THE BROOKINGS INSTITUTION

TRANSFORMING TRANSPORTATION WITH AUTONOMOUS VEHICLES AND THE SHARING ECONOMY: ARE WE READY?

FEATURING KEYNOTE REMARKS BY
REPRESENTATIVE EARL BLUMENAUER

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Welcoming Remarks:

TED GAYER
Vice President and Director, Economic Studies
Director, Center on Regulation and Markets
The Brookings Institution

Presentation One: Can the Markets Address Government Failure: The Case for Autonomous Vehicles:

CLIFFORD WINSTON
Senior Fellow, Economic Studies
The Brookings Institution

Presentation Two: Using Big Data to Estimate Consumer Surplus: The Case of Uber:

ROBERT HAHN
Director of Economics and Professor, Smith School of Enterprise and the Environment, University of Oxford
Nonresident Senior Fellow, Economic Studies, The Brookings Institution

Panel Discussion:

TED GAYER, Moderator
Vice President and Director, Economic Studies
Director, Center on Regulation and Markets
The Brookings Institution

ROBERT HAHN
Director of Economics and Professor, Smith School of Enterprise and the Environment, University of Oxford
Nonresident Senior Fellow, Economic Studies, The Brookings Institution

EMILY KOLINSKI MORRIS
Chief Economist, Ford Motor Company

CLIFFORD WINSTON
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KENNETH LEONARD
Director, Intelligent Transportation Joint Program Office
U.S. Department of Transportation

Keynote Speaker:

THE HONORABLE EARL BLUMENAUER (D-OR)
U.S. House of Representatives

AMY LIU, Moderator
Vice President and Director, Metropolitan Policy Program
The Brookings Institution

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P R O C E E D I N G S

MR. GAYER: Good morning, everybody. Welcome to our event today on ride sharing and autonomous vehicles, and welcome to those of you who are watching on our webcasting.

My name is Ted Gayer. I am the vice president and director of Economic Studies here at Brookings. This is the first of what I hope will be many events hosted by our new Center on Regulation and Markets. The Center, which I direct, and which includes experts from different disciplines across Brookings, will strive to inform and improve policymaking by providing scholarly work on regulatory performance and process and efficient and equitable function of economic markets.

I'm excited about starting this center, especially given its opportune timing. Regulations are critical for safeguarding our health, safety, and economic well-being, but if not done well, they can impose costs on consumers and businesses and they can impede innovation. With the republicans in the majority in the House and Senate and with the incoming Trump Administration motivated towards deregulation, 2017 will likely see some substantial changes in particular regulations, as well as the regulatory process more broadly. I look forward to our new center providing dispassionate analysis and diverse views to contribute to this debate.

The plan for today's event is to start with two research presentations. The first by my colleague, Cliff Winston, who is the Searle Freedom Trust senior fellow at Brookings, is on his new research on the congestion reduction benefits of autonomous vehicles, a paper he's coauthored with Quentin Karpilow of Yale University.

Following Cliff we will hear from Bob Hahn, who is a nonresident senior fellow at Brookings, as well as the director of Economics and a professor at the Smith School of Enterprise and Environment at the University of Oxford. Bob will present a recently released paper on the consumer benefits from ride-sharing. Bob's paper, it should be noted, in addition to being coauthored by Steve Levitt and Bob Metcalfe at the

University of Chicago, also was coauthored by Peter Cohen and Jonathan Hall, who both work at Uber. Bob, however, did not receive compensation from Uber for this research. In addition, it turns out an Uber employee is a member of what's called the Brookings Society, a forum for Brookings to engage with young professionals, but Uber does not support the work of the Center on Regulation and Markets.

Following the two presentations, I will moderate a panel discussion with Cliff and Bob, joined by Emily Kolinski Morris and Kenneth Leonard. Emily is a chief economist at Ford Motor Company, and Ken is the director of Intelligent Transportation Systems Joint Program Office at the Department of Transportation.

We will follow the panel with a keynote speech by Congressman Earl Blumenauer, moderated by my colleague, Amy Liu, who is the vice president and director of Brookings Metropolitan Policy Program.

Again, thank you all for joining us today, and so now I welcome Cliff to the stage to give his presentation. Thank you.

