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P R O C E E D I N G S

MS. HENRY-NICKIE: Good morning and a very warm welcome to Brookings today. I want to thank you guys for taking the time to join us. I know there's an exciting event across town so to all of you, we express our gratitude. I'm Makada Henry-Nickie, Rubenstein Fellow here in race prosperity and inclusion initiative in governance studies. And before I introduce the panel today, I'm just so happy that we have a distinguished set of folks here to talk about the ICT sector and its implications for our economy. I want to sort of set the framework for our conversation.

So, the digital economy will have a profound influence on our global trajectory and the well-being, of course, of all citizens. It affects everything from resource allocation to income distribution and growth. The information, communications and technology industries stand at the center of this dynamic. And I think it creates interesting intersections between labor or policy, economic growth, trade, immigration, even privacy. And the sectors growth as well as its setbacks have profound implications for the U.S.

So, today I'm joined by this distinguished panel to discuss these implications and examine ways to balance the indispensable need to create economic gains against the consequences of its growth such as income inequality. So, I want to welcome my panelists. On my far left, I've got Tom Wheeler. Tom is a visiting fellow at the Center for Technology Innovation here in governance studies. He is also former chairman of the Federal Communications Commission serving from 2013 to 2017. Thank you for your service, Tom. His new book “From Gutenberg to Google: The History of our Future” is an excellent read. I just got done reading this book last weekend and so I recommend that you pick it up at our bookstore.

MR. WHEELER: Thank you that's a great -- the bookstore is out just around the corner.

MS. HENRY-NICKIE: No really, very fascinating book on, you know, how networks and economic history find themselves intertwined and explain where we are today. So, to my left is Karim Foda. Karim is an economist at the International Monetary Fund and, you know, he returns home. He was a former associate fellow here at the Global Economy and Development program here at Brookings. His most recent work analyzes the links between slowing productivity growth, income inequality and technical change. Karim's comments here today do not reflect the views of IMF staff, management or its board. Did I get that right, Karim?

MR. FODA: That's right. I'm safe now.

MS. HENRY-NICKIE: And to my immediate left, David. David, welcome. David is a senior economist at the Center for Economic Studies at the U.S. Census Bureau. He's also a research fellow at the IZA Instituter for Labor Economics. David's research focuses on a variety of topics such as entrepreneurship, job and worker flows and migration. Like Karim, David's comments do not reflect the views of the Census Bureau or any other institution he's professionally affiliated with.

So, with that, I'd like to sort of turn to the conversation. And I'll ask Karim to kind of set the scene for us, right. So, productivity is at the top of most economists' minds. What we worry about our future potential to create growth and output and employment but it often doesn't make the headlines. So, it's all, you know, GDP gains, we're looking at BLS numbers on job creation but productivity really holds, you know, the key as to how an economy generates growth and employment. So, if you could sort of set the scene for us on why is productivity so consequential and I know you've written quite a bit about ICT driven growth. What are the differences between the 90s IT boom and the tech driven growth of today?

MR. FODA: Sure, sure. So, thank you, Makada. It's a pleasure to be here

with you all this morning. It's a pleasure to share the panel with Dave, General Wheeler. As Makada mentioned, you know, productivity is central to growth. There's a famous quote by Paul Krugman in 1994 that, boy I hope I can paraphrase this correctly but actually I don't remember it correctly. It basically says in the long run, productivity is always the most important thing.

MS. HENRY-NICKIE: In the long run, productivity isn't everything when in the long run it's almost everything, something to that effect.

MR. FODA: Something like that, something like that. I mean, essentially, if you kind of look at an economy, economy is, you know, the size of its population times the output per person. Output per person is accrued simpleness measure of productivity but in the long run it's the key driver of standards of living and it's the key drivers of, you know, average incomes and quality of life, et cetera. A lot of factors go underneath it.

But technology and technological change is particularly important. The more technology the more capacity an in individual has or an organization has or an economy has the more efficient it can be with the resources that it has. It could produce more with less or more with more or even more with more. And so, with that ICT and the ICT sector has been, you know, (inaudible) did and very rightly so as a critical sector to the future of growth and the future of productivity growth in that long run anchor to growth.

