people who have talked for a long time about how we can increase rates of innovation. There are many policies we implement with that goal in mind, ranging from investments in STEM education, to tax incentives, you know, R&D tax credits for firms or tax cuts for individuals, trying to spur more innovations, spur more entrepreneurship.

Now, the effectiveness of these policies is widely debated, in the latest tax reform bill being one example, while cutting top tax rates really stimulate further entrepreneurship and growth for instance, and that's partly, we think, because of a lack of data on who innovates in America. Who actually are the people who are doing the invention, the entrepreneurship, and so forth, we actually don't really know very much about them because we've lacked data traditionally on being able to look at the life trajectories of people who become inventors.

So, what we are going to do in this paper with my colleagues, Alex Bell, Neviana Petkova, Van Reenen and Xavier Jaravel, use big data to study who becomes an inventor in America.

And the approach we take is to link three very different data sets that allow us to paint a quite comprehensive picture of inventors' life trajectories. The first is, we start from publicly-available patent records, we are going to use patent as a proxy for innovation. They are not a perfect measure of innovation by any means, but we think

they do capture, for reasons I'll explain, important aspects of innovation.

And then we link that data working with people in the U.S. Treasury, who do this linkage internally, to information from Federal income tax returns, where we can see things like kids' parental backgrounds, what their parents incomes were, where they go to college, what their earnings are, and so forth.

And then we bring in a third set of data from the New York City School District where we were able to look at, over a 20-year period, information on test scores in elementary and middle school for all kids who went to New York City schools. And by linking these three data sets we were able to have a rich database that really allows us to study the lives of inventors and ultimately what types of policies might matter to increase innovation.

So, the way I'm going to organize the talk, the way we organized our thinking in analyzing these data is by, it's basically a chronological approach, tracking inventors from birth to adulthood to understand the factors that determine who invents.

And so I'm going to start at the beginning by analyzing inventors' characteristics at birth with this chart here, which shows you patent rates versus parent income, so the way this chart is constructed is each dot represents 1 percentile of the parental household income distribution, and they were plotting the number of kids who go on to become inventors in that income group per thousand children. So, you can see that if you are born to parents below the median of the U.S. income distribution less than one in a thousand of those kids goes on to become an inventor by their mid-30s or so, which is when we are measuring innovation rates.

In contrast, if you happen to be born to parents in the top 1 percent of the income distribution you're 10 times as likely to become an inventor as kids born to parents below the median. Now, this pattern holds not just for innovation in general, but

also for the subset of very highly-cited patents that have a big influence on scientific progress, on commercialization, on market values. So think of, for instance, the Google Search algorithm, a very famous patent that obviously had a big impact. So if you look at the subset of highly-cited patents and ask what fraction of kids go on to have a patent that really has a significant impact, they are in the top 5 percent of the citation distribution,

You see that you see an extremely similar pattern to what I showed you before, and the reason this is important is because it suggests that there's a potential here for what we call Lost Einsteins. What if these kids at the bottom of the income distribution innovated at the same rate as the kids who came from higher income families? We would have dramatically more high-impact patents that could change technology, change medical progress, change our lives in many ways.

Now, before we jump to the conclusion that there are lost Einsteins and this is a problem we need to fix, I think it's important to ask from a scientific perspective: why do patent rates vary with parent income? And here it's useful to classify the set of possibilities into three potential explanations.

So, the first is what economists would call differences in endowments, or in this case, differences in ability. So, perhaps it's the case that kids from higher income families, their parents must presumably have been talented to reach the top of the income distribution, maybe they just have a greater ability to innovate, and so maybe that explains some of the gradient we are seeing, you know, that's an explanation we should at least consider seriously.

A second possibility is that this is about differences in preferences, so a very natural thing you might think of is that lower-income kids, you know, maybe they'd have the opportunity to innovate if they want to, but innovation is a risky career, and as I'll

show you some evidence of. And so if you come from a low-income family you might say, you know, I want to choose a safer path where I can support my family, and so forth, I don't want to do this thing that has incredibly risky returns.

A third possibility is that lower-income kids have comparable talent and perhaps similar preferences, but maybe they just lack the resources or exposure to innovation, or they face barriers to entry that prevent them from going into innovation.

So, why is it important to distinguish these three explanations? If it's the third story, there's a potential role for policy, there's a role for non-profits, there's a role for us to do something about this problem in a way that that could really make a difference. If it's the first two, it's a little bit hard to think about, harder to think about what you might do if people just want to pursue different careers.

You could think about things like reducing the amount of risk they face, but it would point you in a different direction relative to, we think this is about constraints. So, with that structure I want to start by thinking about this first possibility that this is about differences in ability, and this is where we are going to bring in the information on test scores that we have from the school district data.

So this chart here is showing you the same vertical axis, Y axis as we had before, the number of kids who go on to become inventors, but now plotted not against parental income but against math test scores in third grade. And the way this is constructed is each dot represents 5 percent of the test score distribution, so the first dot is the bottom 5 percent, the top dot is the top 5 percent. And you can see there's a very strong relationship between math test scores as early as third grade and probabilities of becoming an inventor. The future kid, the kids at the top of their third grade math class are much more likely to become inventors.

So that's perhaps not surprising, it's intuitive, I mean I think it does show

you that these test scores, even at early ages, have quite a bit of predictive power, which is an important point in the context of the debate about standardized tests.

What I think is of more interest in the context for what we are talking about here, is if you now split this data, looking at kids who come from relatively high-income families, in the top quintile of the income distribution in the orange, and kids who come from lower-income and middle-income families in the blue below the 80th percentile, you see a very interesting pattern which is that high-scoring children are much more likely to become inventors if they are from high-income families.

If you're from a low-income family in the blue, and are at the top of your third grade math class, your probability of becoming an inventor, of having a patent in your mid-30s doesn't look all that much higher than other kids. And so this fact I think really suggests that this can't be purely about differences in ability, because even among kids who appear to be quite talented in math early in childhood you see quite significant differences in rates of innovation.

So, to put it differently, this data seems to suggest that in America you need two things to become an inventor. You need to excel in math and science, you need to be smart and in these fields, and you need to come from a rich family. And that of course raises the possibility that there might be a significant number of Lost Einsteins, that are a set of kids who could potentially come through the pipeline who are not doing so.

So, that data was for kids -- was using data on test scores in third grade. Now, an interesting pattern you find, which I think illuminates what might be going on here is if you ask: What fraction of the gap in innovation can be accounted for by differences in test scores for kids in high-income versus low-income families?

It turns out if you look at the data that I was showing you before, the

answer to that question is about 30 percent in third grade. Of course third grade is not like the starting point, by the time you're in third grade there have been quite different experiences for kids in low- and high-income families, so you shouldn't think of that as a pure measure of innate ability.

But even given that, in third grade you explained only 30 percent of the gap in innovation by differences in test scores, but now if you repeat that analysis and ask, what fraction of the gap in innovation can you explain by differences in test scores in fourth grade, fifth grade, sixth grade, and so on, you see that there's a steady progression over time.

So, basically what's happening here is that lower-income kids are falling behind higher income kids in terms of test scores in school, and so by the time they get to, if you extrapolate out and think about the end of high school or college, if you were to look at test score performance at that time or other measures of kind of ability at that point, you wouldn't be all that surprised to see much lower innovation rates among kids from lower-income families relative to kids from higher-income families.

And what that suggests, and once again is that there's something happening, these kids are going along different paths even though they started out with relatively similar abilities at the beginning, pointing not so much to the ability story but to other possibilities.

So, what I want to quickly show you next, before turning to what those other possibilities are, is that you find analogous patterns if you look at other dimensions of the data. So, if you look at differences by race or by gender you see quite similar gaps to what we saw by income, so this chart replicates the chart that I showed you before.

Now, cutting the data by race and ethnicity instead of cutting the data by parental income, and you can see, you know, really stark patterns here, where among

kids at the top of their third grade math class once again, Asians and Whites have quite high probabilities of becoming inventors, but Black and Hispanic kids who are at the very -- you know, performing at the same level in third grade just have a much, much, almost zero probability of becoming inventors, illustrating the stark gaps by race and ethnicity that we see in this context and many other contexts.

Turning to gender, here we can look at how this has changed over time. So, this is showing you the fraction of inventors who are female by the year in which they are born, and you can see that the gender gap in innovation in America is actually closing, steadily, over time. There are more and more female inventors over time, but if you look at the magnitude of that progression, currently about 14 percent of patents go to go to women and every year there's an increase of about a quarter of a percentage point.

What that means is it's going to take another 118 years to reach gender parity in innovation, right, it's a very slow progress in terms of gender convergence just given the status quo. Once again, you know, that doesn't seem to be related to differences in ability if you look at the set of kids who are scoring at the top of their third grade math class, much higher innovation rates if you're a boy than if you're a girl.

So, what I want to turn to next is, okay, so it doesn't seem like this is about pure differences in ability or intrinsic talent. What might be going on here? So, what we are going to do next is turn to what's going on in childhood and hone in specifically on the effects of childhood environment, thinking about childhood environment in a very particular way.

So, we are going to study the impacts of childhood environment by focusing on the effect of exposure to innovation during childhood through your family or through your neighbors. And so let's start once again by thinking about your own parents, analyzing the relationship between children's patent rates and their own parents'

patent rates.

So, this simple chart here just asks: let's take the set of kids whose own parents were inventors who had a patent, and the set of kids whose parents were not inventors. You can see that the kids whose parents were inventors are about 10 times more likely to have a patent themselves as the kids whose parents were not inventors.

Now, that correlation could be driven by two very different mechanisms it could be driven by genetics, so it could be that if your parents were good at innovating, you know, maybe you are as well, that seems intuitive. Or, it could be about exposure. Maybe you're aware of careers in innovation, you pursue math and science, you are interested in technology because you grew up in a family where that was discussed at the dinner table, and it's really like on your radar screen, something you're interested in.

So, how do we distinguish between these two very different explanations? So, one of the key ideas of the paper is that we can isolate the causal effect exposure by analyzing the propensity to patent in very narrow technology classes. Patents are classified into about 450 different technology classes which are very fine, so amplifiers, antennas, different fields in which you can get a patent.

And the intuition here is that your genetic ability to innovate is unlikely to vary across very similar technology classes, right; you'd be surprised if you have that amplifier gene as opposed to the antenna gene. And so what we are going to do to operationalize that logic is define the similarity of two technology classes based on the fraction of inventors who patent in both of those classes.

So, intuitively you're going to see relatively few people patenting in biology and in computers, so those are going to get classified as being very far apart, but there are going to be more people who patent in one type of semiconductors and another type of semiconductors, and that's going to get classified as being very close. Okay.

To give you a concrete sense of how this works, if we take, in this case, a particular technology class, pulse or digital communications, the next closest class is demodulators, then modulators, oscillators, and so forth.

And basically our logic is, you know, we don't think your genetic propensity to patent is going to be different for oscillators, or modulators, or demodulators. So, we are going to see how your probability of inventing varies across these categories in relation to the field in which your father had a patent.

And so this chart summarizes that finding. What we are showing here is the fraction of kids who invent in each field, where zero denotes inventing in the same field as your dad, and then one is the next closest technology, two is the second-closest technology, and so forth. What do you see is a really striking pattern which is that kids are much more likely to invent in exactly the same technology class as their parents, and not even the thing that's just one away.