(Applause)

MR. WINSTON: Hello, everybody. Thank you, Ted, for inviting me to be part of this. I'm going to unpackage my title to clarify exactly what I'm doing because I have a number of goals. The first part, can markets address government failure? Okay, that's the center part of this enterprise. We had a center a number of years ago that was led by Bob Hahn and Bob Litan and I would say if there was any theme, at least to my participation in that, it was market failure versus government failure. I'll tell you the outcome of that shortly. But to be on the more positive side I'm now looking at things, well, can markets address government failure? All right. So that's going to be one theme at least of my research from the center. And I'll use autonomous vehicles to illustrate that point. But certainly at some point later in the center I'll do more.

Now, on the autonomous vehicles part, this will be certainly a research paper, but the broader concern that I have is my field of specialization, transportation and

economics, and this represents really a nice illustration of the broader impacts of transportation on the U.S. economy. For too long people think of transportation as just a very narrow sector of interest of its own and do not see the broader, bigger picture of what transportation really means for the economy. And so I think with the introduction of autonomous vehicles, one will be able to get that insight. So I'm sort of sandwiched between two goals using autonomous vehicles to do that.

All right. Now, the first part then on microeconomics and government intervention, and at least part of what the center is going to do, government -- and sorry, I'm going to have to go fast to achieve dense communication -- government has two microeconomic objectives in intervening in economic life. First is to correct market failures. So you have an inefficient outcome and the failures I've listed there, market power. Actually, market power isn't a market failure; it's illegal pursuit of market power or achieving such. Natural monopoly, it's a technological characteristic where its social design would have one firm serve the market, imperfect information, externalities, and public goods, public production. So these are motivations for government interventions and this is an efficiency, economic efficiency motivation.

These second objective is social goals. So it's not an efficiency problem but society as a political/social decision does not like the distributional outcome of certain events. People have, let's say, a few skills and they have low marginal products and they get paid low, low wages if, in fact, payment is efficient based on marginal products. SITA isn't like that. They're going to intervene and say, look, you need to have a reasonable standard of living and we're going to raise your wages. All right? So it's not an efficiency concern; it's a social goal. This is going to come back.

What we want to do here though is an economic objective, achieve those things at minimum cost. So those are the two things that government does in microeconomic life, and in my book, Government Failure versus Market Failure, coming out of the first center, if you will, I had evidence that government rarely achieves those

objectives in looking at all the academic empirical evidence that I survey. Okay?

So I want to turn around and say, okay, well, maybe markets could be helpful in correcting government failures. That's usually how we think about markets. Usually we think they're the culprit and government has to correct market failures, but in fact, there's reason over time if one's patient that you can think about markets and their evolution since they have incentives to do so and they innovate, that they might be able to correct government failures.

So let's look at the highway system, and this is where autonomous vehicles are going to come in. Okay, there are many problems with government regulation, if you will, and ownership and management of the highway system -- growing congestion, crumbling payment, structurally deficient bridges, so on and so forth. All of these are reflections of inefficient policies. That's what they have to do with -- inefficient pricing, inefficient investment, inefficient production, regulations, misallocation of funds, so on and so forth. All these things are government failures. Those are your problems. All right. If we address those then we would make a lot of progress in addressing of the observables in terms of the difficulties with the congestion and so on and so forth. Okay?

But that's not what we do. The policy mindset is to increase infrastructure spending. Both presidential candidates mentioned that. But that's really not going to do the job. You're going to be putting money already in an efficient system. I don't believe you're going to get nothing for it but you're still not going to be addressing the fundamental problems. So the question I'm asking is, well, perhaps the private sector could help. Now, I'm not saying privatization of the highway system; that will be for another day, but maybe on the modal side.

All right. So the idea here is that modes lead infrastructure. This has always been true, like forever. All right? Well, maybe forever. Modes have improved their performance regardless of the state of the infrastructure. We had cars actually before we had highways. We had airplanes before we had airports. We had airplanes

before we had air traffic control. And if you sort of look at all the improvements that the modes have made in technological advances and you compare that with the infrastructure, it's night and day. Modes continue to come along. And the latest innovation is autonomous vehicles. Right? The potential to prevent collisions, reduce regular incident delays. Incident delays are when there's like a crash and stuff and then people stop and rubberneck and things take forever to get out. Autonomous vehicles won't do that. Autonomous vehicles will just keep going along. They're not going to look on the side of the road and see what happened. That counts for about a third of delays. So that's intuitively a reason where autonomous vehicles are going to reduce delays. Okay?

So they're going to create a much smoother traffic flow. Okay? Reducing congestion. Now, the benefits depend on how many autonomous vehicles are out there. Fifty-percent penetration, that is 50 percent of the cars that are autonomous that are out there could reduce delays as much as 50 percent according to estimates in the engineering literature. And the estimates there are annual benefits to travelers of some $200 billion.