However, beyond the sector, you know, the real magic, if you will, as ICT as a its role as a general role technology. The fact that it can be adopted and used across sectors, across industries and across functions. That's where the real power comes in at the macro level in driving growth. So, the greater the adoption of ICT and related productivity enhancing technologies by abrupt swaths of the economy, firms and people, the greater the potential for a more dynamic and a more inclusive economy.

However, over the last several decades, we have seen in the United States

and in other advanced economies a less inclusive economy with high and persistent income inequality and a less dynamic economy with slowing productivity growth at the aggregate level. So, it's a big puzzle, it's gotten a lot of attention but the micro data point us to two key trends that really shed some light and some picture as to, you know, what could be going on or help us identify what could be going on.

The first of those trends is a widening productivity gap among firms. Research at the OECD as well as research with some other colleagues here at Brookings have shown that the most productive firms, those firms at the frontier have actually been continually to grow relatively quickly as one would expect with the pace of technological change and productivity enhancing means of production. While the rest have kind of been left behind, that gap has grown.

The second trend is a widening wage gap between firms. A very well-known paper that was recently published earlier this year, the quarterly *Journal of Economics* shows that two-thirds of earnings inequality in the U.S. are explained by between firm differences in wages. One-third is within firms. So, the productivity among firms, the wage gap among firms are real and these trends of productivity and inequality are related.

On the productivity side, the gap, the implication is that it's harder for laggard firms to invest and catch up with the frontier and drive a broader aggregate level of growth. And on the wage side, it's harder for larger numbers of people to get into those firms that offer those higher paying jobs. So, what's going on? The big question is why. Those are the trends, those the stylized facts, if you will, but the question is why.

And, you know, in the interest of time, I know this is still an introduction, a long introduction. I'll just highlight three key possible areas that are related also that all share in common the idea that the diffusion of ICT and related technologies that drive productivity and have the potential to drive productivity are slowing down. And there are real frictions

there and that could help point to us to some areas of where policymakers could focus and where more research could be devoted to.

So, three areas really quickly. The first one is a declining level of competition. A number of trends put together suggest that increasingly dominant firms are pursuing rent seeking behavior, profits are high across several key markets but firm entry is low. The erection of barriers is being seen as prevalent. So, there are a number of indicators that point to a declining level of competition and the effect that would have on growth and entrenching of the situation of frontier versus laggard both in terms of productivity and in terms of wages and inequality.

The second trend or the second possible area is the growing importance of intangible capital and intangible investment. We're talking about knowledge, research and development but also organization structures. You know, you can adopt a technology, you can invest in a software and install it but what do you do with yourself, how do you organize your firm around it. How do you evolve your supply chains and your customer relationship management strategies, for example, have shown to be increasingly important and an increasing area that drives competitiveness of firms? And those pose specific challenges to small laggard firms who may find it hard to get a loan for an intangible investment without, for example, something tangible to put up as collateral from a bank. Just as a picture as an example.

The third reason, third possible area really quickly is a declining public investment in basic research and basic RND. This can be important when it comes to the diffusion and the availability of knowledge, the availability of technology that's at the frontier. RND has been growing, a big chunk of it has been private RND and there have been cases or instances or reasons to believe that there's a lot of activity related to patent trolling or the anti-competitive use of intellectual property. There's been rising industry consolidation

where firms would acquire other firms to keep intellectual property within firm that helps also strengthen and create more rigidities in these gaps that we were talking about earlier.

So, those are three quick areas. There are a lot of other ones, structural ones that I'm sure my colleagues here will mention as well. But the promise is real but to drive the dynamic in inclusive economy, I'm afraid the promise won't realize itself.

MS. HENRY-NICKIE: That's actually a pretty good segue. Tom, I think Karim's laid out the theoretical, you know, economic case for productivity. It increases income that then follows on to raise, improves standards of living. But I think we lose sight of the details. How does this process unfold? Because that's the moment that we live in. So, new tech, whether it's AI in and out of things, clot and edge computing, I think, like you said, they're going to be sources, crucial sources of growth. But all that potential, I think, rests on a premise of a robust physical infrastructure. Without infrastructure, people and technology cannot be connected.

