THE BROOKINGS INSTITUTION

WEBINAR

HOW INNOVATION CAN POWER ECONOMIC GROWTH

A HAMILTON PROJECT WEBCAST

Washington, D.C.

Wednesday, June 17, 2020

PARTICIPANTS:

Framing Remarks:

PAUL ROMER
Co-Recipient of the 2018 Nobel Prize in Economic Sciences
University Professor in Economics at NYU

Roundtable Discussion:

JAY SHAMBAUGH, Moderator
Director, The Hamilton Project
Senior Fellow, Economic Studies
The Brookings Institution

LISA D. COOK
Associate Professor, Department of Economics and Department of International Relations
Michigan State University

JOHN VAN REENEN
Gordon Y. Billard Professor in Management and Economics
MIT Sloan School of Management

HEIDI WILLIAMS
Charles R. Schwab Professor of Economics
Stanford University

* * * * *

P R O C E E D I N G S

MR. SHAMBAUGH: Good afternoon. Welcome to the Hamilton Project event on "How Innovation Can Power Economic Growth". I'm Jay Shambaugh; I'm the director of the Hamilton Project. We're really thrilled to have all of you with us today.

How to drive economic growth has long been a question the Hamilton Project thinks about. In fact, our mission statement includes the phrase "fostering economic growth and broad participation in that growth". At the same time we currently have a pandemic, we have the highest unemployment rate we've had since the Great Depression, we have concern over racial injustice and police violence driving protests across the country. And so one might ask, you know, is this the time we should be worrying about long run growth. That said, there is this long told sorry about a retired French general who asks his gardener to plant trees down by the road so he can see them from up by the house and the gardener replies, but, sir, it will take 50 years for you to be able to see those trees from up here at the house. And he says, well, then we should hurry, we don't have any time to lose. And I think there is that sense that just because policies might take a while to provide good outcomes is not a reason to delay them.

More seriously, this pandemic requires innovation in technology. The increase in debt due to our response to the recession makes faster growth and output in the long run even more important. And, most of all, we know that to increase living standards in the long run we need innovation and we need productivity growth. And so making sure our policies and institutions support growth and innovation and technology is essential. And for that, again, I guess there's no time to wait.

We're very fortunate to have Dr. Paul Romer with us to lead off this discussion. He is the University Professor of Economics at NYU, a former chief economist at the World Bank, and a recipient of the Nobel Prize in economics for his foundational work in the concepts of innovation and technology growth and their relation to economic growth.

I honestly can't think of anyone better placed to open this. So I will now turn it over to Paul Romer to talk to us for a bit.

MR. ROMER: Thanks, Jay.

In my conversations about innovation, about testing, somebody gave me a version of the story about trees where they said the best time to plant a tree is 20 years ago. The second best time is to plant it today. And that's the mindset we have to have. There's lot of things we could do right now that will pay big returns even in a few months, certainly in years, decades down the road. And this pattern of saying we can't attend to the future because we're dealing with something so urgent right now is the reason that we face n urgent problem right now. That was what we did in the past, we didn't do a little bit of investment that could have avoided the pandemic and the crisis, the dual crises that we're in now. And if we keep doing that, we'll just repeat this error.

In particular, when I started talking about testing in March at population scale, the reaction was something like well, we can't do that this week. Okay, fair enough. We couldn't test at population scale this week, but we could have tested by now, a couple of months later, but at the time everybody wanted to know what are we going to do this week, but now, here we are a few months later, we're still facing the same incredibly grim options that we faced back then. And I've never experienced a time in my life where the innovations that are possible could be so valuable and our failure to invest is so painful. The difference here between the social rate of return -- or the magnitude of the social rate of return that's available to us with the right kind of investments in testing, I just find staggering and frustrating. So it's a kind of extreme case of the very general problem we have about sustaining innovation in a modern economy.

I'll make some remarks at the end about the degree to which we can rely on, in this particular case, or more generally, the private sector to be the engine that with appropriate subsidies, with appropriate incentives, could be the engine of innovation and growth. There's a reason why that isn't working for us right now on the current crisis, and I think we need to think about whether this could be a sign about broader problems we're going to have building a consensus for innovation in the future.

So, if I can, what I'd like to do is share my screen and give you just a little bit of a sense of where we are in the United States in the middle of these twin crises. These are the current projections

about -- the data about deaths and projections about deaths for the United States as a whole. As you've seen in charts like this in the newspaper, we had a big spike in deaths in April, you know, almost 2,200 a day. Things have come down substantially since then. The thing that this hides is that there's really a significant difference between the New York City area, where there was an enormous run up in deaths -- that's the blue line here -- it's actually New York, New Jersey, and Connecticut, but it's really mainly New York City. New York City accounted for the majority of the deaths in the United States. It ran up very quickly, but it's come down -- we've instituted measures that have brought the pandemic under control. But the rest of the United States has not had anything like that kind of a success. So we're now at a situation where in the U.S. as a whole we're just like repeating, continuing along in a steady state of around 750 deaths per day. And what that means in terms of infections -- and this is the number to tell yourself, tell everybody you know -- 100,000 people get infected with this virus everyday in the United States and about 1.5 million people are currently infected with it. So, if you're thinking about contact tracing, trace all the contacts of all of the people who are currently infected -- you know, if you've got 20 contacts times 1.5 million people, you've got a lot of contacts you're going to have to trace.