Now, my interest though, as I said, is in transportation economics, the broader effects on the economy. You know, how much could the economy-wide benefits be? And that's what my research was about. Okay, so I'm going to measure the broader effects to the benefits of the economy. I have a basic model here, and I guess I'm told that when you have an equation, it reduces your audience by half. Right? I guess I would argue that for every equation, you increase the motivation for privatizing schools.

The relationship is the growth rate of economic performance -- so I'm going to have some sort of growth rate variable -- employment, trade flows, wages, GDP -- as just a simple function of congestion. Intuitively, you can think about congestion certainly can affect employment because your job search is going to be much less. It takes you two hours to get to work. It's going to be much harder for you to get a job and

you're going to look in a much narrower area where you might get a bad match, not to mention your own productivity and so on and so forth. So you reduce the cost of transportation. You could increase your job search. That would be a good thing. Trade flows and trade costs are going to go up for congestion, so on and so forth, so it's intuitive as to why congestion would be having these broader effects, and this is sort of what we call a reduced-form relationship.

Now, the question is, well, are we really going to get a causal effect? Can I really say that congestion is causing these things? Because unobserved factors that affect congestion are undoubtedly going to affect my performance variable. Okay, and it's these unobserved things that really could be driving everything. Right? So this is the standard stuff. You know, the New England Journal of Medicine says, you know, watching TV shortens your life. Right? Well, it's the unobservables, probably, that cause you to watch a lot of TV, and those same unobservables that shorten your life that are really doing the trick. All right, so that's really the idea. You never can believe anything you read in the New England Journal of Medicine, by the way. Another matter. Another day.

All right. So the idea is getting the causal relationship. And so this is science of what we're trying to do here. And estimating a causal relationship, using what we call an instrument that purges these unobservables, okay, and then enables you to get a clean relationship between the variable you care about and what things it's causing. So I want to get a clean effect of congestion on these performance variables, and what I do is I use what we call natural experiments in the form of legislation to pass self-help county taxes. You're probably not aware of these -- I wasn't until I got into this -- but certain counties in America have the option to put legislation forward for people to vote on that would increase the sales tax by a small amount, and you can use the money for transportation. Okay, so improving any part of the transportation system.

Now, it turns out these things are completely politically driven. All right,

these things are sort of independent of macroeconomic forces and local forces and it really is about mobilization and just getting political support for this thing, so the core of the paper goes into doing that. And so that can make a plausible instrument.

Now, even if there's any science that I go through to go through this, it really is ultimately an art. You have to tell a story to do this. Okay, so if you want to be deep and really critical, you could always go around saying your instrument is implausibly exogenous. Your instrument is not plausibly exogenous means you're not going to get a causal relationship. If you do this enough, then you will become the next Chauncey Gardiner. Tough crowd. Chauncey, C-h-a-u-n-c-e-y for younger people. Gardiner with an I. You guys must be in a bad mood still because of the election. I'm a bleeding heart libertarian. I see benefits on either end.

All right. So the core of the paper goes through self-help county taxes and their exogeneity and justifies then my causal relationship. I will now move on. I use that then to estimate the effect of congestion on wages, employment, trade flows, and GDP for California counties, and then I use these estimated parameters to see the effects of reducing congestion. So I see congestion's effect on these performance variables and then I say, okay, if I reduce congestion, right, from autonomous vehicles, what gains am I going to get in terms of improving these performance variables.

All right. So the rest of you now can tune out.

This is basically just an accounting relationship.

All I'm doing is I'm estimating beta, that is the effect of congestion on my growth rate variables, and then I want to isolate then what the effect is of introducing autonomous vehicles, and in the end I get an equation that enables me to do that. That is the post-growth rate will then be an expression in terms of the current growth rate raised to some exponential. Again, my beta I've already estimated. No problem there. The alpha then is what I'm assuming the effect of autonomous vehicles have on reducing congestion. So if I use this 50 percent assumption, I plug that in. I'm assuming 50 percent reduction,

that's going to be the end effect. I could use other things, too, for sensitivity.

Here's what I wind up getting. You know, big effects in California on jobs -- improvements in employment, 300,000 plus; 35 billion GDP; wages, 14 billion, so on and so forth. The individual effects on counties are not particularly big but there's just an awful lot of it. A lot of congestion. And when you start aggregating this up, you start getting big effects. The bigger numbers come in nationally and you start seeing if I expanded the results of California to the rest of the country, and even if I say, well, California is unusually congested so let me just take 80 percent of the gains, you know, I see huge improvements -- jobs, 2.4 billion; GDP, 213 billion; earnings, 90 billion. These are big macro effects. No matter how you spin it, you know, I could even assume the alpha a quarter. It's still going to be a large effect, way beyond what you normally think that micro policies can do saying, you know, this is really a very promising technology, and those of you who are familiar with Bob Gordon saying, look, we're not going to have the kind of innovations that change society, not according to this.