So, enter 5G and to Karim's last remark there, there is a lot of promise and hype around 5G. It is billed as the tech that will deliver improved well-being and also to, you know, drive productivity gains. Is the hype true, is it as transformational as we think it should be? Can it live up to the aspirational goals that we set for 5G?

MR. WHEELER: Well, I think you're using the right word in terms of hype. And let me just start off with a positive report though, okay. Yesterday at a press gaggle in the Oval Office, the President of the United States said, "I know all about 5G and we have companies that are now getting very, very strong in that department. Nobody was focused on 5G but now they are. Now they're going at my request, they're going into 5G."

Did I say anything about hype and 5G? Look, 5G is a transformational technology. Karim had a really good point that you have to deliver on the promise, okay. The reality of networks is that it is not the primary network itself that is transformational but

its secondary impacts, okay. And we can substitute the word ICT for networks in that calculation as well.

5G is transformational in terms of the kind of network that it is. It is the first all software network. In that regard, it is probably the last time or it is probably the last major overhaul of a network that we'll see for decades because its upgrades will be done just like your iPhone gets upgraded at night, okay. Download new software into a software driven network. It is the culmination of the moving from networks that centralize their activity to networks that distribute their activity. So, it is lots of microchips out here at the edge talking to each other. Thereby creating new opportunities and the ability to deliver new services.

You cannot underestimate the importance of the impact of 5G in redefining how we connect in the services that can be offered. You can overstate the hype about 5G because it is going to be an evolutionary process. It is going to be a process that investments will be made in building the network as its understood how those investments will pay off. And what we need to be focusing on is, what we need to be concerned about is how it has been turned into a political tool.

You know, the President before yesterday when he announced he had solved the problems kept talking about the 5G race as though there is a start and a finish and whoever gets across that line. Well, the first question is, what's the line, okay. Is it people using it, is it geographic areas, is it speed, is it latency, you know, you have no idea what that is. So, the first question is let's understand that our goal ought to be to rationally facilitate the rollout of the new technology but not to use it as a rationale for reducing competition. What Karim said about competition is absolutely spot on but we have everybody running around right now saying oh well let's reduce from four wireless carriers to three wireless carriers because it will help us win the 5G race.

It should not be the excuse for substituting trade issues for cyber issues.

And the thing that we need to be aware of with regard to 5G in general, and then I'll shut up, is that it is being -- is that it is revolutionary and it is being manipulated, the concept of that revolution is being manipulated for ends that are not associated with what it will be delivering.

MS. HENRY-NICKIE: I think you raised a number of critical points there. David, I want to invite you in here. So, in addition to the promise of 5G and the concerns that Karim's laid out around slowing productivity, we obviously need to grow ourselves into a future of, you know, strong growth and strong employment prospects. And obviously one that has, you know, beneficial distributions for all.

So, at the center of that are people, you know, the people who are at the forefront of innovating and producing innovation. You know, your work, I think you and your colleagues have done some fascinating work looking at new data from the census that tells us exactly, you know, more about this innovation production process. So, could you share a little bit about your research, what are some of the key main takeaways.

MR. BROWN: Okay, thank you, Makada. So, I've been working with some colleagues at George Mason University using a variety of census data including the annual survey of entrepreneurs which is a new data set. Like the first nationally representative large scale sample where you can look at innovation and you can look at who's doing the innovating in terms of the business owners. So, we're asking a question, are immigrants more entrepreneurial.

So, one way that you could bring in more innovation into the economy, more productivity to the economy is by your immigration policy. So, we find first of all that immigrants tend to be self-employed to a greater extent than native born Americans. Part of that may be because in the labor force as an employee, their wages are lower on average than those native born people. And so, they may have a greater incentive to become self-

employed. So, self-employment can be more entrepreneurial, you can be more creative that way.

But then we look at, okay do you have employees or are you simply just working by yourself. And they also have a greater tendency than the general population to have employees. Though if you look at -- so among self-employed people, do they have a greater or less propensity to have employees and the answer is no. But since they're just more self-employed immigrants, they are also more immigrant owners of employer businesses that have employees.

But we find that among the businesses that have employees, immigrant owners tend to have smaller firms on average than native born owners which is maybe contrary to popular belief. Because we have all these case studies about the Google's of the world that are founded by immigrant entrepreneurs. If you look at the data as a whole, we don't see that on average, that they tend to have smaller firms.