So we will continue at this pace of about 100,000 new infections a day and then the corresponding 750 deaths a day for as long as it takes to get to a vaccine under the current policy. There's a real chance that the infections and deaths will actually creep up as various parts of the U.S. continue to remove some of the restrictions that were in place before. So we'll inevitably have at least 200,000 deaths by the end of the year, perhaps more.

The other thing that is so discouraging is the economic cost. So if I can show you this chart from the CBO, we're aware that we're facing about a 15 percent unemployment rate in the United States, if you correct on account of the problems with measurement error that they're having, but if you just look in the difference of the CBO's forecast for 2030, between what they were forecasting the crisis and what they're forecasting now, we're going to lose about $16 trillion worth of output because of this pandemic. And this pandemic is entirely the result of people being infected who infect other people with a virus which is scary and kills many people. All it would take to avoid all of this loss is simply to know

who's infected. If we know who's infected, all then we have to do is isolate them for a relatively short period of time, two weeks, maybe three weeks, and then the $16 trillion in loss goes away, unemployment goes away, the continuing deaths go away. So it's really just a matter of solving an information problem. How do we find out who's infected and then how do we isolate them?

There are two strategies that we could use to figure out who's infected. One is contact tracing, but we've never seen contact tracing work at a scale. We've got 2 million people who are infected and there are very serious logistical questions about whether contact tracing can work at this scale. We can try and do it, but there's no evidence that it's going to work. It's the kind of thing -- it's supposed to work at a much smaller scale, like what we had in January, and it didn't work in January when in the early stages of this infection. So there are reasons to be skeptical about whether contact tracing is up to the job here.

The other way is to test people. We know how to test people for the presence of this virus and if we test everyone we'll find everybody in the country who has got the virus. It's really as simple as that. Now, you have to think about the cost and thing about the logistics. I've been pushing this idea of testing about once every 14 days -- test everybody. That would be enough to be sure to get the reproduction rate for this virus well below one. We're on a path where the exponential declines of the virus goes away. To do that for the population as a whole you need about 23 million tests a day. If those tests cost $100 per person, which is the high end of the Medicare reimbursement right now for the sophisticated test systems, we can't afford that. That would be like $1 trillion a year in tests. If they cost $10 a test, then it's about $100 billion a year and we could easily afford that if what it saves us is this kind of many trillions f economic loss that we're facing and many hundreds of thousands of lives that would be lost.

So, is it possible to get the cost of a test down to something like $10? And that means not just the cost of reagents, but the things like the time cost, the logistic costs. The answer is it's entirely possible. There are many feasible paths forward that could be pursued to achieve this. Let me just give you one example. Because I've been promoting this, people get in touch with me now. This is a faculty

member from CalTech who's holding a PCR machine in his hands. Usually a PCR machine is bigger than a washing machine and a dryer next to each other, but this is a true PCR machine. It's not like the Abbott that, which relies on a different technology called LAMP, this is true PCR that you can carry around. It has a limitation in terms of throughput because it does one sample at a time. You can pool a bunch of samples together and then process many people at a time, but you can scale this approach just by having many units like this.

So this is in development, it may well be available within about a month, but there's about, you now, a dozen other things like this that could do testing at what they call "point of care", just, you know, in office, even in your home. There's proposals for home testing, there's proposals for massively scaling up the throughput in the existing laboratories. And, you know, the tragedy here is that we're not devoting the resources that it would take to encourage people to do this kind of testing, so it's the classic problem of a divergence between social value and private value.

On top of that problem, which is serious enough, we have an additional problem, which is that our regulatory systems are now dramatically slowing down innovation in this space. The FDA is a huge break on progress in this area. And I've not been somebody who is a big critic of regulation in general. I think regulation is important, I think it has to be strengthened. I'm not a critic of the FDA regulation in general, but on testing they have been astonishingly shortsighted and narrow in their focus, not looking at the big issues and just sticking to their parochial concerns.

To give you just one illustration of this, months ago a researcher at Rutgers figured out how to use saliva samples instead of these swabs. We had a swab shortage, it's painful to get swabbed, if somebody is infectious they get swabbed by a healthcare worker, the healthcare worker is exposed to the risk of infection, all kinds of things wrong with swabs. The saliva samples are actually more accurate than the swab samples. It took a month to get to the point where the FDA would even allow it to be possible to use a saliva sample to be used as a test for somebody who didn't have symptoms of the virus. So, you know, forget about surveillance testing, forget about identifying asymptomatic transmission, it was against the law to test somebody with a saliva test for a month if the person didn't already have

symptoms.

That's finally been relaxed. There was also a prohibition on spitting into a tube and then having a doctor watch you over Skype. You spit in the tube, you mail it in. that was illegal. You could stick a swab up your nose, but you couldn't spit into a tube for a month while the FDA was trying to decide if they were going to allow that. It just goes on and on. And it just defies reason.

Now, what's behind this? And this is I think the broader lesson that we have to worry about. There's enormous suspicion of private sector actors right now in the innovation space. We've seen cases of antibody tests where the FDA actually let a lot of these through that were bogus, you know, they made overtly ambitious claims about accuracy. And we had a history of like a tech sector which is engaged in a lot of dishonest predatory kinds of behavior.

So there's a growing sense that part of what regulators have to do is protect the public from predatory innovation. And this is I think the mode that the FDA is stuck in right now. This is a very bad sigh. And when I talk to people like congressional staffers, they understand the problem, but they're extremely nervous about anything that would get the FDA to just back off and let like university labs start doing testing without going through the usual FDA kind of long slow process. They're incredibly nervous about this because they've seen cases where private firms have -- once they get through the gateway, have done enormous harm.