So, if your dad invented a modulator you're exactly -- you know, you're more likely to invent a modulator, and not even an oscillator or, you know, some other thing that's like super similar. So, intuitively you would think like that's probably not about genetics that's, you know, you were exposed to that field, maybe you got an internship while you were growing up, you worked in a company that your parent is connected to, or something like that.

And that gives you a flavor for what we think might be going on here in terms of the mechanism. So, you know, how does this tie into what I was showing you earlier about differences by income, differences by race and ethnicity? We think this type of exposure is much more likely to occur for high-income White men, simply because there are more high-income White men who are inventors to begin with, it's kind of like a self-reproducing process.

So now, that's, I think, interesting evidence that gives you some sense of what might be going on looking at parents, but now coming more towards potential policy solutions, the parents obviously are not a very easily replicable source of exposure to innovation.

So, next we are going to turn to a broader source of potential influence, trigger or neighbors, the kind of community in which you are growing up, and we are going to examine patent rates here by commuting zone. So, think of commuting zones as analogous to metro areas, they are aggregations of counties, and we are going to look at the commuting zone where you grow up and see how that relates to your probability of becoming an inventor.

So, this map here shows you the origins of inventors in America. So, for 740 different commuting zones it takes the set of kids who grew up in that place, and asked what fraction of those kids went on to become inventors. The dark blue colors are places where more kids went on to become inventors, the lighter colors, the white colors are places where fewer kids went on to become inventors.

We've labeled the top five cities in terms of producing inventors, some of them might be intuitive, like San Francisco, San Jose, the Silicon Valley area. I think it's interesting that Detroit is on the list, in many of the other studies we've done on rates of upward mobility Detroit is often at the bottom of those lists. In the context of innovation Detroit is at the top, we think that might have something to do with the presence of auto firms, and engineering, and tinkering, kind of, in Detroit that might change the exposure that that kids have. And I'll come back to that in a little bit more detail in a second.

One feature of the map I'll point out to you, you see, in the southeast much lighter colors in general, maybe fewer kids go on to become inventors. There's one notable exception to that, there's a blip in Texas where you see darker colors. What is

that? That's Austin, Texas, where you see many kids growing up to become inventors.

So, you can kind of see an interesting pattern in this map, which is the places where kids are more likely to grow up to become inventors are the places where innovation is occurring. So, if you grow up in a place like San Jose you're much more likely to become an inventor yourself. So, this is plotting kids invention rates, versus the patent rates of adults working in that area; if you grow up in a place like Brownsville, Texas, where there very few people working in the innovation sector, you are much less likely to become an inventor yourself.

So, this is again consistent with the idea that exposure to innovation, this time not through your parents, but through your neighborhood more broadly, might affect rates of innovation.

Now, once again you might ask: how do we know that those differences across areas are actually driven by the effect of exposure, versus other differences across places? The people who live in Silicon Valley are really different from the people who live in Brownsville, Texas, or Atlanta; right; so, you can't conclude just from that that exposure matters.

So, we are going to take the same kind of approach of looking at these technology class differences, and so, rather than showing you the empirical econometric analysis here, I'm just going to give you a simple example that summarizes the key finding.

So, let's say you've got two people who currently live in Boston, let's say they're students at MIT, and suppose one of them is from Silicon Valley, and suppose the other is from Minneapolis, which is a medical device hub, there are a lot of medical device firms in Minneapolis. It turns out if you look at these two kids the one from Silicon Valley is much more likely to patent in computers, and the one who grew up in

Minneapolis is much more likely to have a patent in medical devices.

And this is true not just at the level of computers versus biology, it's true again at that very fine technology class level that I was talking about before, which really suggests that it's something about the environment in which you're growing up, as opposed to other factors that are driving these differences.

And moreover, one of the findings that I find particularly interesting here is that these patterns are gender specific. So, what matters is not just the overall rate of innovation in your area, but the rate of innovation by people of the same gender.

And so let me illustrate that in this chart. So, the way to interpret this chart: is suppose you move to an area -- move from an area that's at the 25th percentile in terms of rates of innovation for people of your gender to the 75th percentile. So, you're moving to a place where you see more innovation among current workers.

How would that affect the number of inventors? And we are going to consider four different cases. On the left we are going to consider the effect of having more male inventors in your area, on boys' probabilities of becoming an inventor. And you can see there's quite significant impact there, the rate of innovation rises by 1.1 out of 1,000. Now, remember the average innovation rate in the economy as a whole, it's about 2 in 1,000 people become inventors by their mid-30s. So, this is like a 50 percent increase, it's quite a substantial effect.

In contrast, if boys grow up in areas where there are more female inventors, you don't see any statistically-significant change in their probability of becoming inventors. Now, let's turn to girls on the right-hand side. If girls grow up in areas with more male inventors you see essentially no impact at all. In contrast, looking at this fourth bar, if girls grow up in an area where more women are inventing, you see really significant effects.

So, these exposure effects are not just technology class specific they are also gender specific, which I think is important to think about as we think about the mechanisms here and what potential policy of the solutions might be. Just to give you a different way to think about the magnitudes, if girls were as exposed to female inventors as boys are to male inventors, the gender gap in innovation in America would fall by half. So, these exposure effects are quite important in magnitude. Okay.

So, the findings that I've been showing you here are consistent with other evidence that our research team has documented, and others have documented, that neighborhood environment in childhood really matters for kids' long-term success. But what I want to stress here is that the differences across areas in the production of inventors, is unlikely to be due to the mechanisms we usually talk about in that literature which are about differences in the quality of schools, or neighborhood resources, and so forth, because these very specific exposure patterns by technology class and by gender, they're too narrow for that.

It's unlikely that there's a school in one place that helps you, you know, patent in amplifiers versus antennas, right, coming back to that example. And so it's more consistent with the idea that this is about mentoring, or role models, or information, changes in aspirations, things like that.

So, I want to show you one final piece of data, which is now turning to inventors' careers. Let's look at what inventors' careers look like, in particular their salaries, basically, from the lens of wanting to understand how financial incentives might affect individual's decisions to pursue innovation.

So, we'll start with just a very simple fact. So, this is drawn from income tax records looking at the income distribution of inventors on average, what's their average annual income between the ages of 40 and 50. And what you see is this

distribution is incredibly skewed, as you might expect intuitively, the 99th percentile is 1.6 million, the median is only 114,000.

So, many inventors, you know, they do well of course, relative to the average person in the economy, but they're not astronomically wealthy, but there are a small handful of people who make a tremendous amount of money in this sector.

Now, what's interesting is if you ask: who are those people making 1.6 million dollars? If you relate that to the scientific impact of the patent as measured by citations, you know, how many other people in the field are basically building on your work, you find that this is showing mean annual income by the number of citations you have where you form the citation distribution, you see that most inventors with patents that are not well cited, or moderately cited, they are earning salaries of around $200,000 or so on average.

But then if you look at the set of people who have the extremely influential patents, the Google Search algorithm kind of patent, those people are making more than a million dollars per year on average over, you know, several decades. So, these people are earning, you know, more than, let's say, 20 or 30 million probably, over their careers.

So, why is that fact interesting? I think that evidence suggests that changes in financial incentives, for instance cutting top income tax rates, or trying to provide tax subsidies for innovation, have relatively limited potential to increase quality-weighted innovation in America.

So, what's the logic? There are basically two pieces to this argument. First, changes in financial incentives are unlikely to influence the star inventors who have the innovations that really transform society. Why is that? Those guys are already making more than a million dollars a year, you would think intuitively if you make an extra

50,000 or 50,000 less because of a 5 percent change in the tax rate, you would not expect that affect somebody's career choice in a fundamental way.

The second important point is that tax incentives, by their nature, can only affect the people who've had exposure to innovation, right. If there's this whole set of people who are not even thinking about going into a career in innovation to begin with, fiddling around with the tax rate is not going to change what they end up doing. So, we think that also greatly dampens the potential impacts you're going to see through financial incentives.

In contrast, we think that if we can find ways to change exposure to innovation, to increase exposure to innovation, we can have quite substantial effects. If women minorities and children from low-income families were to invent at the same rate as high-income White men, the innovation rate in America would quadruple based on the data that I've been showing you here.

So, there's a big -- you know, there's a lot at stake here, there's a lot we could potentially do. The key question becomes: How can we recover these lost Einsteins? And so we don't have a definitive answer to that question in this paper. I'm hoping that Reshma and Tony will tell us what to do on the panel that we'll have after this.

But let me just lay out the way that we are thinking about the problem. So, I think it's useful to think about these things in kind of three steps: diagnosis, treatment and ultimately evaluation. So, in the context of diagnosis here one of the things that I think is useful that emerges from this data, is that we can identify the women, minority and low-income kids who are potential inventors at pretty early ages.

You saw that in the simple test score data that I was showing you, and that wasn't even a very refined analysis, there's lots of other information that you can use

at early ages to identify these kids who are prospective, you know, potential Einsteins.

And so then you could then hone in on the subgroup of kids who are really underrepresented in innovation and try to help bring them through the pipeline. How might you go about doing that? Turning to the treatment phase, you know, that could be through tailored mentoring programs. What I mean by that is matching people in the right way.

This might mean matching a girl with a successful female inventor in the area, it might mean matching a Black child with Black inventor in their area, and so forth, through targeted internship programs, through programs like *Girls Who Code* for instance, more broadly, through expanding opportunities for kids in these subgroups.

And then finally, I think a really critical phase of this where we need to do more work in this space, is to evaluate scientifically the impacts of these interventions. What exactly is the value added of various programs that people are trying in a treatment-control kind of framework? We can use the data that we've assembled to test, historically, what are the impacts of the different efforts that have been tried.

So, I want to end by talking about why I think this is an important moment, particularly in the United States to be thinking about these issues, by showing you this chart here which Ted mentioned in the introduction, this fading American dream trend.

So, what this chart is showing you is the fraction of kids who earn more than their parents did at a comparable age based on the year in which they are born. You can see that back in 1940 it was a virtual guarantee that you were going to achieve the American dream of moving up relative to your parents, 92 percent of kids born in 1940 earned more than their parents did.

If you look at how this has evolved over time, it's steadily declined such

that kids born in the 1980s, who are entering the labor market today, their chances of achieving the American dream it's basically a coin flip, 50/50 whether you're going to do better than your parents.

So, what's underlying this trend? There are two things that are going on, there lower growth rates, GDP growth rates in the U.S. over the past thirty years or so, than in the past. When you have less GDP growth you're going to have less opportunity, basically, to do better than your parents did. So, that's about one-third of what's going on. Two-thirds of what's going on is that the way in which GDP growth has been distributed is very different today than it was in the past.

In the past we had much more equal growth across the income distribution, today as you know, much of the growth goes to people at the very top of the income distribution. As a result fewer kids across the income distribution, in the middle class and at the bottom, end up doing better than their parents did. So, basically the rise in inequality contributes to the fading American dream.

So, why do I mention this at the end of a talk on innovation, usually people think about these two trends as two independent things, changes in inequality and changes in growth, and in fact people think they're in tension with each other. Often the narrative is that in order to spark growth we need to do things that might come at the cost of increasing inequality, like changing tax rates to, you know, changing the amount of redistribution and so, forth.

So, I think we have this conception that equity efficiency trade-off that there's a tension between these two things. And perhaps there is in many contexts, but I think -- what I'd like to say using these data, is that in this context it seems like tackling the problem of inequality, of opportunities, reducing inequality could actually be quite beneficial for growth itself because it allows us to bring more inventors through the

pipeline, and make those discoveries that ultimately spark growth.