But we find that immigrant owned businesses tend to innovate at a much higher level both in terms of product innovations, process innovations, research and development, whether they have patents or not and the number of patents that they have. And we've looked at this both through all sectors as well as specifically in the high-tech sector we find this. That the immigrant owned businesses have a clear advantage in the amount of innovation activity that they do.

And then we see, okay well how can we explain this. Is it that they tend to have higher human capital then native born owners? We do not find that to be the case. I mean, even though in the descriptive statistics we find that maybe they have a higher share of people with graduate degrees. We also find that they have a higher share of people with less than a high school education. So, they're kind of being in the tails of the education distribution. So, once you control for that, you still see this significant advantage in

immigration by immigrant owned businesses.

Then we look at finance. We find that they do tend to have more finance than native owned companies. But even after controlling for that, we still see an advantage in innovation among immigrant owned businesses. And then we look at okay well maybe they just have a tendency to go into sectors where there's lots of innovation. We find that as true to some extent but even after controlling for that, we find that immigrant owned businesses still innovated to a greater extent.

There are a a couple exceptions to this. We find in the high tech sector that they are less likely to have copyrights and trademarks which is more of a marketing aspect than native born owners. And also, they tend to be doing less imitation which is where you are introducing a new product to your firm but it's already in the market as a whole. They tend to have more of the truly new innovations where this is a product that's new to the market as a whole for immigrants. So, I think I'll stop right there for now.

MS. HENRY-NICKIE: Thank you. And so, I want us to switch back to Tom here because I think you brought up some really key points around who innovates. And that should sort of have us thinking about where these people live and where that innovation tends to occur. So, Tom for you, of course, I mean I think you're right, 5G network technology will be transformational. But it's how this tech is distributed that will matter, right? It will either be convergent as we would hope or it will act to widen disparities.

You know, I think about some of the numbers I've seen on how much it's going to cost to build the 5G infrastructure in this country. I think Deloitte has an estimate between 130 to 150 billion. Accenture puts it at $275 billion. These are really large numbers. And when you sort of dig down, there's a clear case given the technical specs for developing 5G in urban densely populated areas but not so much rural areas. So, if it matters, who and the kinds of innovation that's actually happening in this economy and who's bringing it to the

forefront, how can we ensure that 5G is more of a convergent tech and its benefit reaches all American communities.

MR. WHEELER: Well, you know, the interesting thing about 5G, this incredibly powerful wireless network is that it requires a new level of wired connectivity, okay, to bring the data back from all of these small cell sites. And to be able to virtualize some of those activities of those cell sites in the cloud.

So, all of the excitement about this wireless technology also comes down to fiber, okay and how connected we are with fiber. So, if you want to talk about rural areas, for instance, we're not connected with fiber in the rural areas. If you want to talk about policy questions, we need to be thinking about how are we going to extend the reach of fiber and as a result of that, so many other things will happen.

Let me tell you a story. When I was chairman, I spent a lot of time in coal country where there was economic devastation. It's interesting that coal and the coal economy was enabled by the driving network of the 19th century, the railroads, that hauled coal out into industrial applications. And as coal shrunk, the question is, was there a new network that came in.

And I was in some parts of eastern Kentucky, for instance, where they had made a considered effort to have fiber throughout the community. Cooperatives coming together and organizing to do that. Governments stepping up and providing middle mile connectivity and things like this. And they were using the new network the same way they used the old network to create jobs.

I was in one small town, one traffic light in the entire town and every home was connected to fiber. And they had a higher employment rate than they had had for the last decade because people were at their homes doing work for UPS, Hertz and other kinds of folks because they were connected to be able to provide services.

The other thing that was fascinating is that individuals with disabilities who heretofore had been unable to get out and get a job, the connectivity came to them and the job came to them. And so, you had a higher level of employment and self-sufficiency amongst individuals with disabilities because of this.

I went to another town where again they had fiber connectivity and they were teaching coal miners to code. Now I gotta tell you, so I go to this school where they're teaching coding to miners and I'm shaking hands with the miners that have hands that just envelop my hand, you know, big guys. Who had the gumption to go to the coal face who now have the gumption to go get the code face. And Apple and Microsoft were hiring these coal miners to do coding for them.