So we are in a situation where we're suffering trillions of loss of output, hundreds of thousands of lost lives. They could easily be solved with technologies that are right on the horizon ready to be implemented. We may get them anyway in a few months, but it's just almost criminal that we're so slow and so far behind in finally doing this.

It will take some money. The one positive sign is that the Congress did allocate $25 billion for testing in the last bill. They're contemplating the possibility of another $75 billion in the next bill, which gets you to the $100 billion a year you would actually need to do the full 14 -- test everybody in the United States every 14 days. So there is money being allocated.

The final thing that I think where economists could rejoin this debate -- and I'll just use my

last slide here -- is if there is this kind of money to support things like testing, it's time to get serious again about things like prizes. We want a system that motivates innovation in this space, that produces public knowledge, that avoids proprietary hold ups, that lets these things be used all over the world. And prizes on a very bi scale I think should be the way that we accelerate some of this innovation in this space.

So I've been talking about a $1 billion prize for centralized lab facilities that could get up to 10 million tests a day. And we should have another $1 billion prize for somebody who can do an at-home testing solution at a given cost point. Because faced with trillions of losses and hundreds of thousands of lives, a stretch goal that we might not even have to pay out on of $1 billion for a few key innovations would be the best investment that we could make.

So let me stop there.

MR. SHAMBAUGH: Great. Thanks so much for that. That was a really interesting tour through what we're seeing right now and the importance of innovation and technology growth in the face of it.

So there are a lot of reasons we need productivity growth, and yet we've seen this marked slowdown in the last really 50 years where we've seen growth lower in labor productivity growth and also in what we economists call total factor productivity growth, which looks at growth after you control for labor and capital increases. Since 1973 both have been much lower, with the exception of this kind of brief boom in the mid '90s through the mid 2000s. And since 2004 we've had the lowest labor productivity growth and lowest TFP growth since World War II. And this can seem odd to I think many people who look around them and they see new innovations and new products and things like that, but when you look at the data in terms of how innovations have turned into output, we have seen a fairly marked slowdown. For those interested, we have a new Hamilton Project paper kind of walking through some of the aspects of the slowdown.

What we want to do now is turn and think about some of the solutions. We have three terrific scholars who are putting forward kind of their own ideas based on their research. John Van Reenen is a Professor of Management and Economics at MIT. Lisa Cook is a Professor of Economics at

Michigan State, and Heidi Williams is Professor of Economics at Stanford. All have written extensively about innovation and intellectual property rules and economic growth. We're thrilled to have them here, so thank you.

John, we'd like to start with you. You've written a broad proposal reconsidering our innovation policy. Can you just tell us a bit about what you think we should be doing to generate more productivity growth?

MR. VAN REENEN: So thanks very much, Jay, and thanks everybody else for the opportunity to share some f my thoughts.

So my proposal here is for a step change in governments funding technological innovation. And I've put this as an idea around grant innovation funds for research and development to kind of reinvigorate American growth and provide high wage, good jobs in the future. And I kind of see as a response to at least three urgent challenges that have already been mentioned. Think of this as kind of missions for America. So one mission is the health mission the polls talk about, particularly around the pandemic and future pandemics, and many of the other health challenges, such as the stagnating life expectancy for many, many Americans.

The second mission is an environmental mission. So the most clear example of this is climate change and how we're going to provide a world which is fit to live in for our children and grandchildren.

And the third mission is the one that Jay just talked about, the productivity mission. So the lackluster productivity growth that the U.S. has had over many decades, in particular since the Great Recession, has been I think the major cost of slow wage growth, which in turn has caused many of the social and political problems that we experienced over the last few years.

So the good news is that we have at this point I think abundant empirical evidence that technological innovation and policies towards it can boost productivity growth. The bad news is that the private sector left to itself won't provide enough research and developments on innovation. And this is for many reasons -- and Paul has been a pioneer in documenting this -- but one of the primary reasons for

this is what we call knowledge spillovers, the fact that the companies who invest in the research and development in innovation only get a fraction of its ultimate benefits. Many of those benefits go to consumers and other firms. And what that means is that firms by themselves have insufficient incentives to make investments.

So Heidi and myself, with other colleagues like Nick Bloom, surveyed this whole literature recently and we found consistently that the social returns to research and development vastly exceed the private returns. Something, you know, in some recent studies by a factor of three or four. So that actually means that there is a good case for government support for research and development. Again, the bad news is that if you look at in the U.S. the fraction of our national income which is spent by the federal government in research and development, a lot of this is basic research. That's actually collapsed since the mid 1960s, and the mid 1960s we were spending something like 1.9 percent of GDP on federal research and that's gone down to under .7 percent today, so a third of what it was in terms of our GDP. Although corporations have increased their research and developments, that has been more near market research and development rather than the basic research which creates these major R&D spillovers.

So I suggest an ambition to have a large increase of spending on research and development. I suggest in the paper maybe restoring about an extra half a percentage point of GDP, about $100 billion. That is much less than the gap we had in the 1960s, but that could make a major difference. But my view is that it is not the absolute amount, which is the critical thing here. The critical thing is how that money is spent and the principles on which we should design the allocations of those funds in innovation policies. And I think to do that, I mean you could draw on a deep reservoir of evidence we have now on what works in innovation policy.