So, I think at this critical juncture in the U.S. where there's a lot of tension, a lot of polarization, I think this sort of unifying approach of thinking about equality of opportunities is benefiting us both in terms of fairness and in terms of economic growth, as hopefully a useful lens to move the policy debate forward. So, I'll stop there. Thanks. (Applause)

MR. REEVES: I'm going to ask the panelists to join us on stage. I'll briefly introduce them. My name is Richard Reeves. I'm a Senior Fellow here at Brookings. I work on issues of inequality and social mobility, which is a fancy way of saying I sit in my office and wait for Raj and his team to produce a new paper, and try and write it up, and question them on occupational choices.

I'd like to say that by the age of 30, I think 30 or early 30s is the point that's used to measure patenting -- the number of patents I've taken out was zero, so I'm a zero patent person by age of 30. Who else is a zero patent person by the age of 30? Okay so that tells us absolutely nothing (laughter) because that's an end of whatever, and Raj likes to deal with ends of 200 million, or something, which is why his sample is better than the one I just used.

I will say though, just to add something, not specifically on Raj's scholarship, but the way his team operates and has had access to high-quality administrative data, underlines the importance of being able to access, and match, and use administrative data, and I think that that is something that is a particularly on the minds of many of us at Brookings right now, which is to be able to access that data and use it.

And secondly, Raj and his team have done an exemplary job of making that, as you'll see in the bottom right-hand corner, the data available at the project, which

means that those of us who are kind of catching up with some of the work that Raj and his team are doing, the data is all available online, and it's available online in a very usable format, you can download it Stata or Excel. And therefore, ask lots of different questions, and I just want to commend Raj and his team for the work that they've been doing on that.

So, I'm going to briefly introduce our two panelists, who are going to briefly respond to Raj, and might add some of their own thoughts, and we are going to have a moderated discussion up here on the stage, and then I'll invite your questions.

So, first of all we are going to hear from Reshma, who is on your right. Reshma Saujani, is the Founder and CEO of *Girls Who Code*. Raj has already mentioned that her work, which is a national non-profit working to close the gender gap in technology. So, highly relevant to the work that Raj has been doing. In 2010, Reshma became the first Indian-American woman to run for Congress, and she's the author of many articles and books including *Girls Who Code: Learn to Code and Change the World*.

And then we are going to hear from, on your left, Professor Tony Jack, who is a Junior Fellow at Harvard Society of Fellows, and an Assistant Professor of Education at Harvard. He has been named by the University of Michigan, in 2016, as an Emerging Diversity Scholar, and his own book which is forthcoming from Harvard University Press is called *The Privileged Poor*, which looks at those from low-income backgrounds, but with a privileged education, who end up at elite universities.

So, they're each going to speak for five minutes, and then we go to a moderated discussion; so, Reshma, you first, over to you.

MS. SAUJANI: Sure. Hello. Reshma, CEO and Founder of *Girls Who Code*. I spent my life trying to teach girls how to computer program. Full disclosure, I am

not a coder. I was definitely not in the top of my class, my math class at in third grade, so I wouldn't have been, you know, identified as an inventor.

MR. REEVES: Not at the (crosstalk).

MS. SAUJANI: But, you know, my parents came here as refugees, and they were expelled from Uganda, I've had a job since I was 12 years old, and so I'm a big believer in the American Dream.

And from a very young age I wanted to give back, ironically I thought the way to do that would be through politics, ran for office, lost miserably, but as part of that experience I would end up going into a lot of New York City schools. And I'd walk into their computer science classes, or their robotics classes, and I would just see a ton of boys, right, clamoring to be the next Steve Jobs or Mark Zuckerberg.

And I thought to myself, you know, where are the girls, right? At a time where women are the majority in college, they are majority in the labor force, 40 percent of all of America's breadwinners. Where are we in this industry that is literally shaping our collective future?

And So, I started an organization to try to solve that problem, and over the past seven years we've taught over 50,000 girls how to computer program, put that into perspective only 10,000 women graduated in computer science.

You know, we spend a lot of time talking about the future of work, like how do you increase opportunity to the America Dream, well, it's in a computing job. You know, 71 percent of all STEM jobs are in computing, where you can make $120,000 a year as a software programmer right when you get out of college. And the problem is, is that if you talk to any business executive, and they can't find enough engineers, and I think the solution to that is women.

But if you look over the past 40 years in our country, you know, women

have been dropping out of technology; 80 percent of all -- I mean in the 1980s about 50 percent of all computer scientists were women, this panel in the 1980s would have been called: Where are the Missing Marie Curies; not, Where Are The Lost Einsteins.

Today that number is less than 18 percent, you know, and a lot of that has to do with, I think, two important things, one is culture. You know, we talked about this earlier: you cannot be what you cannot see. That's why Raj's work is so important because I think it identifies something that we've seen in our work.

Girls are inspired by what their parent does, what their next-door neighbor does, who they see on television, and when every day they look at the face of an inventor or an entrepreneur and they see Mark Zuckerberg, and they don't see themselves, that doesn't inspire them to think that this is something that they can actually do.

Culture has played a huge role in pushing girls out. We still have Barbie dolls that say, I hate math, let's go shopping instead. You can walk into a Forever 21 and buy a T-shirt that says: I'm allergic to algebra. Mean Girls, which we watch on repeat, all of us here do, right? Remember that scene where she gets an A on her math test, and she crosses it out and puts a D just to get the affections of a boy. Culture is having a massive effect, and making this STEM gap get even larger.

And the second thing is, and again Raj talks a lot about this too, is this idea of risk aversion. How do we inspire failure? To be an inventor you have to be really excited about failing. And here's the thing, you know, our girls are not excited about failing, because from a very young age we straighten their dress, and we fit their clothes, and when their bow falls off we make sure that it is on perfectly.

You meet my son, he's 3 years old, he's a pigpen, he's got a booger in his nose and yesterday's breakfast, he is a mess.

MR. REEVES: You know we are live?

MS. SAUJANI: He is free to be who he wants to be, right, and so this idea of: How do we stop coddling our girls? How do we inspire imperfection? How do we teach bravery, right? How do we teach them that you don't have a fixed mindset, that you can learn everything and anything; that rejection is awesome? Once we teach that I think we will inspire a generation of women who will fail, and who will build inventions.

The last thing, and I want to close here, because I know Richard is going to tell me to stop talking; it's this issue is so important, because there are so many innovations that are sitting on the sidelines because we are not solving this problem. I am surrounded by teenage girls, and in our programs you can build whatever you want, and every single time I see this, I see Cora whose father has MS, and so she decided she wanted to be a doctor because she wanted to save her father's life.

Well, when she could build whatever she wanted, she built an algorithm to help detect whether a cancer is benign or malignant. I have 16-year-old girls in Austin who were so sick and tired that Congress couldn't get it together to pass a bill on funding that they built a machine-learning tool to track where Zika is going.

Girls are constantly seeing problems in their community, whether it's climate change, whether it's homelessness, whether it's inequity, and they are using technology to solve them. Just go to our Project Gallery at girlswhocode.com, and you will see exactly what I'm talking about.

So, if you want to change the world, if you want to solve these problems, you not only have to teach girls to code, but you have to do the very recommendations that Raj talks about in his report, and we can close the gender gap in this issue, and at the same time save our world and our country while doing it.

MR. REEVES: Thank you for setting the bar so high, Reshma.

(Laughter) So, good, Tony, follow that.

MR. JACK: That's my (inaudible), right?

MR. REEVES: Yeah.

MR. JACK: I love this research because we do know that mentors matter. I study students who, especially low-income students at the college level, and we know that contact with professors, deans, presidents, residents and counselors, is the mechanism through which they get access to institutional resources, right, whether it's counseling, whether it's support, a grant, an application, summer internship, whether it's just understanding how to set up their first bank account.

But not everybody feels comfortable reaching out to an adult, especially an adult that they have -- that they only met in the first week of school, especially how social class shapes these particular processes, right? And so always in my research I ask the question: What does it mean to be a poor student on a rich campus? We have an understanding that to be a poor student on a rich campus, it's about isolation, it's about culture shock, and it's about not understanding what to do.

And we base policies, and we try outreach based upon that that understanding, but that understanding is only half-right, because the reason why my work in the book, why that's called *The Privileged Poor*, it's because I study, and I show that roughly half of the lower-income African-Americans at elite colleges, on average, graduate from Andover, Exeter, Deerfield and St. Paul's, which cuts against the grain. What does a student who lives in Section 8 housing and receives food stamps doing going to a high school that costs almost $50,000 a year.

And colleges get their new diversity from all sources. They go to these well (inaudible) to get their diversity, and what happens is, you have half the students who graduate from disadvantaged high schools, and they come in with one set of

strategies for engaging adults, and it typically is withdrawal, it's about difference, because we don't teach being agentic about reaching out to adults in our public schools.

But if you go to a private high school where the average class size is 11, and most classes are smaller than that, and you're used to sitting around the Harkness Table talking to a professor about the differences between your favorite classical musicians, you begin to have an understanding of how to interact with adults, you become comfortable with it. And so when you get to college and you hear those two words that everyone says but no one actually defines, "office hours", you become very comfortable.

You know where to go to ask for help for an extension, not because you need it but because you wanted to watch *The Crown* as I love to do, right? (Laughter) But it's very interesting that I talked to a Dean in college, and she said that when she told her working-class students, that my office hours are from Tuesday from 3:00 to 4:00, students from working-class background took that as a time that she should not be bothered.

So, she was left in her office twirling her thumbs waiting for students to come to her so that she could mentor, which is the exact opposite of what office hours are, but if we don't do that kind of translational work our students, especially our lower-income students, and our students who are women, will continually be trapped by this hidden curriculum, of a whole bunch of things that are always expected of us to know, that are so gendered, so classed, and so raced that we will always have the gap between access, that means getting into these universities, getting into these jobs, and being fully included in them, getting access to all the resources.

And so until we close that gap between access and inclusion, we will always have some of the inequality that you see, because it's being reproduced in these

institutions. Are we admitting students, are we had many employees, are we admitting fellows, but we are not actually prepared for them?

Are we prepared for students from rural Appalachia, and the inner city, as well as those from the suburbs? Are our counseling centers able to handle all of their issues to help them succeed, but also all of their interests? Because it's not always a burden to introduce more lower-income minority and women into organization, it's a privilege and a benefit.

And until we change that orientation we will always be behind the eight ball. And So, I think this the act about mentor is absolutely important, we need more students to have access to mentors, but those mentors also have to be ready to be able to understand who was sitting in front of them.

Do you only know how to mentor White men who are heterosexual, come from upper-middle-class backgrounds and went to private schools? And that's the fundamental question that I know as a professor, a lot of us have to ask, because they come in with a certain set of expectations, strategies for engagement, and understanding of self that aligns with: oh that person is being, you know, putting himself out there. We should reward that. We shouldn't reward class strategy; we should reward talent and ability. And the question is, are we ready to do that?

MR. REEVES: Thank you, Tony. Thank you, Reshma and Tony, for those comments. I would like to pull out a couple of things to put back to you Raj, but then invite the two of you too, before I add a couple. Let's start with risk aversion and the kinds of relationships that seem to foster these kinds of opportunities. To Reshma's point, when you look at your charts and say, well, one reason kids from higher-income backgrounds might be more willing to think about taking out a patent, or even take some risks is because the downside risk is much lower for them.