So, the connectivity is key. The problem is in the last figure and it's probably a questionable figure, about 11 percent of the people in America don't have access to high speed connectivity that opens those kinds of doors. So, what our challenge has to be, in order to deliver the kind of promises that we're hearing, you know, David and Karim talk about, is that we have to focus on policies that are going to deliver the networks of the 21st century. You know we helped the railroad build by giving them land, all right, and it fired an industrial economy. We need to have the same kind of approach to how we're going to deal with the network of the 21st century which starts with fiber and then goes to the hype of 5G.

MS. HENRY-NICKIE: Thank you. I think Tom alluded there, Karim, to this idea that, you know, technological innovation it happens, it can be automatic in some cases but it doesn't mean inclusive growth, right. So, you say 11 percent, the recent statistics I've read from the FCC say 21.3 million people don't have access to basic broadband services. Microsoft says, I think the estimate is eight times higher than that. 162.8 million people actually don't even use broadband. That's a lot of missing potential growth, right.

But when we talk about equity, we really sort of really talk mostly about leaving people behind. We never really talk about firms. And so, connectivity and the network is really important about bringing the jobs out and pushing innovation to, you know, unlikely places. Then I think there's some larger macroeconomic implications here for productive equity gaps between firms. Maybe you can kind of draw out some of those larger and maybe take Tom's stories and abstract them up for us.

MR. FODA: Sure.

MS. HENRY-NICKIE: What are the implications?

MR. FODA: Sure, absolutely. I mean, the applications are large, they're big. Connectivity, the physical infrastructure is incredibly important to have connectivity via ICT and have your idea spread from the palm of your fingertip, right. I think, I'll highlight just a couple areas that come to mind that are important to consider to ensure that when someone has a 5G connection. Or when someone is now connected or when a firm now can go online much faster and then engage in much more intensive activities. To just, you know, communications between, you know, enter into different value chains from broader global value chains, for example, that are important.

One is the competition that they're facing from the rest of work and the skills aspect of it. Is everyone who is connected now is the job that's available to them to become a coder? You know, what are the jobs of the future. Is it strictly an outsourcing of a specific task for a large company that can outsource them from anywhere in the world? So, there's the aspect of, you know, competing for a coding job between someone in rural America versus someone in rural other lower income, lower wage country. So, the effect that it has on wages from that sense is one aspect.

The effect that that type of disaggregation of productive services by larger companies could have on wages as well. You know, on the one hand it provides people

with opportunities of a job, the other hand, that job could be so minute and so specific. That, I mean, one possible implication is a continued wage gap and so how do you move up that chain. And so, that's one big consideration that comes to mind.

I think the key and, you know, I'm not an expert in place based policies but connecting different regions, connecting different rural regions in an economy and in an environment where a glomeration is important and where you have more and more people going to the cities and having spillovers of ideas et cetera, is how to create those ecosystems in those areas. And it's a big challenge.

I mean, I don't pretend to have the answer. It's an answer that's more than economic, it's also social. You know, investing in human capital is mobile. Investing in fixed capital is not. So, do you bring the capital to the people or do you tell the people to move to the cities? That's obviously, you know, a much bigger question than economics. And we've seen over the last, you know, several decades that that mobility isn't as quite as high as theoretical economic model with a rational Asian would predict.

So, there are big questions that involve, you know, how do you stimulate a broader ecosystem. Not just of an individual who can do a task but to have firms develop, provide productive services, employ more people, have a supply chain that's linked in with other parts of the industry and industries and kind of engage in this as well. So, I don't pretend to have the answer but those are big kind of considerations and questions that, you know, policymakers face as well as researchers face in terms of, you know, trying to find where the right balance is and what the effects on wages could be.

MS. HENRY-NICKIE: Okay. David, I think your work looking at, you know, productivity gap between immigrants and native entrepreneurs suggest that maybe these gaps aren't all bad. And there might be some positive spillovers. Can you talk some more about your observed?