So, you know, I won't go into all the details, but there's really two types. So one is on what you might call demand side policies and those are things like research and development tax credits, which is shown to be very effective, you know, sort of taking the private sector response. There's also direct grants through research, through things like the National Institutes of Health, the SBR, this Innovation Challenge Fund that would increase set amounts of spending. I'd allocate about half of all my

spending to those. The downside of course in these type of policies is that if you stimulate the demand side without increasing the supply side, then that might mean just an increase of the cost of R&D without increasing the volume. So Paul himself was (inaudible) about this.

So I would focus on three of what we've seen as effective supply side policies. First of all, boosting the size of the STEM workforce to more resources studying science and technology. Secondly, through relaxing the rules on skilled immigration. I mean this is a great way of quickly -- supply side policies actually often take a long time -- to quickly get high quality science in America at a low cost. And, thirdly -- and, you know, perhaps most neglected, is the fact that we lose a lot of very talented potential inventors, especially from minorities, for women, for people who belong to low-income families, because they don't have the opportunities growing up, the exposure to even the possibility of becoming inventors. And there are many policies I think around here which I hope we discuss in the Q&A where we can actually increase the amounts of inventors and lock the talent that we're losing from those -- what we, Raj Chetty and I, call the "lost Einsteins" or the "lost Marie Curies".

So these are policies not just about social justice, although they of course will help with that, they help with inequality, but they are also policies which will actually lead to faster growth.

So, you know, picking up on the question, can we afford this -- no. And this was touched on by Jay. I say the question is can we afford not to. As Paul and others have said, we need to spend on tackling pandemics -- that needs various responses. But I think we also need to have what I call new Marshall Plan to put the economy back on the sustainable, stable, and inclusive growth path. And a way of seeing that is that our current growth model is not fit for purpose. A lot the benefit -- growth had not just slowed, the benefits are being appropriated by small numbers. And we're at this point of history where we can actually reset the current path we're on, we can reset our growth model much in the way that after world War II we realized the importance of global independence and we realized the need to make massive investments in science, what Vannevar Bush called the endless frontier of science.

And my view is that the challenges of security, of health, of environment are no less pressing now than they were then. We need an equally ambitious response.

Thank you.

MR. SHAMBAUGH: Thanks very much, John. That's a terrific tour of your proposal, and people can find that on the Hamilton Project website.

Lisa, I'd like to turn to you and think a little bit about this question John touched on close to the end there, and this question on who invents and who is an innovator and who has kind of access to say the innovation pipeline and ecosystem and how we may be leaving output on the table effectively by losing people from that system. And talk a little bit about what you think we should be doing about it.

MS. COOK: Okay. Thank you, Jay, and the Hamilton Project for having me here to discuss broadening participation and innovation.

So the problem here is that there is serious underrepresentation of minorities and women and minority women in the innovation economy. So one thing that we know, that I've written a lot about lately, is that 1899 is still the peak per capita year for patents for African Americans. What we have seen since the 1970s is more education in STEM, Ph.D.s, all degrees, for African Americans and women, but we haven't seen much movement outside of that in the practice of innovation and the commercialization of invention, or the innovation at the end of the process.

So as a macroeconomist I'm really interested in living standards and increasing living standards. What are we missing out on by not having these people in place? John and Raj call them the "lost Einsteins". I call them the lost "Katherine Johnsons" from hidden figures. So what are we missing out on? We're missing out on 0.6 percent to 4.4 percent of GDP per capita. That's what we're missing out. That's a calculation that my co-author and I made. And this is consistent with the findings of Hsieh, Hurst, Jones, and Klenow in 2019. What they find is that the output effects are large from the misallocation of talent of African Americans over a 50 year period. So this isn't new and this is broadly corroborated.

I am proposing three things. First, taking up the National Academies of Science recommendations on commercialization, so in focusing on commercialization. So the recent National Academies' study sought to increase the diversity of applicants and reviewer pools. And this would

increase the amount of innovation that would come through small businesses, through the SBIR and STTR programs. And that was the review. So one recommendation was diversification of those two applicant and reviewer pools. The other one was to connect R&D partners to applicants early so that they could have better proposals, have better chances of getting the awards. Recruit in places where they are typically not recruiting. There are geographic areas where inventors, African American inventors are, women inventors are, like Atlanta and Austin. So rather than go to institutions, go to geographic places where these ecosystems are already existing.

The other proposal is to -- given these geographic distances -- to create virtual mentoring programs. And I think that a lot of us have gone on line, this is -- a report came out before COVID-19 pandemic became widespread, so this was forward looking. I think that this could be a real actionable item.

The second part of the proposal is to take seriously the recommendations of the SUCCESS Act and the IDEA Act. So these are pieces of legislation that were based on my 2010 paper with Kongcharoen. And what they seek to do is to count the number of patentees we have and to see what the variation with respect to demographics is. And I think counting is critical because you can't do anything if you don't know how many people there are, if you don't count these individuals. And machine learning isn't good enough. The last time I examined this issue and looked at the latest program, the match rate was roughly 84 percent. And if we were just counting them when they're registering, when patents are registered, we can get a 100 percent sample, or closer than 84 percent. So I think that's really important to count and report the demographic data so that we can figure out what we should do to increase the number of patentees.