MR. CHETTY: Mm-hmm.

MR. REEVES: Bob Putnam has a great phrase which is: that everyone crashes, but rich kids that have airbags. And if it doesn't work out, and so there's a whole sense of kind of a risk probably I think really comes out of Reshma's comments quite strongly. And then the second point I think relates to both comments of Tony, is about mentoring and the kinds of relationships, and the exposure effect you find.

So it's like, what kind of relationships? Mentoring covers a very broad spectrum, arguably parents are mentoring their kids, and that's a very thick relationship, it's a very, very intimate kind of mentoring. Or it could be someone who you see twice, a couple of times and then feel good about yourself at dinner parties, because you are mentoring, right, which is very thin and doesn't impact much.

In fact, I'm looking at your maps and your charts across commuting zones, and I'm just inviting you to think about how far do you think those ties are stretching? Do you think that within the D.C. commuting zone a kid who's growing up in Northeast D.C. is more likely to take out a patent because there's a bunch of people doing that in Northern Virginia? You know, I don't know how far do those ties stretch? What kind of relationships matter? So, risk and relationships, right?

MR. CHETTY: Thanks, Richard. And thanks for the great comments. So, on the issue of risk, so I absolutely (inaudible) with the intuition that, that risk aversion can matter quite a bit. I think it might matter here in a very particular way, so I didn't spend time on a set of results where we look at how this data breaks down by college, so you can find online, as Richard pointed out, on our website, data on innovation rates by college and parental income.

And the interesting pattern that you see there, if you look at the colleges that produce the most kids who go on to become inventors, these are places like MIT,

and so on, those kinds of places you think of, but also other institutions, like Kettering University, which is a place outside Detroit; I think in Flint where you see lots of kids go on to have patents there.

The pattern you see in all of those colleges is that the gradient that I was showing you, the large gap in innovation between kids from low and high-income families, is much, much attenuated. There's a much smaller gap between kids from low and high-income families among those attending MIT.

And so why do I bring that up in the context of risk? If you thought that it was really about risk preferences you might expect that the kids at Stanford from low-income families go on to become doctors, or pursue other professions, while the kids from higher-income families take the risks of becoming entrepreneurs or inventors, in fact you don't see that much of a difference,

So, that makes me think at least in the labor market this is not really about differences in our risk preferences, it's about factors that are affecting you before you get to college. Now, that said, it could be that kids from higher-income families are more willing to take chances or pursue certain things while they're in school, before they get to college, than kids in lower-income families.

And so I think those kinds of ideas could make a lot of sense, but to me a lot of this ties back to differences in childhood environment and childhood opportunities, which could then influence risk preferences, as opposed to the way we usually think about risk is, you know, you're working in the labor market, you face risk and I don't. I think that narrow conception of it doesn't quite fit the data.

On the second issue of exposure, so I think from working with these data in various contexts, in this particular instance of becoming an inventor, it's the strong deep connections that really matter. So, if you think about the technology class

specificity, for instance, and that's more consistent with the idea that somebody is influencing you in a very particular way to pursue a particular pathway, as opposed to generally, you know, as you put it, in Northern Virginia there are a bunch of people doing this thing, and you kind of heard about it, you know.

How would you have heard about this one very specific thing? A more direct answer in our ongoing work, one of the things we are working on is zooming in from this very broad geography that we've been working with, the metro areas or counties, which of course are, nobody thinks of their neighborhood as the entire D.C. Metro area, but that's really, it's been a data limitation in the past in terms of having to work at that level.

We are now zooming in to be able to look at the data at the tract level, so tracts consist of about 4,000 people, so really find definitions of neighborhoods. And one of the findings that's emerging from that work is that what really matters is neighborhoods in a very, very precise sense, not even 3 miles away really within a mile or, you know, in a very particular way. Or it's about social networks, you know, that might stratify those boundaries, but I think it's much more precise than the general.

MR. REEVES: Presumably your maps are conditional on the parents having, so when you say the exposed to the (crosstalk) effect. So, we know it's not just the direct effect of the parents, but it could be --

MR. CHETTY: Where you're excluding kids whose parents are known --

MR. REEVES: Yes. So it could be, but it's friends of parents. It's your immediate neighbor.

MR. CHETTY: Exactly, exactly.

MR. REEVES: It's not the person on the other side of the -- of the kind of commuting zone.

MR. CHETTY: That's my sense.

MR. REEVES: I think it's come up already, but this distinction between entrepreneurship and inventiveness, you said at the beginning, patents is a proxy, and I think you make a good defense of patents as a proxy for it, but Einstein himself provides a good example of this because he had 50 patents including for a refrigerator, and no one's got an Einstein refrigerator. But he couldn't patent the theory of relativity, which had a big effect.

And so, can you say a bit more, and I would invite Reshma and Tony to add their thoughts too, on the distinction between being an entrepreneur and having a business idea that you're willing to commit to, and the idea of being an inventor, because they are clearly distinct terms?

MR. CHETTY: Absolutely!

MR. REEVES: Can you say a bit more about that?

MR. CHETTY: Yeah. So, you know, if some inventors become entrepreneurs, clearly there are many entrepreneurs who don't have a patent, so these are two distinct things. We are currently working on measuring entrepreneurship in the way that we measure invention here, looking directly in the data at who start successful businesses that end up growing quite a bit over time.

And while I don't have findings to report from that data yet, broadly my sense is there are like to be similar patterns in terms of who becomes an inventor, probably not identical but I think similar factors are likely to be at play, of risk preferences perhaps taking an even more central role there; differences in exposure, and opportunities.

So, you know, I don't think you should think of the findings here as being unique to inventors, my sense is exposure likely matters much more broadly for any

career choice, but this is a particular area that we are able to measure very well at the moment. It's something that matters if not just for business, you know, more broadly scientific progress, it's extremely important we think in driving society and the economy forward, which is why we focus on it. But it's not that we think the findings are exclusive to innovation and wouldn't apply in other contexts.

MR. REEVES: And Reshma, are you trying to create entrepreneurs or inventors in your work, or both?

MS. SAUJANI: I mean, I would say both. I mean, I think we are trying to create change makers, you know. I'm sure everyone in here, in this room, has had an idea that you talked yourself out of, right, all of us have.

MR. REEVES: Usually, that was a good idea.

MS. SAUJANI: Right.

MR. REEVES: You talked yourself out of.

MS. SAUJANI: Right, and sometimes it's not. But I think that the idea is, you know, what if we lived in a world where we didn't talk ourselves out of that idea, and we took those one step, two steps, three steps, and we wouldn't know what would happen. I mean, in some ways I feel like I'm a living embodiment of that. I'm a serial failed politician, I've run twice and lost twice, it's kind of my thing.

But I'm also a woman who spends -- started an organization called *Girls Who Code*, and I don't code. I didn't really even bother to learn before I started it, but the thing is, is that that happened because I like risk, I'm okay with failure. I lost a couple times, I didn't die, and I'm okay. So, now when I have an idea I don't talk myself out of it, and I talk myself into things I know nothing about.

So, the question is it's: how do you inspire that amongst people, right? And I think that's really at *Girls Who Code*, you know, what why I think coding is so

powerful, because I think most people will probably think you have to be a super genius to know how to code, and most of our girls come into our program are thinking that you have to be extra-special smart to learn how to code.

And then they find, is that you don't. And that you just have to be willing to fail, and to try, and to have your code break apart a bunch of times and not give up, and to keep trying, and to keep trying. And so, to me it's embracing imperfection, and being comfortable embracing imperfection that has changed girls' mindsets.

And so, not only would it be now, you know, try something they didn't think they could do, but they are more likely to follow an invention, become an entrepreneur, start an organization that they are not an expert in.

MR. REEVES: Thank you. I wanted to push a bit more on the gender side of this, because obviously it's relevant to all of you. And so, Tony, your undergraduate degree was in Gender Studies.

MR. JACK: Yeah.

MS. SAUJANI: And he's (inaudible) right now. Sorry I had to. (Laughter)

MR. REEVES: Again, life. But it is, as Raj said, a very striking finding, that this effect does seem to become very gender specific that chart you kind of produced. And in some ways it's quite a challenging finding perhaps, because we might all like to think that we can try and -- I'm just saying, to some extent the race perhaps, that we can transcend some of those boundaries, and if there's a person who is, you know, the right kind of person, in the right field, and they are committed to their relationship with you, and so on, that it perhaps shouldn't matter as much whether they're the same gender or the same race.

I think that would be -- but it turns out it's quite a utopian way to think about the world, and that that would push us towards more gender-specific programs

where we are matching like with like on the basis that doing that, and I think that's quite -- I do think as a matter of policy, that's quite challenging. And maybe for institutions too, yours is specifically *Girls Who Code*.

But talk a bit more, Raj, about what you think the implications are of that very striking finding, because if you're -- to the extent that it's right I shouldn't be worrying too much about whether the men inventors are helping women, I should be worrying whether there are enough women inventors to help women, and whether the men inventors are helping men; and that almost, have a very strongly sort of segregated way to think about it, to use the deliberately-provocative term.

Whereas Reshma is making the point that, culturally, we keep treating men and women differently, and girls differently, and we should stop doing that. While your research suggests that we should kind of carry on doing that, to an extent. Doesn't it?

MR. CHETTY: Well, so I think, you know, you capture the starkness of the findings correctly, whether the implication is that we absolutely need to have women mentoring women, I think is not clear because it depends upon what men are currently doing when they mentor women, or whether they mentor women, right. So, it could well be the case that for whatever reason, given current cultural norms, and so forth, what ends up getting reinforced when a girl looks for mentor among male inventors in their area, they don't really find the right type of connection, et cetera.

That doesn't necessarily imply that that can never happen, that it's some biological thing that girls can only be influenced by girls. Presumably there's a way to replicate the kinds of conditions and experiences that female inventors are providing to women in their area through other mechanisms. Be it through men, or through changes in media, through changes in social media, changes in what's on television shows, and

so forth.

MR. REEVES: Yes.

MS. SAUJANI: Yeah, I mean the way that I -- actually the way that I interpreted what you were saying, too, is that it's where you're kind of thick or thin connection goes, to something to (crosstalk), right?

MR. REEVES: Yes, fine, yeah.

MS. SAUJANI: It's to me, I think that seeing, watching a movie about a start-up and seeing no women in that, if you are a 13 or 14-year-old girl that has a major impact in thinking that that field is an option for you. And so that, so when girls are exposed to female inventors, even if simply it's watching a movie, or having a cup of coffee, or seeing -- you know, (inaudible) your neighbor down and who has just invented that refrigerator, a light goes off in her head, and she's like: oh, I can do that too.

And I actually think it's that, it doesn't need to be that intense of an interaction, it is simply an idea, or a conception that is now born in a young girl's mind about what is possible for her life journey, and it has that powerful of an effect. That's why I think it's almost such a shame, right, that we are not making these shifts and changes in our culture, in our education institutions so quickly, because I think that things can change.

I'm not waiting 118 years, right? And I don't think we have to, right. I think that there are some real things that you've uncovered, and I think some changes that we can make quite quickly, I think that could get us to parity quite quickly.

MR. REEVES: There are broader cultural issues as well as those, sort of take time as well.

MS. SAUJANI: Yeah.