MR. BROWN: Yeah. One thing I didn't mention at first was we also did find a significant gap between productivity of immigrant owned businesses versus native owned businesses that the immigrant owned businesses were significantly more productive. Like 12 to 18 percent more productive in labor productivity. So, one thing about innovation is that there can be spillovers. So, even if the immigrant owned businesses aren't creating tons more jobs than anybody else, if those innovations can then be used by other companies as well. So, you could have more growth in the economy as a whole from the innovations that are happening in the immigrant owned businesses.

If I could return to something that they were talking about earlier about rural versus urban areas and inequality and opportunity. You know, immigrants tend to congregate in certain places around the country. And so, that has implications for the work force. If you're fortunate enough to be in a community with many immigrant entrepreneurs, they you may be able to be in businesses that are going to be successful, more productive, more innovative. But if you're in an area that doesn't have, then you aren't going to have maybe the same opportunities. So, the human capital of the owners of those businesses seems to matter and it's not evenly spread.

MS. HENRY-NICKIE: All right, thank you. So, I want to wrap up here with a quick fire round on what are we thinking when, you know, I think Karim raised it and, of course, you too, Tom, around getting a future ready workforce. I mean, your story of the coal miner who were now code miners so to speak, I'm not sure that that is a model that will be, you know, spread far beyond that maybe one or two towns. But you've walked through in your own research, you visited other shops, other organizations. What are some other strategies beyond turning coal miners into coders that we should be looking to when we think about getting this future ready workforce to be able to harness all the potential of 5G and in all of tech?

MR. WHEELER: Well, I refuse to accept your assumption that it can't be done. It's damn hard but I don't think we ought to just throw up our hands and say it can't be done. We need to talk about what is necessary so that it can be done. And I think that what are the training issues. You know, it's interesting, Randall Stephenson, the CEO of AT&T went before his workforce about 18 months ago. And said, if you are not doing ten hours a week of training, you're probably not going to be relevant to us anymore.

The interesting thing, you go back in history and you say, okay well there's always been a kind of dislocations that happen when new technology comes along. You know, you go back to Ned Ludd and the Luddites and the Jakar Deloom, you know. The difference then was that there was a basic skill set, you know. If you're buggy factor, you got put out of business by Henry Ford. You didn't need really different skills to work on the line building Model T's.

We're existing in a world right now, however, where you do need different skills. And even when those folks who are employed in technologically driven businesses like AT&T are being told, if you don't keep your skills up, not so sure what's going to happen to you in the future. So, what are we doing to address training? And that was the exciting thing that was going on what they call silicon holler. And that they were addressing training and the key to that then was connectivity.

And so, the statement you made is an outcome conclusion that we don't have to be satisfied with. If we will address the question of how are we going to make sure that people are continually trained and how are we going to make sure that we have the networks of the 21st century that will connect those trained individuals to opportunities.

MS. HENRY-NICKIE: So, ideally, I mean, essentially, we're facing a change in production function, that's exactly what these technologies are doing. And we're caught between, I think, different jargon, whether it is a skills upgrading. Does it mean that, you

know, we need to go back and overhaul K-12 or traditional education? What is your work telling us about the link between educational attainment, David, innovation?

MR. BROWN: So, our work is simply looked at the degree of educational attainment and how that impacts innovation. And there's a clear, you know, pattern that you would expect that it's the people with graduate degrees that were doing most of the innovating, particularly the research and development piece. And that immigrants, immigrant owners have like doubled the percentage of graduate degrees among them as natives have. And so, that is a big part of why you see this gap between immigrant owned businesses and native owned businesses.

But I think there's something more that you can't just measure through the piece of paper which is their life experience. So, just the fact that they have come to this country is an entrepreneurial exercise. They are more risk taking, they've demonstrated that and I think that is going to help in the innovative process. And secondly, they've experienced difference cultures, different institutions and they can bring that experience here and that might help them to better identify new opportunities in the market that aren't here already. And so, I think those are some of the ways that they're getting an advantage.

MS. HENRY-NICKIE: I think yeah, I think what I take away from your response there is we have to be careful about how we measure, you know, these human capital outcomes, right. To Tom's statement, to what we think are proxies for skills are probably proxies for entrepreneurial spirit background. You know, if they're coming from different markets, they've seen new products and process and what looks new to us actually probably doesn't look very different to them. And it sort of shows up as an innovation here so I think we ought to think very carefully about how we, you know, advocate for changes, large structure changes to education and training system though they are needed.