So a final thing that I think we actually have to do, final recommendation, focuses on what is happening now. Something that is being brought to light now, even though it's been in place for a long time, and that's addressing workplace climate. So there's a recent CMBC study that shows that only 1 percent of founders who receive VC backed funding are African American and 0.2 percent are Black women. So that an indication of how much things have to change, but what we also know is that there is

in that CMBC study the comment that humiliation was a common feature for African American entrepreneurs in Silicon Valley. So there's some workplace climate issues that need to be addressed. And I have some specific proposals in that regard -- require public reporting of employer pay and promotion data broken down by race, gender, and to provide greater visibility to employer pay practices and also to divide these data up by foreign and domestic work pools. Also require employer reporting of steps taken to address these workplace climate issues. And that would be when SEC filings are made, and that would include eliminating forced arbitration for sexual misconduct and harassment cases. And this would also include anti Black bias training and other types of bias training at all levels of staff. And also increasing funding for enforcement.

So I think we have an opportunity at this current moment to address issues that have been longstanding with respect to systemic racism and with respect to sexual harassment and discrimination and we should do that now.

Thank you.

MR. SHAMBAUGH: Great. Thank you so much for that.

Heidi, I'd like to turn to you now. You co-wrote a proposal for us at the Hamilton Project looking at patenting rules. And can you told us a little bit about the changes you think we should be making on the one hand to our patenting system, but also why you think that might be useful for innovation and productivity growth?

MS. WILLIAMS: Thanks for having me.

The proposal was joint work with Lisa Larrimore Ouellette at Stanford Law School who, if you don't know her, I would highly recommend looking at her work. The starting point for our proposal is essentially the patent system is very highly debated, but almost all of the debates tend to focus on what you can think of as a very big picture question -- should patent rights be stronger in the sense of having broader or longer patent terms, or should they be weaker in the sense of being shorter or more narrow. And so it turns out economists and policy makers just don't have a lot of good evidence on what should base those kinds of decisions. So debates about things like should human genes be patentable, the

Supreme Court made a decision that the costs of patents on DNA outweigh the benefits, but actually we don't have the data to sort of make statements like that right now.

In my and Lisa's view, these debates tend to take up so much space that we kind of don't move on to talking about are there smaller more feasible reforms that could generate substantial improvements, even if we don't know the answers to sort of these, you know, 300 foot questions. And so what we're doing in this proposal is focusing on three relatively tailored reforms that we think are politically feasible and have the potential to improve welfare, again, even given the uncertainty about the patent system as a whole in terms of what kinds of reforms might be best.

So each of these reforms is basically intended to say the patent system is meant to accomplish some goal, but it's failing to do so. And so we're just trying to say can we make small tweaks that would let it accomplish the functions that it's setting out to try to do.

So first is a key role of the patent system is to disclose accurate information about new discoveries. So in exchange for getting a patent, you're supposed to teach the world about your ideas. And so in contrast with that goal is the very commonly used, but actually not well known practice of what are called prophetic examples. So most economists and lawyers even that work on the patent system have not ever been introduced to the term prophetic example. Put bluntly, what it means is that it is completely legal to write up fake experimental data in your patent application for an experiment that has never taken place. So the only requirement is that real data is generally described in the past tense, whereas prophetic examples, or fake data, are supposed to be written in the present or future tense. Very unfortunately for society, very few people know about the tense rule. And so it turns out Janet Frielich, for example, who is a law professor at Fordham, has documented evidence of about 99 times out of 100 when scientists cite experiments and patents that are prophetic examples, they cite them as if they're real data, because lots of the people that use the knowledge disclosed in patents actually don't have a way of distinguishing between real and fake data.

And so whether we should allow prophetic examples is an important question and we think people should work on that. We're proposing a much simpler reform, which is just we think there's

not reasonable justification for presenting prophetic examples in patents without having them be clearly labeled as hypothetical examples or prophetic examples. And so we discussed some ways you could do that. The USPTO could do that on their own, or that could be something that would be led at the direction of Congress.

The second reform that we talk about is that the patent system is meant to disclose accurate information about who owns patents. And so this has been a big area of debate. A lot of the patent rule debates, for example, are about obfuscation and ownership and the concern that that's imposing large tax. Admittedly formal empirical evidence on how costly it is not to have good information on owners is lacking, but both logic and I think a lot of anecdotal evidence suggests that if we knew better who owned patents, that the market for patents and the markets for invention would work much better.

And so we do an analysis of why previous reforms in this area may not have worked and we propose a much more targeted set of reforms that we think are politically feasible that could make progress in the space, admittedly more incrementally than some of these past reform efforts on ownership transparency that failed.

And then the third proposal that we do is the most speculative of the three, which is to say that the patent system is meant to provide uniform terms of protection to all inventions, but in practice people are starting to document sort of clear examples of where it's failing to do that. And so one example that we discuss is from my own work with Eric Budish and Ben Roin where we show that in practice the patent system provides vastly different amounts of patent protection to different types of new drugs. And, in particular, we provide much more patent protection to drugs to treat late stage cancer patients who are likely to die relatively quickly and much less patent protection to early stage cancer drugs or drugs to prevent cancer. And so we talk about some pharmaceutical sectors, specific reforms, that could be used to equalize patent protection. We're agnostic on the level of whether we have more or less patent protection, we're just trying to say if the goal is uniform patent protection, right now we can point at examples where we're failing to do that.

And, so, again, going back to the big picture, improving patent policies is I think one key

part of improving innovation policy. And I think a lot of it, our time tends to get taken up with this big picture debate about stronger versus weaker patents, and so we're just trying to make some incremental progress by proposing some more targeted reforms.

MR. SHAMBAUGH: Great. Thank you.

Heidi, I'd like to actually stay with you for a moment. So as you noted, your proposal is kind of on quite technical rules, right. And at the same time you've done lots of research on the broader questions around intellectual property and innovation and growth. And I'm wondering if you could just put this proposal in a little bit of a broader context for us also.