MR. JACK: Yes, because at the same time, we have great empirical

data, there's national -- you know, huge data set, big data showing historical patterns, and we understand that, but we have to realize mentoring is one-on-one, like who is sitting in front of you; it's the micro interactions that matter just as much.

There are some students who turn away from certain majors and concentrations because on the first day that person who was sitting in front of them will say, are you sure you can do this? Maybe you should go into nursing instead of being a doctor. Maybe you should go into the history of science instead of chemistry, like study what other people have done because you won't be able to do it.

But we have to realize that there is a cultural shift that is needed, but at the same time we have to understand these individual moments are gate-keeping moments, and if we think -- and if we don't pay attention to how we make different industries, different occupations open to all, it will still -- like this funneling effect will still continue to happen.

And so when I think about the students who I see on a daily basis and, you know, I'm a first-generation college student, and I tend to, like a lot of the students who I work with, who I have the privilege of working with are also first in their families to go to college. And so to be a professor, you know, the only thing I knew about being a professor was the three stripes on the robe that we get to wear, the regalia.

And I go, oh, that's kind of cool, but I actually got to see it now, I'm here now, but those, even those little, small moments, that may seem funny, and may seem like: did you really choose to go this path? And the answer it's kind of yeah, they're based on those little, small moments because you never know, that new exposure, that first time that you see something new, and it really changes your way of thinking because you begin to investigate: what does that person do? How is that person's life structured? Because it's not just about the money, because the risk aversion -- and if that was the

case, if I knew I could make $230,000, I probably would have got a different degree than going into sociology, (laughter) to be honest.

But it's like those other things, right? It's like, what about that lifestyle, what about that -- like there are conferences that you get to go to, and like you begin to investigate all these different things, and the whole world opens to you, because it's not what, you know, clock you punch day in, day out, it's about the lifestyle that you are able to have that people begin to understand, because we get inside knowledge of it.

MS. SAUJANI: Right.

MR. REEVES: To all the students who are watching, sociology is a perfectly good field.

MR. JACK: Yeah -- No. It's beautiful --

MR. REEVES: That's just bit of a public service announcement.

MR. JACK: Yeah, no (inaudible).

MR. REEVES: Can we talk a bit about race and the findings that you had there, and the extent to which you think that's similar to gender, all being driven by sort of with different effects. I think you explained the gender differences quite strongly through some of these exposure effects which we just talked about, but the findings on race are also very striking, and you see kind of particularly strong departure, you said, of why Americans, and also Asian-Americans as well.

It's just that their line, particularly at the top is very, very, very much higher, and if I'm reading it correctly, you can't explain all of that through the parents being much more likely to have been inventors. It doesn't seem like that's what you've found, it seems like there's something else going on there too.

So, could you just talk a little bit about what you think is behind some of those race differences, especially for Asian-Americans given that there isn't that sort of

straightforward explanation over the world, just their parents were more aligned to have been inventors. What's behind that, do you think?

MR. CHETTY: Well, if you think these exposure patterns, we were not able to study these directly in the data, but if you think it operates like gender, where you are more likely to be influenced by people of the same race and ethnicity at present, and if you just -- it's like a self-reproduction, right, where if you are a White man you have more White male mentors. Similarly, for Asians, there are a lot of Asians now in science and technology. For Blacks and Hispanics you see very different patterns.

I do though agree with your intuition, Richard, that those patterns are even sharper than in the other cases, and so I think there's something additional going on, in particular with minorities, where it might be a lack of opportunities more broadly, a lack of inclusion, as Tony has stressed in his work. Those are actually issues we are investigating directly in some of our ongoing work on racial disparities and opportunity more broadly, but I can't say quite what it is from these data, but I agree with your instinct that there's an additional element in the context.

MR. REEVES: There's something else going there. Tony, do you have any thoughts on the race gaps that we saw in this study, or how it relates to your own work on relationships and exclusion?

MR. JACK: You know, your other research on Race and Economic Opportunity, when you think about the neighborhood itself, and in this country the difference between growing up in a lower-income White neighborhood, as compared to a lower-income Black neighborhood are two different worlds. When you think by the work of Pat Sharkey whose research shows, if I'm not -- I think I have the numbers right, a White family that -- a Black family that makes $100,000 lives in a similar neighborhood as a White family that makes $30,000.

And so when you think about the fact that a two-parent household, each parent bringing home $50,000 lives, can own a home, and think about the parks, think about who their neighbors are, think about the resources that they do have exposure to, and the schools. Like that whole constellation of experiences that that person can have, you're making three times what a White family does, of that of a White family, and you live in the same kind of neighborhood.

And so understanding the racial difference, or the racialization of class in a very concrete way, I think it does affect the kind of exposure that students have to a young -- to youth, to a number of things, not just innovation, but another thing that shapes their mobility.

MR. REEVES: Raj, is there a way we can bring some of this data to bear on some of the more specific questions that we face like: does mentoring work? So, as Tony just said, we know mentoring works. Well, that's a strong claim to say that it works, and I think there's evidence in both directions, and the truth is, the reason it's hard to know it's just because it's really hard to design studies that would tell us, because we don't have the data, we have selection effects, it's very hard to randomize.

You know, there's just so much going on that it's really hard to show whether or not mentoring can (inaudible). We had lots of, kind of, qualitative evidence, but quantitatively it's just incredibly hard to prove the same kind of (inaudible). But you've got all this data, now is there any way to start connecting that to more direct interventions or policies as you go forward?

MR. CHETTY: I'm glad you brought that up Richard. I mean, I think that's exactly the right next step in this agenda. The way I would phrase the question is, I think a lot of us have the intuition that mentoring works just from introspection that there's somebody in our lives who had a huge influence that led us down a particular path.

And so I view the question, not so much as testing the hypothesis of: does mentoring work or not, yes or no. It's more, what types of mentoring work? What is effective? Is it light-touch mentoring, or, you know, mentoring of the *Girls Who Code* type in the sense? Or, you know, in your school teachers? And so to get at that, you know, one approach you could take is to try to design experiments where you have different mentors and see what happens.

That is a very costly way to do things, both in terms of expense, literal financial expense, and in terms of time. I think the power of these large data sets that we are assembling, and others around the United States are starting to use as well, is that you can basically take a retrospective look at the type of efforts that Reshma has been pursuing, that many others have been pursuing, and set up research designs that basically allow us to evaluate, with fidelity, essentially as good as an experiment, what works and what doesn't.

So, to give you an example, suppose you have a particular effort, like a Big Brothers Big Sisters Program, that is rolled out or expanded in one city but not another, for a certain set of kids of a certain age. What you can do is go back and look at these types of data and zoom in on exactly those kids who were in that neighborhood in a particular age range, and compare them to the kids who were, you know, a few blocks down, kids who were a little bit younger, kids who were a little bit older, lots of sensible kind of counterfactuals, that is people who would represent what would have happened had you not had this treatment.

And I think you can start to build a library of kind of estimates of understanding, which of these programs are working, what are the elements of programs that work, and that's the approach I think.

MR. REEVES: You can zoom, you can zoom in close enough?

MR. CHETTY: Yes.

MR. REEVES: Even if you don't know the individual you can use that to zoom-in close enough to be able to make some sense of --

MR. CHETTY: And you can have the data over time that I think, really, allows you to understand what's going on.

MS. SAUJANI: And I think organizations like ours should be encouraged to -- you know, I said earlier, you know, Bill Gates said, "You can't solve what you can't measure." Right? And so all of us should take data seriously, I mean since inception of *Girls Who Code* we have tracked all of our girls, so I know, you know, my girls in my 2,013 Facebook Class, I know where they are in college, I know because of the National College Survey whether they've majored or minored in computer science.

And so I know now whether that our intervention played a role. And since I can compare them towards -- whether with the college graduation rates, or of the high school that they went to, I can compare whether our program helped or supported college readiness.

So, you know, we take data seriously and we track our girls because I don't -- I think that one of the benefits is, I mean this problem is so bad, so when we talk about our work, only 10,000 women graduated in computer science, we have 500,000 open jobs, parity means teaching 20,000 girls to computer program, and get them into the pipeline.

I can count one, by one, by one, by one, by one about whether we succeeded or not. And it's the same thing with inventions, right, I mean we need more inventions, we need more inventors, but you can count about whether your interventions are actually going to increase parity and racial equity.

MR. REEVES: Do you have more girls who want to do your camps than

you're able to provide help to at the moment?

MS. SAUJANI: Yes.

MR. REEVES: So, then how do you select? Do you randomly select them and then follow up the ones that don't go and (crosstalk)?

MS. SAUJANI: Well, unfortunately, we don't select the ones that would have majored in computer science anyway, so when the young girl who is on her fourth coding camp, right, but that's a shame, because we shouldn't have to turn anybody away. We don't look for GPA, we look for like: do you want to be a change maker, right? And we intentionally pick girls that are living -- half our girls live under the poverty line, and half our girls are Black and Latina.

Girls Who Code has 3,000 *Girls Who Code Clubs* in the country, we are oversubscribed. I mean the demand for this stuff, for coding education is ginormous, and the demand for coding education amongst girls, and to be in single sex environments. I mean this is what goes to your point, I do think that in this space, right, our education system -- you know, having girls participate in a computer science classroom where it's 80 percent boys and 20 percent girls, is not working. Like, we need to have spaces where girls can learn, fail and iterate on their own.

MR. REEVES: Okay. Tony, I used your comment about mentoring programs as the way into that segment. So, I should give you the chance to amplify it or respond, if you like, to your original statement: that we know that they work.

MR. JACK: From the research that I've done doing two years of ethnographic observation of a college campus, and interviews with over a hundred students, I've just seen how school administrators are able to go to bat, and go above and beyond for students who they know best.

I mean there's, in a kind of funny way there's a prize that is given to the

highest GPA in like a certain cluster of the school, and for years I observed how that the person who won the prize didn't always get -- the one who had the highest GPA didn't always have -- didn't always win the prize, because that person didn't have an advocate, that that person wasn't known, they necessarily wasn't put up, they wanted someone to expand beyond just the person who had a perfect 4.0 GPA.

And I thought it was interesting what they brought to bear in that conversation. Like, oh this person really helped me with this, they're a great babysitter, they are a great member of the dorm community, all of these different things. And so when I think about even those individual moments, about who gets the benefit of the doubt for the extension, or for a test, or even when they get in trouble, who gets all the extensions, who gets the internships, who are the first students in line to get help when they apply for summer abroad, or a winter whatever, where they study abroad, or internship, the students who are known get the most help.

And the sad part about it is, I've seen students who have had family members who worked in the White House, like as directors and things, and they are the first people who want their résumés edited, as if they really need to have a perfect résumé. But the students who would benefit the most are often left unknown, and you see, the college's assume that they are doing okay, and that's not necessarily the case, they just don't know, necessarily, how to make their needs, their wants and their desire known to other people, so that there can be a melding.

And the reason why I say mentoring works is because it's not just what you know, or who you know, but who knows you, and who is willing to go to bat for you.

MR. REEVES: You've also used, I think, broken down the idea of mentoring into different components; there's coach, there's navigator, and there's advocate, and at different moments you want a different -- and so I think that word is sort

of capturing a huge amount of diversity.

I'm going to ask one more question, then I'm going to come to the audience. And it's a specifically to you, Raj, about how this work sits within your broader body of work, I also see the work of you and your colleagues at the Equality of Opportunity Project, all of their data is online, I remind you, as being really about inheritance of inequality. It's really about, and what are the transmission mechanisms through which inequality is inherited?