Karim, I want to bring you in for the final word. Training, retraining, upscaling,

however you want to tie it, it's crucial. But we've got a big demographic headwind ahead of us and that is an aging populous. Are these strategies sufficient enough to buffer against that?

MR. FODA: Well, I don't think any one strategy is sufficient. I think this is a major multipronged overall policy agenda which might even be understating it. I mean, a revamping, redesign upgrade tweaking of the social contract at large, I think, is going to be necessary to adapt to this new modes of production, these new ways of connection and these new skill requirements and the transition ahead.

The demographic headwinds and the aging populations in the U.S., Europe, China included, are very significant and make the case for driving faster productivity growth that much more important. And faster productivity growth, you know, it's not just a simple matter of efficiency and quantity and more. You know, you can measure output inequality adjusted way. You know, if you have declining population, you know, that puts a lot of pressure on your pension systems and on the fiscal sides which then has implications on a capacity for public investment, et cetera. There are a lot of spillover effects.

So, the need for faster productivity growth to make up for a slower growth or a decline in labor makes the push or this kind of overall policy agenda that much more important. Immigration is one way to boost the labor supply, bringing more people into the force and increase labor force participation rate is another way to increase the labor supply. But, you know, you still need a boost of productivity growth to offset that impact to at least maintain standards of living to be able to continue to service. You know, on the fiscal side in order to maintain a kind of health and ability for public investment. And to be able to provide public services and secure that social contract. And so, that makes the case for productivity growth that much more important.

And, you know, we mentioned learning and lifelong learning and training as very

crucial. I agree 100 percent. But there's a big question still on my mind which is what skills learn what and by whom? Are we talking public education or are we talking, you know, employer sponsored vocational training? Are we talking simply on the job experiences?

And then with that, what are, you know, what are the skills demanded from the labor market? We don't really know. I mean, we know that computer programming and science and ability to have advanced artificial intelligence to be able to operate these kinds of high tech internet of things, machinery et cetera, that's all clear. But going forward, having that kind of dynamism, have that competition, having that diffusion of technology is critically important for the market economy within the sufficient bounds to evolve itself and have human skills and human cognition compliment what technology is increasingly capable of make sure that we all have a better quality of life going forward.

MR. WHEELER: Can I try one last thing here? This is not a new experience, okay. The theme of my book is we've been here before. This is the history of our future. *Gutenberg to Google: The History of our Future*. Put yourself back in the last technology driven, great technology driven revolution, the second industrial revolution. Incredible expansion in the size and number of cities. People had never been that compacted before because the networks were drawing industrial activity which were drawing people which had the following kinds of impacts.

One, cholera broke out because you didn't have sufficient sanitation and people had to figure out, how are we going to deal with that. There wasn't a textbook for figuring that out. Two, public safety was never so much needed as people were jammed together, crime happened, fire protection happened, had to invent new ways of doing that in real time. Three, education to the point that Karim was just making. How did you prepare people who were prepared okay for the farm to be able to be on the floor of the factory and read manuals and do the basic math. How do you have health systems in an environment

where the doc, the town doc doesn't work anymore and you have to develop healthcare systems. On and on and on.

And what was significant in all of those times was that they were just like today in that there was, as I say, there was no text or tutor that could say, here's what answer is. They had to work through and find the solutions. And that's where we are today and I would suggest to you that that is an exciting time to be alive. And to be doing the work that these kinds of gentlemen are doing and the kind of research that you're doing. But it's the challenge that we all have and we've gotten through it before, we'll get through it again.

MS. HENRY-NICKIE: Thank you for the note of optimism. We are a few minutes into our question time, possibly half so I'm probably going to take three questions at most. Questions, not statements and also if you could be brief so we can accommodate, you know the responses. So, I'll take this gentleman right here in the white shirt right on the right, on the left and let me just, and this gentleman. Oh, do I have someone in the back, so we'll do the four, thanks.

SPEAKER: With all the developments we going to have in productivity and self-driving vehicles, 3-D printing, all good stuff. How many jobs are we going to have for all the people that are going to lose their jobs? They're going to just become jobless.