MS. WILLIAMS: Sure. Absolutely. So as a faculty member I teach about innovation policy. One of the areas that I'm most enthusiastic about teaching is around innovation and inequality. And so I tend to organize my thinking around three types of questions.

So first is who becomes a scientist or inventor? So Lisa mentioned some of her work on that topic, John has some excellent work recently using the tax data to try to get a broad overview of that in the U.S. Those kinds of studies I think are incredibly important in quantifying who are we missing from being involved in the innovation process.

A second question is who benefits from product innovation. So just to point people to two examples if they're interested, David Cutler, Ellen Meara, and Seth Richard-Shubik have a really nice paper documenting that even sort of a government that is trying to maximize social welfare by construction if what they're trying to do is to target research subsidies through the National Institute of Health, for example, towards the diseases that re most common that might actually serve to exacerbate racial inequality and health outcomes if on average the majority group has different causes of death than the minority group. Chavier Herbold (phonetic) dissertation work was sort of a similar mechanism for private sector investment and why product innovation could increase inequality.

And then the third question is who benefits from innovation policies like patents. And (inaudible) dissertation research and some recent work that I have with Pat Klein and Neviana Petkova and Owen Zidar has tried to look at when firms get patents, do those rents from patents get passed

through to wages and whose wages. And so we find that on a variety of margins, patents seem to increase within firm wage inequality. So, for example, men that work at these firm that get patents see their wages go up more than women's wages. And so there's a lot of patterns that you can look at and just sort of like quantify who benefits from these different types of innovation policies and how does that shape how we think about their benefits, not just from an efficiency perspective, but also from an equity perspective.

MR. SHAMBAUGH: Thanks. I'd like to sit with kind of question of where the benefits from innovation to. And, Lisa, I turn to you in particular thinking about the black-white wealth gap. So it's a topic that is quite stark in the data and something that has gotten a bit more attention over the last few years, but especially few months. And I'm wondering if you could talk a little bit about how you think about innovation and patenting linking to those questions.

MS. COOK: So, like Heidi, when I teach innovation I typically teach about the three stages of innovation, education and training, the practice of invention, actually becoming an inventor, being in a lab, and then commercialization, this third stage of commercialization. And commercialization is where the greatest inequality -- especially with respect to wealth -- can come from. Let's say an IP of a tech firm, and what we know is that 7 of the 10 wealthiest people are affiliated with some sort of tech IPO like this in tech. and, as I was saying, African Americans are really missing out with respect to -- and women as well. For women the VC backed startups are 5 percent rather than 1 percent for all African Americans and 0.2 percent for Black women. So I think this is where the real wealth gap is extended, in the commercialization stage. And I think that's what has to be addressed by addressing workplace climate. For example, the SBIR, STTR program and the USPTO data. I think this is where we really need to address it, to accumulate wealth.

For the beginning stages as well, it's not irrelevant because wages in the innovation economy are higher than they are in other parts of the economy. And, of course, that's income inequality, but certainly that can become wealth inequality. So all of the stages have to be addressed. There's inequality that can creep in at every stage of innovation.

MR. SHAMBAUGH: Great, thanks.

And, John, I wanted to just bring you back in on this, because you mentioned it earlier and kind of s Lisa has teed up for us here, kind of taking it one step back towards the who gets exposed to be an inventor and how do we get people into that stage.

I know you had some thoughts on that and I wanted to turn to you.

MR. VAN REENEN: No, absolutely. So I mean it's one of the things that we found in this work, as we've mentioned with Raj Chetty, is that being exposed to the possibility of being an inventor at an early age seems to be an important factor in opening the horizons or closing the horizons if you're not exposed to the hope of becoming an inventor in the future. So I think that that's important for lots of different groups. I mean I think there are several ways in which the innovation gap by class and race and gender can be tackled.

One of those ways I think is to obviously, you know, improve investments in public schools at an early stage in disadvantaged areas. Another more cognitive way -- and there is some good evidence on this -- is that if you can spot the potential inventors, say kids who are good at math at third or fourth grade, that's a very good predictor about whether you might grow up to be an inventor. And there's evidence from gifted and talented programs, if you can target those kids, especially if they're in these disadvantaged groups. David Cods (phonetic) and Julia Hana (phonetic) have some evidence of that. For minorities, for example, those types of policies within schools, while giving extra support in say STEM, can be a major factor in improving test scores and outcomes later on.

I mean another one might be to -- and more straightforward -- is that having smart student grants, which I think we abolished in 2010, which were kind of up to $10,000 for minorities and kids from disadvantaged backgrounds to go and study at college, that's another mechanism that can actually help getting these kind of pipelines and unlocking some of this talent that we haven't got.

MR. SHAMBAUGH: Great. Thanks. The audience has given us many questions and I'd like to turn to some of those.

But I'd like first to turn to one audience member who has Nobel Prize in this stuff. And

since Paul Romer has stuck around, I'd love to turn to him. I know he has a couple of questions and I'd like to leave it to him to ask.

MR. ROMER: Sure, thanks, Jay.

So for John, we haven't really talked since -- about this issue, like the (inaudible) subsidies, in a while. Since my thinking has really shifted pretty dramatically away from the subsidies that go to proprietary controls by firms. I think there's economic disadvantages with proprietary ownership, like Heidi pointed to with manipulation of the patent system. I think there's going to be an increasing political problem of this backlash against tech based firms.