But very often if it's an issue such as colleges and so on, it has the feel of something of a zero-sum game, right? There are only so many seats at the institutions that are not taking poor kids, and so there's something of a sense of, look, in order to get more poor kids to get these opportunities then, to some extent, it will mean fewer of the undeserving rich kids getting it. I just put that in to be a bit more provocative.

But you've explicitly said that's not the case here. In fact your calculation was, if we could bring up patenting rates to the same level as at the top, then we'd have quadrupling. And so are you entirely convinced there's no zero-sum here at all, and that we can just -- everyone can patent, and there's no problem, and there's just a limitless supply of good patent ideas? Or, is there some zero-sum here which would require those that are sort of at the top to get it a little bit less good at holding all these patents compared to everybody else?

MR. CHETTY: So, you've highlighted precisely what got me interested in focusing on this issue, working on issues of equality of opportunity, the very common question you'd get: is this, you know, kind of just shuffling, this is musical chairs if you're helping low-income kids do better, it comes at the expense of others, we think that's useful from perhaps a justice or fairness perspective, but maybe not so important in terms of economic growth.

And this struck me as a particular case, where at least our intuition is that it's not a complete zero-sum game. That if there's just this urn of inventions, and if you pull one out, then I can't pull that one out, it doesn't feel like that's how it works. In fact if you think about the empirical literature, it's more that if there's more innovation there's more capacity for others to build under discovery.

So, if you find something I now have a better idea. You discover a new technique; I can now apply that in my work, right? So, you could actually argue that it's potentially super-additive rather than just, you know, adding up. Now, do I know that if you would quadruple the number of inventors you will get quadruple the amount of innovation, in the sense that we care about in society, and the economy?

Certainly not, and I think it's quite plausible that you'd only get twice the amount of innovation, or even one-and-a-half times the amount of innovation but, wow, that would be a tremendous increase.

MR. REEVES: Would you live with that?

MR. CHETTY: Yes.

MR. REEVES: You'd live with doubling the amount of innovation you are likely to get.

MR. CHETTY: That's right.

MR. REEVES: Fair enough, I think you've set the bar, way too low. Okay. So, we are going to go out to the audience. Now, please, if you can, tell us who you are, please make it a question, I will cut you off if it goes on too long. And the very few people here, who did say that they do have a patent, this is not the opportunity to sell your idea for a (laughter) -- for a robot leaf blower, or whatever it is that you're here to talk about.

Yeah, I'm going to start with the colleague there because I know he's

interested in data. Andre?

MR. PERRY: I'm Andre Perry, I'm here at Brookings. If you look at the south where there's virtually no -- nobody is inventing, how do you convince a Bezos, or a Zuckerberg, or one of these other major companies, to invest and move their companies there, and away from these places that already are inventing?

MR. REEVES: Can I take a couple, two or three, would that be okay for you?

MR. CHETTY: Sure.

MR. REEVES: Fine, let's take a couple more let's take the woman here on the second row, and then I'll come to the gentlemen here on the first row.

MS. ASHE: All right. Greetings everyone; my name is Keshia Ashe, I'm an AAAS Fellow at NSF, with my colleague here, we work on broadening participation in computing. I'm also co-founder of a technology-driven mentoring organization. So, I'm literally in heaven right now. But I wanted to ask a question around risk and reward, because that's what this larger conversation seems to be about.

And so we've talked about risks from the sense of economic gain or loss, but one of the questions that, you know, really garnered my attention, was risk in another sense, in terms of the familial expectations, and sort of meeting those, not meeting those, having those at all, or not having them, and how that might affect sort of all the other downstream things that we've been discussing today. So, I would love to hear your comments around that.

MR. REEVES: Okay. Then I'll take one more from here, and then I'll come to the panel. And so select away, if you don't you can pass on them if they're too difficult, give them to someone else on the panel. Okay; to the gentleman here on the front row.

MR. MITCHELL: Thanks very much. I'm Garrett Mitchell. I write the Mitchell Report. I'm zero on the patent score, and I'm zero on having been elected to public office too, I might add.

MR. REEVES: You're in great company.

MR. MITCHELL: Yeah. Dr. Chetty, as I listened to your presentation, and the data, and particularly the maps, I was struck by what seemed to me to be a pretty significant overlap with, for example, the research that Robert Putnam has done in, *Bowling Alone on Social Capital*, and then in his later book, on *Our Kids*, in the notion of how stuck they get, and how difficult it is to get out of there. And it raises the question for me of: what factors and when did it become like this in America? And is it as simple as, if you could snap your fingers and make the GDP growth rate 4 percent, and fix the inequality problem, or are other factors at work? I'd love to hear your thinking on that.

MR. REEVES: Great. So, I will come to you first this time, Raj, and then invite the others too. So, Andre's point about the location of some of these tech companies in particularly; and Keshia's point about risk and reward and how that plays into familial expectations, is fascinating. And Garrett's point about: when did it all start to go wrong?

MR. CHETTY: So, let me try to take a quick stab at each of those big questions. So, you know, what are the factors at play here? Is this just about GDP growth and inequality? When did it go wrong? I certainly share your intuition that there's a lot more going on than just economic factors. So, social capital in particular, we find is a very strong correlate of differences in upward mobility across areas. Not just rates of innovation, but upward mobility more broadly defined.

Understanding how exactly to manipulate social capital from a policy point of view is very difficult, as you know, and so I think that's why the conversation

tends to gravitate towards things like schools, and inequality, and things that we might be able to tackle through traditional policy tools. But one of the things that I think is great about this conversation that we are having, in general, is usually when you're talking about these kinds of questions the policies you're talking about are things like, traditional investments in human capital, tax policy, R&D subsidies, corporate policy, and so forth.

But here we are having a very different conversation that's really more rooted in sociology, and thinking about things like exposure, and I think it echoes the types of things that you're talking about. On the issue of the South and how can you potentially change the situation there. So, we've been focusing in the Equality of Opportunity Project on certain places in the South, like Atlanta and Charlotte, which strike me is very interesting examples, because they are really engines of job growth.

There's a ton of economic activity in those places, yet what I think is striking, is Atlanta and Charlotte have very few kids who grow up to become inventors, and you see in these data, they also have very few kids from low-income families, more generally, who climb the income ladder and achieve the American Dream. And I think those are particularly striking cases because in places where you don't have a lot of opportunity in terms of jobs you might understand why kids don't have great chances of climbing the income ladder.

I think it's particularly surprising and depressing, frankly, in places like Atlanta and Charlotte that you have large swaths of people who are being left out, essentially, of the growth that's occurring, because talent is being imported from other places. Atlanta is basically outsourcing other people that bring in the growth.

So, you could imagine a company like Amazon or Facebook thinking about developing a presence in those kinds of places, might be more plausible than starting out in the other parts of the South where you don't have the right infrastructure to

begin with. You know, just a thought as one thinks about these decisions.

And then on the final very interesting question about risk preferences, I mean, my proclivity, as you know, is to give answers based on the data, in this case I guess an anecdote came to mind as you were describing the issue of risk preferences, in terms of meeting families expectations.

So, in my own case, you know, many of you might know an Indian culture being a doctor is like at the top of the ladder, then being an engineer, and I think being an economist is like not even on the ladder --

MS. SAUJANI: No. Not on the list. Not on the list.

MR. REEVES: What about a sociologist?

MS. SAUJANI: No. Forget about it.

MR. CHETTY: Yeah, the sociologist is probably (crosstalk).

MS. SAUJANI: No. (Crosstalk).

MR. CHETTY: And so I remember when I was an Assistant Professor at Berkeley, a good friend of my mom's, who is a physician, asked her, you know, what happened to Raj, like I thought he was pretty smart in high school. And so she said, you know, he's a Professor at Berkeley. And she said, oh, well that's good, but don't you think you should do an MD as a backup? Just to make sure things go okay. And so, you know, I totally agree that that kind of phenomenon seems potentially quite important.

MR. REEVES: Okay. Tony and Reshma, did you want to add anything on that? Reshma?

MS. SAUJANI: Another Indian parent story, sure. Yes, I think similarly, I think that, you know, I can speak from an immigrant community. I remember when I got my first paycheck as a summer intern at Davis Polk & Wardwell, and my father framed it because they had never seen this much money before. And the point of that sacrifice in

coming to this country was basically to get a safe job, to take as little risk as possible, which meant being a doctor, or a lawyer, or an engineer.

And so I do think that that plays in very much, I think, to risk aversion that may happen in terms of, you know, wanting to start your own company or, you know, or becoming an entrepreneur. Forget about even discussing C Capital, and we talked about earlier today, I mentioned there are less than 30 women in our history that are Black women who have raised more than a million dollars in our country. There's something wrong with that.

MR. REEVES: Do you mean from venture capitals specifically, or? Yeah.

MS. SAUJANI: And so, you know, I think part of that is not the lack of the interest and, you know, desire or ideation. So, I do think that like really looking at that kind of -- about that. And to me that leads into the American dream. You know, when I graduated law school I was $300,000 in student loan debt, you know, my father encouraged me to take debt after debt, after debt, after debt, because for him, you know, education was the American dream, and you would eventually be able to graduate from a Harvard and Yale to get that six-figure job, right, to pay off that debt.

You know, fortunately I would argue their debt system. I see a lot of kids at *Girls Who Code* who got into MIT, Harvard, but didn't get the financial aid package, and so went to Caltech or CUNY, and unfortunately many of these Silicon Valley companies are not even looking for them there.

MR. REEVES: Mm-hmm. Tony?

MS. SAUJANI: Yeah, you can add to that.

MR. JACK: I completely agree with what you're saying. It's like, what do students assess about career? So, when I brought up the issue of becoming a professor,

it wasn't just the economics that became of an interest to me, and I had to do a lot of explaining about going to graduate school in of itself. And as I said earlier, there are only three -- you're talking about the information gap, right, because they are only in -- in my neighborhood there are three Ivy League schools, Harvard, Yale and Princeton, and the reason why Princeton is on there is because of the Fresh Prince of Bel-Air.

There is simply an information gap about what it is, at even the undergrad level, let alone for graduate school, to say I'm going to graduate school for quantum -- you know, I'm going to quantum mechanics. I did get the question like: oh, I thought Tony was smart, he's going to school called Amherst. What is that? Like, literally, I went to Amherst College, and people didn't understand exactly what it was.

And so the assessment of the reward is not just about how much money you're going to make, because something that interests me about what I actually learned about what Professor Bill Miller did during the summer, it's I was like: oh, wait, when you were not -- when we are out of school, you're out of school.

So, you get a spring break, you get a Thanksgiving break, a six-week winter break, and summers off, technically, because we have to write books and stuff. And I was just like, oh, I like that, I like being able to set my own hours. And so when I had my first job, and it was more of a 9:00 to 5:00, I learned more about what I didn't like, but I was exposed to that -- my professors and other people, and I began to narrow down the industry that I wanted to go into.

And so, that is another way in which exposure actually matters, but you can only have it when you leave the confines of X community, which is actually very, very hard when you think about: who gets to climb, and who doesn't. Who gets to be exposed and do the internships? Like do you want to be a physiologist or do you want to be a surgeon? Oh, those are two very different lives -- I'm sorry, or a general practitioner,

those are two very different lives, two different types of medical school training, the different years, and all that kind stuff like that. And that is when, again exposure matters, and the assessment of risk is different than just economic capital.