Okay. So autonomous vehicles then are effectively addressing the government failure by significantly reducing congestion. I argued earlier if we had efficient micro policies, congestion pricing and the like, that could do it but that's not what we have. So the private sectors are coming in. Private sectors coming in helping. Benefits are substantial. I see the government's role is to just expedite the introduction of this. I don't want them micromanaging the transition. After all, if anything, they're going to learn from the private sector about what this technology is about. They should just be good listeners. I think autonomous vehicles are going to perform much better on highways that perform efficiently, so there's still a role for improving the highway system, and as I said for another day, that may be if highways are privatized. The end.

(Applause)

MR. HAHN: Good morning. Thank you. Thanks, Ted, for that great introduction.

I want to start out with a question following off of Chauncey Gardiner. How many of you have heard of William Francis Sutton? Don't worry; he's not going to be on the test.

So great American bank robber, William Francis Sutton, aka Willie Sutton, aka Slick Willie, long before Slick Willie may have come to Washington, D.C., was being interviewed, or the story has it was being interviewed by a journalist. Now, Sutton lived from approximately 1901 to 1980, had an illustrious career for about 40 years, was in and outside of prison, escaped from prison three times. So the journalist, figuring out what to ask William Sutton says, "Okay, Mr. Sutton, why do you rob banks?" So he thinks about it for a minute and he goes, "I don't know. Because that's where the money is."

Well, you can imagine a similar journalist in this day and age asking an economist the question, "Why do you study demand or demand curves?" And I might answer, "I don't know. Because that's where the money is." At least somewhat under the curve, the area under the curve. And I think it will also, in the case of the application I'm about to talk with you about for the next 10 minutes, might give us some insight into what I loosely refer to as the ride-sharing revolution.

So I'm going to talk about some joint work, as Ted mentioned, with a couple of folks at the University of Chicago, Mr. Freakonomics, Steve Levitt and my frequent coauthor, Rob Metcalfe, and a couple of people from Uber as well. We were interested in trying to understand and estimate some of the benefits that might accrue to individuals that take -- use Uber as a service or use similar services like Lyft, though our data was from Uber. And we were interested in it for two reasons -- or I was interested in it for two reasons. One, because I wanted to know whether it was a big or a small number because firms, upstart firms -- I guess it's not an upstart firm anymore -- like Uber faced quite a bit of resistance in many places around the world, so were consumers were getting a lot of benefits for this? And the second reason was more academic along the

lines of those equations that Cliff was showing you earlier. We don't really have a lot of good estimates, precise estimates out there of demand curves, particularly outside of, you know, the supply and demand point of equilibrium that you see. And we, as I will explain shortly, thought we had a nice experiment so we could tease out what this demand curve looked like.

So that's the basic problem. I'm going to talk a little bit about what our approach was to addressing this problem, give you a very quick summary of results. I'm happy to talk a little bit more about them in Q and A if you want. To the extent there are implications for autonomous vehicles, I will speculate about that and then I will briefly conclude.

All right. So this is a picture that may be on the test or may have been on your test in micro from 10 or 20 years ago or whenever you might have taken microeconomics, but it's a standard demand curve and supply curve. The demand being -- the demand curve being downward sloping as a function of quantity. You charge a higher price for ice cream cones, people demand fewer ice cream cones.

We were interested in estimating just the demand curve for Uber services over a period of time in 2015 so we could get at that shaded area which I've abbreviated consumer surplus. And consumer surplus represents the difference between what someone is willing to pay for a good and what they actually pay, and we use that, we integrate that area and get a measure of consumer benefits.

So as I mentioned, these demand curves are pretty easy to draw. I spend my life drawing them at Oxford and introductory courses, but they're not so easy to estimate out there in the real world. So I want to talk a little bit about our estimation procedure. And just to warm you up, I didn't want to put an equation on the board like Cliff did because I figured you'd be asleep by now. Instead, I want to talk about hockey.