So I wonder -- and this party of why I'm moving towards prizes -- so I think the traditional idea of just putting a lot of money into like basic research strikes many people as not enough because there's this connection between practical problems that just funding basic research doesn't always address. And so I wonder if you've thought at all about in your grand vision significantly scaling up prizes as a way to provide more demand side incentives with the focus on practical problems, but to do so without creating the proprietary ownership and inequality that's associated with that.

That's kind of the question for John. And then for John and Lisa, the other thing that struck me as I listened, is that subsidies on the supply side may be a lot more politically defensible and achieve these dual goals of both equality and efficiency. And so I think the supply side should really be a big part of how we think about this.

John, you mentioned fellowships. I think we could be doing a lot more about that. But I think also we could be offering -- for example, paying people to contribute to something like open source where you can actually see are people actually contributing, but creating an onramp, and maybe a targeted onramp, that provides funds for people to get involved in activities that they may have missed out on in their education.

I'll just close by saying that the U.S. Army faced this problem of an officer corps that was too White, and the way they addressed it was by investing lot in ROTC programs, for example, at historically Black colleges and making a big investment in the supply side of candidates who could be part

of the officer corps. And what's interesting about that is it succeeded and it didn't produce the kind of hostility that can arise when you think about like affirmative action type programs that are drawing differences in terms of things like promotions.

So I think for many reasons, the supply side initiatives might be a huge way forward. But maybe prizes could complement those as well.

MS. COOK: So, Paul, I think you're exactly right. I'm on the board of the Lemelson Center for the study of innovation and invention and there's a Spark!Lab there. And in that Spark!Lab school kids go and they go through seven steps, from the very beginning of the conceptualization of an idea to the commercialization of the idea. So they leave there with an invention. And I think that we really should target those -- when I go there, and they give us tours of them all the time, the students are all from the suburbs of DC. And we've got to do something to like just -- there's a bottleneck somewhere. I think there are simple things that we can do, but I think these students come back and they show their pictures to everybody else, they talk about this to their parents. I mean I think this is great way. The supply side is a great way to do it.

And I'm certainly aware of the ROTC programs at HBCUs. You know, I went to Spelman College, so certainly saw that. And I think that's a way to do it a swell. Bring the USPTO, for example, to HCBUs. This is another way to address the supply side, the mentoring programs that it has. So I emphasize that in my proposal.

So thanks for bringing that up.

MR. VAN REENEN: So thanks for those questions, Paul.

You know, my view on this is that we need a kind of a sweeter portfolio of different innovation policies. So I'm very much against the idea that we know for sure exactly the right policies which work. So we need to draw on the best science on those innovation policies which work.

Now, I think on supply side I really -- you know, completely we're on the same page on this. There are lots of answers to the supply side policies. The Lemelson Foundation is doing great work and there are many other ones. I think one of the issues is in terms of the empirics, we know a lot less

about the efficacy of many of these supply side policies. And one of the things I think we want to have in this big push is to have a serious amount of funds going to evaluate what works and what doesn't work.

And on prizes, I agree that they can be very effective and I'd certainly like to see more of these specific problems where we know we need solutions for like, obviously vaccines is (inaudible). They can be effective. So, you know, I would certainly support those.

I guess where I would depart with you is I'm not in favor of kind of throwing away all the demand side policies because I think that is an area, say around the R&D (inaudible), where we do have high quality evidence that they can be effective, if well designed, to stimulate more research and development. Now, a lot of research and development is not captured by the patent system. There's a lot spillovers even with our patent system. And I think that's for the like -- if you think about, for example, the federal directed grants that we might have through the SBIR program that Lisa talked about, or through some of the Nationals Institutes of Health. I'm working on, with Sabrina Howell, and looking at Department of Defense programs where they've actually shifted towards more of an open call, open topic type of approach. That seems to be one way -- seems to be effective.

So I do think there's a role for demand side policies, but I totally agree that we need to have a strong -- in terms of my allocation of funds in the Hamilton proposal, I think I had about 55 percent for supply side and 40-45 -- that's kind of roughly how I would divide it up.

So, yeah, I totally agree with the importance of supply side.

MR. SHAMBAUGH: Great, thank you.

So we got a number of questions from the audience and one of the things I would say in looking at them is a number of them came together around a topic that I think really anyone on the panel could address, which comes to the fact that we often think as economist that innovation of productivity growth is obviously good, but then when we look at people's reaction to it, it's often around fear, fear of having their job automated away, fear of the robots are stealing your jobs kind of idea.

So I'm curious if anyone has thoughts on how do you ensure that economic growth is inclusionary on the one hand, or what role should public policy play in assisting people who are losing

jobs, knowing that even if we believe that there will be more new jobs created from innovations than destroyed, how do we make sure that kind of the people losing their jobs aren't left behind.

And that's honestly to anyone, so I don't know who would like to jump in.

MS. COOK: I can say a little bit about this. I think that there is this fear and, you know, I'm sitting in Michigan. That fear has been articulated from the manufacturing industry for a long time, from the auto industry for a long time. But I would emphasize that the innovation economy is typically not as narrow as many people imagine. It's not just engineers, it's also people who are making high level and lower level tools and people who are involved in logistics. So it covers the gamut. And I think we have to demystify the notion that you need a Ph.D. in engineering to take part in the innovation economy. And I think we also need to compensate people who might be left behind. We need to retrain people.

But one thing we have to avoid is what happened with NAFTA, sort of provide retraining and not fund it. So I think if we're going to go down that route, we certainly need to make sure that it's funded and that retraining actually happens.