MR. REEVES: Thank you. All right, let's keep going. Hands, questions? Where's the microphone, yeah? Let's just go down here, come to the gentlemen right on the aisle there, and then the gentleman just in front of him to the right, and then we'll go over there to the lady on the left. Yes?

MR. GORMLEY: Our schools and our school districts are on the frontline --

MR. REEVES: Could you say who you are, if you don't mind?

MR. GORMLEY: Bill Gormley, from Georgetown University.

MR. REEVES: Thank you, Bill.

MR. GORMLEY: So, our schools and our school districts are on the front lines, they have a lot of important decisions to make. If you were to offer advice to them would you focus on whom they should hire, the demographics of the teaching? Would you focus on classroom pedagogy, maybe focusing more on one-on-one instruction? Would you focus on extracurriculars, on (crosstalk) --

MR. REEVES: Is your mic turned on, by the way?

MR. GORMLEY: -- science fairs, or something else?

MR. REEVES: You're talking about K-12 schools specifically?

MR. GORMLEY: Pardon me?

MR. REEVES: K-12?

MR. GORMLEY: k-12, that's right.

MR. REEVES: Okay, fine. Thank you, Bill.

MR. GORMLEY: What would you propose?

MR. REEVES: The gentleman in front of you, just to your right, to pass it forward.

MR. BHANDARI: I'm Ryan Bhandari, I'm an Economic Policy Adviser. I actually had a very similar question in terms of the fact that, you know, one of the things that you're --

MR. REEVES: Could you speak up a little, I think the mic is not working very well?

MR. BHANDARI: Working now?

MR. REEVES: Yes, it's a bit better.

MR. BHANDARY: Okay. One of the things that you mentioned in your presentation was identifying the kids who have the potential. So, obviously it's tough to, you know, legislate how families and, you know, things outside of that, like identify those kids, but how the schools can identify the kids. So, what more could they do? I mean, obviously it's wonderful to have non-profits like *Girls Who Code*, but is there something from like -- is there a policy lever that you can pull where they can do a better job identifying, and then, you know, helping these children?

MR. REEVES: Within the school system, so related to the other question. Yes. And then over here on the far, my far right? Thank you.

QUESTIONER: Thank you. I'm (Inaudible), I'm a Visiting Fellow here. Thank you for this timely work. But my question is whether you've looked at firms, like you've looked at elementary school test scores, you've looked at colleges and their impact on invention. Have you looked at the impact of firms in individual's ability to innovate? Or by then are the cards -- you know, the deck stacked?

MR. REEVES: Thank you. So let's give, so the first two they could almost be taken together I think, around identifying high potential in school, but also what

would you do in K-12. I don't know if Ted mentioned it or not, but some of Raj's earlier work was on teacher quality and the impact that that had. So he'll be able to speak to that. And then Marsha's question about: if there are firms, and the impact of firms in those neighborhoods. Raj, why don't you have a go first again?

MR. CHETTY: Yeah. So, let me say a few things about what I think we could do. So first, in general I think there's an issue in the United States of how we recruit and retain the best teachers. There's quite a bit of rigidity in the system in terms of being able to keep the best teachers in the school system. As Richard mentioned, our earlier work, we look at how the value-added of teachers seems to affect the kids' long-term outcomes quite substantially. That was focused on things like earnings and college attendance; I suspect it would apply to outcomes like innovation as well.

So, I think being able to attract very good teachers in our schools can be important both in terms of pedagogy and in terms of mentorship, right. And I think the U.S. is in a different position relative to Scandinavian countries.

For example, where if you think about a country like Finland, kids who are at the top of their class aspire to become teachers, and I think the United States, for various reasons, partly cultural, partly related to status, partly related to pay, that's not the case. And so that's a broader issue in education that I think would have bearing on innovation.

There's a second issue of the particular teachers you have. So, do they connect with the students, as tony said? You know, do they recognize the challenges that kids from particular backgrounds face? Does that mean we should be training our teachers differently, or recruiting a different set of teachers? I think that's a really interesting set of issues to think about, that could be quite important.

And then the third point about, you know, identifying these kids that --

you know, how can we identify these kids? Can we do that in some systematic way in schools through policy? But I'd say there is -- I was surprised frankly by the predictive power of even simple math standardized test scores in third grade. So, you know, the current discussion of standardized tests, as you all know, they are much maligned as measures of ability that, you know, this is capturing teaching to the test, or various other things.

But these measures do have some predictive power. I'm not advocating for the standardized testing system as it is, but what I think what that suggests is there's value in investing and trying to better measure kids' talents. There's one particular talent which might be, you know, associated with innovation, there are going to be kids with other talents where they'd excel in other paths, and I think if we can figure that out relatively early, we can help guide kids down each of those paths.

So, I think investing more in understanding what types of metrics at early ages, beyond just these standardized tests. Is that about measuring non-cognitive skills? Or even maybe measuring risk tolerance, or persistence, things like that, grit, I think that type of measurement, and trying to incorporate that more systematically could be very valuable.

MR. REEVES: (Crosstalk) also there was a question about firms. So, actually I'd like for Tony and Reshma to comment on this point about schools. Tony, your work on *The Privileged Poor*, looks at the ones from private schools and how well they do even if they're from low-income backgrounds. I think you attribute a lot of that to network, social capital, cultural capital; could it also be about the quality of the teaching in those schools? That actually just, you know, teacher-for-teacher, one of the reasons people go to private schools, to try and get kids in them, is because they are higher quality institutions of one form or another? Do you find that?

MR. JACK: Well, I don't know. On that piece, because that was a head start -- I had a taste of both. I was head start through eleventh grade public, and then in twelfth grade I went to Gulliver Prep in Miami for my senior year. I think it's not necessarily teachers' quality, I think it's opportunity for teachers to actually showcase their talents.

Because if you're trying to teach a class where the average class size is 40, as compared to your class load is 4 to 10, even the best teacher will get burnt out over time when you're overcrowded, and you're trying to manage resources, and you don't have enough spaces in your classroom for every student to have a chair. Now, granted if you go to private school most of your teacher is 75, some schools as high as 90 have terminal degrees, and most will have a Master's with a specialized subject.

So, I'm not trying to say even on a credentialing level, private school teachers may actually be more credential on the way that we would think. So, I don't want to say that is equivalent to teacher quality though, because the opportunity that private school teachers have to teach not only a select group of students, but also when you're talking about the Harkness Table, there's six people reading primary text.

MR. CHETTY: Right.

MR. JACK: That's a very different experience, and it is true, when you think about the difference between lower-income students who go to public high school, those who I call "Doubly Disadvantaged" and the privileged poor, those who go to private schools, it's their exposure to their peers and to a certain type of teaching style, is what gives them a social advantage in college. Of navigating, they don't experience culture shock in the same way, of navigating teacher relationships.

And so, it's not saying that they will automatically do better GPA-wise, but they know to look for what really makes college the biggest bang for your buck, and

that's getting -- that's milking it for every opportunity, whether it's research, social, economic or extracurricular that they have available to them.

MR. REEVES: Tony makes a very important distinction teaching style, but also between good teaching and good teachers. Now, clearly those two things are related, as Raj's earlier work shows, but I think you point to the fact that good teaching takes place in a better resourced environment with other kinds of supports, in a certain kind of climate, and so on. And so there are other factors that go into good teaching as well as the work we know about a good teacher, so quite an individualist way to think about it.

Reshma, if the schools are doing better you wouldn't need *Girls Who Code* because they would be coding at school, surely.

MS. SAUJANI: Yes, right. Exactly! Well, I think one of the things that's not happening, or we are encouraging to happen more in schools is data collection. So there's a massive movement across the country to get computer science in every single school, and what *Girls Who Code* has really pushed for is great, but can you track gender and race? Can you make sure that every time you put computer science in a classroom you're collecting data on how you're doing in recruiting kids, women and kids of color, right.

And by doing that, by having that data we can see what we are doing well, or we are not doing well. To me, you know, a lot of solving this problem, if you assume and then you accept that there's a gender gap in most computer science classes, and we are far not reaching kids under the poverty line, or kids of color, is to think about like what we can do to change curriculum to make it more attractive.

So, a simple intervention that we have been kicking around is this idea of, you know, changing the standards to mandate having women in tech spotlights, in

computer science classes. So, if you're going to teach a computer science class you're going to talk about Ada Lovelace, you're going to talk about Katherine Johnson.

You know, you're going to make it very clear to boys and girls, right, that the pioneers of computer science were women, and so that chart that Raj, you know, popped up there where you see that dramatic increase, you know, of girls being interested when exposed to role models who are inventors, we can have a hope, you know, that that one small intervention can actually make a difference. I think it really can.

MR. REEVES: Good. Thank you. Just coming back to Marsha's question about firms, and the role of the kind of firms, and in particularly places were you thinking, and the way they're embedded in communities and networks? Or was it within their internal labor markets? Could you say a tiny bit more?

QUESTIONER: Right, and whether they effects of the individual opportunities of making someone likely to become an (inaudible) --

MR. REEVES: So within, okay. Yeah, because your measure is in their 30s, so they've in work for a while.

MR. CHETTY: Yes. We think firms, you know, are likely to matter, but I come at it more from a different angle. So, if you look for instance at women in certain scientific fields like biology, for example, you nearly have gender parity in terms of the number of graduate students who start out in biology, but then you see a dramatic change over time in terms of the number of women who stay in the field to eventually run their own lab, or lead a scientific team. And so clearly there's something happening there, right, where through childhood we are getting people to the entry point of the career stage, but then things are happening within firms, or within universities, and so forth.

And so I absolutely think it's important to think about those issues. That

said, in this context, you know, we were looking at the data, it does seem like these childhood factors drive a lot of what's going on. Who gets in the door at Google to begin with, as opposed to what happens thereafter. So, I think we should be paying attention to both sets of issues, and there might be different types of factors that are at play in terms of family leave policies, or discrimination, or other things that arise within firms relative to the mentorship, childhood exposure effects that we've been talking about here.

MR. REEVES: Thank you. Okay. Let's do another round; we have time for one more round. So, yes, the gentleman right in front of you, and then the woman two rows in front of him, and then this gentleman, yes.

MR. POSER: I'm Carl Poser, and I stated a project called The Center on Capital and Social Equity, which explores inequality, and also seeks more inclusion, but particularly in the middle and the bottom. My question is about the risk aversion. If you look at -- maybe looking at just those that have gotten patents, it's too small, like for the universe, it's like just looking at the people that got to the NBA.

We need to look at the risk-reward of putting all that time and money into the education, versus the reward. All the bench scientists and all the professions that are drawn from it, and the people that make, you know, regular salaries, where most of the workers are.

And then from my own family experience, my grandfather had a patent that really revolutionized rayon production, but the company got all the money. He had a tiny little house and a bunch of tools in the basement, and my brother has a bunch of patents, X-ray equipment for ore underground, dragged around by helicopters, the company gets all the money. So, you need to look at the arrangements, you know, on how the person benefits from the patent. It's complicated, I know, but it's a bigger universe.

MR. REEVES: Do they actually get the economic value for it?

MR. POSER: Yes.

MR. REEVES: And Raj's chart did suggest at least some people are getting quite a bit from it. So, it might be the patent lawyer that your family is using, or maybe not. Yes?