SPEAKER: Thank you. Chairman Wheeler mentioned it's a lot of hype going on in technology and I think that's very important to notice. This panel has two governance experts and two economists and no technologists. Shouldn't there be somebody who knows technology on that panel to help vet the hype?

MS. HENRY-NICKIE: Thank you. We've got this one question and then we'll have the final one in the back.

SPEAKER: Yes, what's the relevance of lower orbit satellite constellations and the communications revolution? Of course, Elon Musk has great ideas but even current

systems, in particular, Chairman Wheeler banned 53 recently approved by 3GPP some globally harmonized spectrum of global star that can now be used for terrestrial applications. What are the implications of that and will you be staying afterwards to autograph your book?

MR. WHEELER: Second answer is real easy one.

MS. HENRY-NICKIE: So, we have a last question, the gentleman standing in the back in the blue shirt, yes.

SPEAKER: I'd like to get everybody's perspective on what the next steps should be in the next six months.

MS. HENRY-NICKIE: Wow, all right. You should be the moderator next time, I like that question. So, we've got, you know, where are the technologists, they should be here. We've got, you know, how many jobs are we expected to lose given this, you know, churn and this (inaudible). Chairman Wheeler, the question to you on satellite tech, implications of that. And then finally, if you could just, 30 seconds in the next six months, what would you be saying about one or two things we should be focused on. So, I'll start with David and then go down the line.

MR. BROWN: Well, so one thing I would like to look at is, you know, if we find that immigrants are so important for innovation, what affects, what implications does that have for our immigration policy. And so, you know, one thing that we found was that the immigrants who are owners are very different from the average immigrant. They're not so much Hispanics, they tend to be Asian so what implications does that have for how we might change our immigration policy. There's been a lot of debate about that.

And one of the maybe positive spillovers of the heightened interest in the administration about citizenship statistics is that the Census Bureau may get much better quality data on, you know, Visa status and things like that. So, that we can understand much better what the implications of the immigration policy is for our economy.

MS. HENRY-NICKIE: Thank you. Karim.

MR. FODA: So, on the question of automation displacing jobs and what are people going to do. You push pause on the world today and we let all those technologies take those jobs than those people will be jobless, I'm afraid, and have to find other jobs that currently exist today. But the good news is that I just said what I said two seconds ago and time moves on and there's a dynamic process and the jobs of the future will be different. I don't know what the answer is. How do we facilitate that transition, well how do we kind of keep the guardrails around that transition to make sure that jobs of the future are being created.

One interesting research area I know by McKenzie Alyse was the automation displacement of tasks not occupations or to a certain extent. I think that's very important and that highlights a very critical aspect of how people can continue to add value in ways that I don't have the answer to right now. Given what humans can do and what an artificial intelligence capability cannot or while the two together can work. It's a social question, it's a political question but it's also an economic one.

So, I don't know what the jobs will be but I'm optimistic that there will be some. The transition will require a public response and that gets me to what I would get to in the next six months. First of all, I wouldn't do anything unless you know what you're doing. But having said that, if you do know what you're doing, the first thing I would tackle is this area around competition and the market power of dominant firms to help begin to ensure that we have this dynamic and well-functioning economy that can create jobs and create opportunity.

MS. HENRY-NICKIE: Well, the DOJ started on that yesterday, right, so trust investigation.

MR. WHEELER: Which is one part.

MS. HENRY-NICKIE: Which is one part. Tom, I give you the final word.

MR. WHEELER: So, first of all, your point about Leos is really well taken and they can be a new form of back hole. As I was saying, the important thing about 5G and other wireless technologies is getting out of the base station and back and they offer great opportunity for that, particularly in less developed really remote areas of the world.

Secondly, I just want to second third and fourth what Karim's saying about competition. What should you do in the next six months, quit living with soundbites and start thinking about long term policy built around competitive solutions and encouraging and promoting and protecting competition.

MS. HENRY-NICKIE: Thank you. Thank you, thank you to my panelists for, I think, what was a really engaging discussion and conversation. Thank you for your questions and for your presence and now the competition between us and the Mueller hearing is over.

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