MR. VAN REENEN: So my other hat is on. I'm on a kind of -- with David Autor -- MIT task force into the kind of future of work and the work we've been doing very much focused on how you can think about the way in which automation and other new technologies can be used to help benefit the workforce. And so there's lots of answers. I think some of the fears of automation are kind of displaced, you know, are fears of other things. We've always had this fear of robots when there have been other things which have caused people to be worried about the future. So I think even going back and you look at the headlines of the 1930s, people were kind of scare of robots, so it's not a new fear. But I think it's a genuine concern because of the problems that we've had in the labor market with stagnating wages and inequality.

And I think there are several ways that one can think about addressing this. I mean one way is to try and have better ways of enabling people to be more resilient against not just shocks they get from technology, but shocks they get from trade, shocks they get from other things. And that requires a mixture of having a decent health and welfare function to give them insurance, plus what Lisa was talking

about, enabling people to get the kind of human capital skills to help them deal with those shocks. So that's a very important part of that adjustment process.

The other thing I would say is that -- and this goes back to what we've been discussing -- if we can think of different policies which simultaneously try and stimulate more economic growth and productivity growth, but also help deal with inequalities and social justice, those are the types of policies I think you can really get a political consensus on board for. So some of the things that we've been talking about, the loss of potential inventors because of inequality and barriers towards going into innovation entrepreneurship that minorities face, that women face, that (inaudible) face, I think those are things which you can build a very strong political consensus for, which can both simultaneously increase productivity and also release inequality.

So I think those are the -- maybe the types of policies you can build more of a consensus for. There's obviously many other things we can say, but that would be my two, my two thoughts on this.

MR. ROMER: So, Jay, if I could just comment on this. I think that we may be confusing two things here and it's important to tease them out.

One is imagine you took a bunch of people who were in kind of like standard entry level jobs and you said to them, there's a new technology that's coming, it's going to cause some of you to lose jobs, some of you will have increased demand for your skills, how do you feel about that. That's the way we usually frame this.

The other way to frame it is to say to all of those people, you are all going to lose. Some of you are going to lose a lot, all of the gains are going to go to some elites that you don't know who they are, they control the world. And how do you feel about that.

And I think a lot more of the resistance we're seeing is about that concern, not just about my job prospects. The place that this is like very evident right now is this idea about digital contact tracing, that we use smart phones as a way to kind of do digital contact tracing. Nobody was worried about job losses amongst the contact tracers. Like everybody hates the government, there aren't that many people doing contact tracing anyway. But there was enormous resistance to this idea of more

surveillance of all of us by some unknown actors in the system that's already taking advantage of us in ways that we can't just even begin to understand.

So I think that kind of the bigger thing we're going to face in terms of a backlash against technology is that phenomenon of these anonymous, opaque, very powerful interests that are the ones that they've captured the benefit from all the innovation.

MR. SHAMBAUGH: Heidi, I'd actually like to turn to you because on the questions that we got from the audience kind of pivots back to this and some of the other points Paul has made, which is this question of making kind of the gains from intellectual property proprietary, right. And so one of the questions was quite blunt, it just said why do we have a patent system at all, what is it for in some sense.

So you've talked about ways we can fix it, but why do we have one?

MS. WILLIAMS: So I tried motivate our presentation by sort of saying that's the question we're not answering because I just feel like actually if you ask me like what is the justification for having the patent system I would look 50 or 60 years to people that were writing it's not clear that we should have a patent system in the sense that it's not clear that the social benefits generated by the patent system outweigh the costs.

And so it's not that I think we shouldn't have one, it's just that I think the data and the evidence sort of isn't really able to speak to that. And so I think the question the way you've framed it is sort of like asking me to justify why we should have one, which actually I don't personally have a view on that. But it is something that I find very frustrating in the sense that it's a dime a dozen to find people who are happy to share their opinion on why the patent system is incredibly necessary for economic growth and development or why this is like the worst thing that we could possibly do. And my personal view is neither of those views is well justified based on the data and so I would hope to encourage people to just have a more skeptical view of people with incredibly strong opinions in this space. And, like I said, I don't think that needs to be a full stop on reforming the patent system, we can create the sort of space for tailored reforms that I think would generate benefits as the same time that we're trying to provide more systematic evidence on sort of the bigger picture questions about whether this is the right thing for us to

be doing.

MR. SHAMBAUGH: Great. Thank you.

And, with that last comment, I think we're going to wrap things up. I know we could talk with this group for hours about innovation and productivity growth. It's an unending topic, but I guess we'll end it here.

Thanks so much to Paul Romer for joining us and sticking around with us, to John and Lisa and Heidi for their work with the Hamilton Project, their proposals, and for joining us today. And I encourage all of you to read more about their thoughts on our website.

So thanks, everyone, for joining us and thanks to all the panelists.

MR. VAN REENEN: Thank you.

MS. COOK: Thank you.

MS. WILLIAMS: Thanks.

* * * * *

CERTIFICATE OF NOTARY PUBLIC

I, Carleton J. Anderson, III do hereby certify that the forgoing electronic file when originally transmitted was reduced to text at my direction; that said transcript is a true record of the proceedings therein referenced; that I am neither counsel for, related to, nor employed by any of the parties to the action in which these proceedings were taken; and, furthermore, that I am neither a relative or employee of any attorney or counsel employed by the parties hereto, nor financially or otherwise interested in the outcome of this action.

Carleton J. Anderson, III

(Signature and Seal on File)

Notary Public in and for the Commonwealth of Virginia

Commission No. 351998

Expires: November 30, 2020