MS. SMITH. Hi. So, I'm name Monica Smith, and I'm with the Smithsonian's Lemelson Center of the Study of Invention and Innovation, and we do a lot of programming with children and families, particularly ages 6 to 12, which we know is sort of that sweet spot for capturing young inventors in the making. But one thing I found interesting, in a lot of programs we bring in inventors, the idea is to show diverse inventors, get people to actually get to meet them, and see them, and see these role models.

But what I'm struck by is when we are looking for diverse inventors, how often we find them in government more so than in private corporations. So many come from NASA, for example, or NSF or NIH or, you know, other labs in government, and a lot of them are later in their career, and they talk about that that was where they could get work. You know, that was the place that actually was hiring African-Americans, and so on.

So, could you talk a little bit about hiring and some of those issues about discrimination that there should be a lot of good data from government about who is patenting, who is, you know, on these teams, and how does that compare to what's happening in the private sector?

MR. REEVES: The public and private sectors. And this gentleman in front of you, actually a couple of rows in front of you, you had your hand up, the gentleman with the glasses on. Yes? And then we'll come back to the panel.

MR. LAPID: I'm Patrick Lapid, Economist, CFPB, and I think --

MR. REEVES: What was your name again? I missed the beginning.

MR. LAPID: What was that?

MR. REEVES: What was your name at the beginning?

MR. LAPID: Oh, Patrick Lapid, I'm an Economist at the Consumer Financial Protection Bureau. I'm interested in education still, so hence I'm here today. Thank you for the presentation. My question, I think it might be a lot more of sociology actually, and social psychology, and interactions, but based on what's going on in the economics profession about women in economics, as well as women in technical fields.

I think that -- and it's more of a general comment -- that although I feel like, in the short run, same-sex, or same people of color pairings might be beneficial in mentoring. At some point us men have to step up, like father's have to step up with teaching their sons that women can be role models for them, and teaching us, ourselves, that that we can mentor female economists, scientists and so on, and how much can we do with cross-gender and cross-race mentoring?

As an economist I came up through AEA Summer Training Program and its pipeline program for minority economists. And I might be Asian-American, but I'm Filipino-American, so finding another Filipino-American economist ain't that easy. So, you know, all the women, and all the people of color in the economics profession, I owe their, a gratitude to.

MR. REEVES: All right. Thank you for that. I'll just repeat again, nothing wrong with sociology.

MR. JACK: Absolutely not.

MR. REEVES: Some of our best friends are sociologists; my degree is in philosophy, so I'm not going to throw any stones at sociology.

MR. LAPID: I have an undergrad in sociology, and econ, and (crosstalk)--

MR. REEVES: Hi, who else have studied sociology, hands up? (Laughter)

MR. JACK: Good choices, all good choices.

MR. REEVES: I think I'll start with Reshma, because I think at least two and three, they are kind of hiring point, and a public/private distinction is important. And I think this point about: we don't want to accept gender norms as they are; which I think is your point too.

MS. SAUJANI: Right.

MR. REEVES: What's the role of men in changing those gender differences?

MS. SAUJANI: I'll start with the -- Listen, you know, 40 percent of *Girls Who Code's* teachers, and we hire thousands of teachers a year, are men. Like this movement is built often on the backs of fathers and men who've had enough, and who want to see a different reality for their daughters. And so I don't think that it is -- I don't think it's yes and, or both and, right, it's making sure that we are showing our girls that there are incredible women who they can follow in their footsteps.

And exposing them to incredible men who want to use their resources, their power, their time to elevate and to support a girl. And so I think we need to encourage more. One of the best things that happened to me this year is, I went to the Rochester Institute of Technology to meet with the women in Computing Group, and there were three guys there. And I said: who are you? And they said: we are the men who are supporting the women in Computing Group. And they saw it as their obligation in classrooms to make sure that women were called on.

To your point, Pew had an amazing study that came out two days ago, that 76 percent of women in computing report discrimination in their computing jobs, compared to 16 percent of men. I was talking to -- I was speaking at an event, and in an interview, speaking with a bunch of men who work in a financial services firm who -- and this firm hires, you know, thousands of engineers. And he said, you know, Reshma, the first question I ask in an interview, is often a question about baseball. Do you think I should do that? (Laughter) Probably not.

There is something happening in the hiring process, right, in the offer process, in the first three years where 40 percent of women will leave within the first three years, that is broken. And I think we need to spend more time. We've evaluated the lack of, you know, disparity or parity, in gender and race, you know, in tech but we are not tracking it and looking at what's happening and why, and I think we can do a better job, and we can put the onus on tech companies to provide that that data with us, but I do think that a lot of people are finding a home in government, to succeed and to innovate.

MR. REEVES: Do you see that difference than, to Monica's point, between public and private sectors in terms of their awareness and intentionality of the need to be more (crosstalk)?

MS. SAUJANI: Well, I mean if you think about what's happening in the Valley, some of these companies are young companies that don't even have HR departments. You can't get away in government, you know, basically sending five emails to an HR person about sexual harassment and getting no response, and the guy getting promoted, hopefully. That's another one (inaudible), I think. But we hope, right, that government is more mature and better at weeding out this type of behavior and having a zero-tolerance policy. And I think that tech companies have a way to go on this.

MR. REEVES: Thank you. Tony, I'm going to come to you next on any

of that, but specifically this point about the role of men in changing assumptions about gender in these particular sectors, or in particular areas, because of your own interest in that. Is it up is it up to men to change gender roles at least as much as it is women?

MS. SAUJANI: Say yes.

MR. JACK: Yeah -- No (Laughter)

MR. REEVES: I set it up as a yes question --

MR. JACK: No, no, no, if --

MR. REEVES: And if you say no we are going to have a (crosstalk) answering this question.

MR. JACK: I mean, the answer is, the answer is absolutely yes. When you think -- especially when you think about the people who have positions of power, when you think about who are more likely to be a department chair, a dean, a provost. When you think about not only who gets an offer but the disparity and starting salaries, and everything that gives you some startup funds, when you're trying to set up your lab.

So, all these things, it's absolutely, you have to shoot for equity to the point that, I think, universities actually need to start really looking at assessing their -- assessing the discrimination in a number of different ways, especially even looking at starting contracts of faculty members, so that you can start going to parity with research funds.

When I think about women who are starting labs, and men who are signing labs, you know, labs are very, very expensive. You know, a difference between, you know, $100,000, or ever $250,000 that goes a very long way when paying a post doc, or five post docs in your office, it's a huge expense, but if you have three post docs as compared to five, those extra two minds, can help you get into science, can help you get into nature, can help you get your patents in, it can help you get, you know, your

research out to get promoters.

So I'm thinking about even within academia, but it translates very well to like, who are your mentors. Because of who is in positions of power historically you have to have a coalition, and one in which that you open the doors to more people.

MR. REEVES: Thank you both for that. So, yeah, I think you've done a very good job on two and three, so I think, Raj, feel free to comment on that. But I don't want to Karl's point, the sort of family tragedy of a family of inventors who failed to capitalize on it.

And looking at your charts, in a way we should be pleased if people don't make a lot of money from their inventions, because if they are disproportionately from the top of the income distribution, then if they also get wealthy then it will make it worse, it will make inequality worse rather than better. If we see it as a way to improve inequality, because it's poorer kids who are doing it, then we want them to get the money, so (a) are people getting the money from their patents? And (b) do we want them to, given who is getting the patents?

MR. CHETTY: I'm going to take that, and then I'd like to make a point on the discrimination which I also think are very important. So, in data as you saw, the experience that you described, so the patents that are assigned to the company, but are invented by a particular person in the company, are included, those people who become those inventors in our data, and what you could see is that, at least on average, may not be true in every case, people who had very high-impact patents actually make quite high salaries.

Now, why is that important? I think, you know, given that this is such a risky career, knowing that at least there's some scenario where you do quite well, is potentially quite important. I think it also bears on the issue of whether financial

incentives, as I was saying, is that really what we should be focusing on, versus where the conversation has focused today.

On the issues of inequality, you're of course right, Richard, that if the set of people who have this opportunity are from the top to begin with, and that gives them an opportunity to get even richer you're going to amplify inequality I'm not sure -- I mean, while that is a valid concern, I think if in the process of amplifying inequality you're also increasing economic growth, thereby lifting the absolute standard, the poor and middle class, I'm not sure that we should say that is a bad thing.

MR. REEVES: That's the kind of good inequality if it helps with something like (crosstalk).

MR. CHETTY: Yes. If it happens that way, I think that might be okay. I want to come back to the issues of discrimination which, of course, extremely important in both and women, I think it can play an important role. I think there are subtleties here though, that are important to keep in mind. So, one piece of evidence on issues of discrimination, that both highlights its importance, but highlights the nuance, are studies that people have done using an audit approach.

So, this is basically, you send a set of CVs, a set of résumés to people who are running labs, or hiring at a company, and you vary only one thing, the name of the person. So, it might be Emily instead of Mike, thereby just changing the gender on the on CV. Holding the rest of the record fixed, and it's a well-established fact that if you have a woman's name on the CV instead of a man's name on CV, you get a lower callback rate.

But what I think is a subtlety there is that that's true both if the head of the lab is a man, and if the head of the lab is a woman. So, this is not exclusively driven by a pure, you know, gender-bias issue, it's something maybe about broader perceptions,

norms, something deeper that we need to figure out. And so I think engaging with those aspects of the data is extremely important as we think about tackling these issues.

MR. REEVES: Thank You, Raj. We are approaching the end of our session, so I'm afraid I won't take any more questions. But I will ask a closing question of Raj, if you'll permit me, which is to say that having seen you present now, and read many of your papers, the story is that inequality is very strongly inherited, and that the transmission mechanisms through education, through housing, place, social capital, invention, and so on, are really pretty strong. Those transmission mechanisms from one generation to the next are strong, in some cases perhaps even strengthening.

And so overall the picture is rigorous, clear and rather depressing. And so my question to you is: given all of that, do you have reasons to feel hopeful about the potential for reducing the power of those transmission mechanisms, for making inequality somewhat less inherited in the U.S.? And if you do have such hopes what are they and why?

MR. CHETTY: So, I actually, I have somewhat of an optimistic take on the data, not because of the national trends which you described, which I agree are not very encouraging, but because you do see pockets of the United States, places, colleges, schools where there are extremely good outcomes for kids in low-income families. Where Black kids do well, and I think what that shows, it's kind of an existence proof to me that this is a problem we can solve, and the question is simply: how do we go about solving it?

And so I think that poses a challenge for us as researchers, to figure out exactly what those solutions are, and it's an opportunity for everyone here in the audience to figure out how to enact some of those solutions. And you see, I think my optimism comes from the fact that -- you know the fact that there are these places, and

there are some systemic properties those places have.

You know, it's not that it's just random variation in the data, there are certain types of features like more integrated communities, stronger schools, more social capital, and so on, greater exposure, that I think could be translated to policy, that suggests this is actually something fixable. And it's fixable, I think, at a local community level, which I think is extremely important.

When you look at the kind of monolithic national trend that I ended with, you might think, wow, that's such a daunting problem like: how are we ever going to make a dent there? But when you see the variation across areas, you start to feel like, yeah, I can do something about this in my own community, in my own college by changing the mentoring policies, and I think that can be very empowering.

MR. REEVES: So, a deep problem but a tractable one is the solution. Well, we are out of time, but please join me in thanking Reshma and Tony, and Raj Chetty. (Applause)

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