How many people have -- are familiar with the book that Malcolm Gladwell wrote, Outliers? Great, great, great. So he talked about the Beatles and he

talked about Bill Gates and may have talked about Robert Oppenheimer. I don't remember. But he also talked -- he had a vignette about hockey based on a study that this guy, Roger Barnsley did. And gist of the insight about hockey was that kids who were born in a certain month may have a higher probability of getting into the National Hockey League or being elevated to the next group than kids who were born in another month. Now, why was that the case that kids in January had a better advantage or were more likely in some sense to get to the NHL than kids who were born in December? Well, if you were the oldest boy or girl in a league, and I don't know if this study was mixed sex or just for boys, if you were the biggest kid in the league, say you were born in January, you were much more likely to be able to trounce the little kids independent of your ability. So that was really what this story was about.

But the point was that a small change in one's birth date can lead to you being put in what you can think of as a different treatment group, like in this case are you put in with the younger age kids or the older age kids? And that gave this social scientist an opportunity to tease out what the effect of this treatment was.

So we used a very similar idea in a completely different context. Now, can I see a show of hands how many people use Uber or Lyft or some similar service? Great. Everybody knows what it is. So this is what -- if you tuned in to Uber a couple years ago and brought it up on your app and they had a particular period of intense demand or short supply, they might say they're going to charge you twice the base rate. And unbeknownst to you, they have given you a number, which is the reason the 2.0 comes out here. They give you an actual number to several significant digits, your surge number, and they either round it down or round it up depending on what that number is. And that enabled us in a way that I'll be able to explain to you shortly to estimate a point on the demand curve.

So what we did is we estimated several points on a demand curve with 50 million observations, which we might think of as big data. We used people's purchase

rate when they faced a certain price, like 2.0 times the base price or whatever as a way of teasing out the demand curve. And we exploited information on people who both accepted the offer at 2.0 and people who rejected the offer. And we used that information to then estimate the benefits which I abbreviate as consumer surplus as I said before using the difference between willingness to pay and the price.

So how did we do this? So I'm not putting up equations but I am putting up nasty pictures here. So everyone to the left of the vertical red line was facing a surge price of 1.2. And their purchase rate was roughly 58 percent. Everyone to the right of the 1.25 red line, the vertical red line, was facing a surge price of 1.3. So people very close to that red line who had a surge number which they didn't see, let's say of 1.24, would have been rounded down and get a price of 1.2x, and people just above that surge price of 1.25, say it was 1.26, would see a surge price of 1.3x. And this gave us an opportunity to figure out what the price responsiveness was at about that point 1.25. And when we did that and waved our hands in certain ways that economists are prone to do we got something that looked like a demand curve. So that was the nature of our exercise. And I'm going to just, in the interest of time, move on to what our results are.

The first result is we studied four cities, only four cities -- Chicago, Los Angeles, San Francisco, and L.A. And our best estimate for 2015 of the benefits enjoyed by Uber customers was on the order of $3 billion. If you ramp that up, simply just do a calculation based on population in the U.S. where such ride-sharing is available, you get a number like $7 billion. Is that a big number or a small number? I don't know. When Willie Sutton was robbing banks he got about $2 million over his 40-year stint which was real money during his time. You can decide whether it's real money now.

What I do know is that roughly speaking, for about every dollar that an average individual spent on Uber in the year 2015, they got about $1.60 in surplus back, at least based on our estimates.

So what does this tell us for autonomous vehicles? Well, not as much as

I would like. We don't know a lot about the impact of autonomous cars because there aren't a lot of them out there, and so here's some hunches. One, which Cliff talked about briefly, is that these vehicles may reduce congestion. On the other hand, if we use them a lot more, even if the cars are spaced closer together, it's not completely obvious that they will do so, but I'll say that's a potential benefit. Certainly, you can get more of these vehicles on the road as Cliff pointed out in his paper with a given level of congestion.

But we have the downside, at least in transition. There are a lot of Uber drivers. I think there were 500,000, and Jonathan had a figure, which I'm not going to put up. But there are a lot of people who are in business doing this stuff in the United States and around the world. They're probably going to lose their jobs as we move to autonomous vehicles, and obviously, the wages that go with it. There may be a temporary depression in their wages.

I think there's going to be a huge increase in consumer surplus, and people are essentially going to be able to do whatever they want in these vehicles. Cliff talks a little bit about this. I think indirect employment will rise as a result and productivity will rise.

There are also some big issues which I know some of you are working on now. One related to barriers to entry even before we get to autonomous cars and a second related to sorting out liability issues.

So let me stop there. And thank you.

(Applause)

MR. HAHN: Sorry, I've got one more slide. I didn't realize that.

Okay. So what did my application show? Sorry, Ted, this is going to just take a minute. Okay.

First, how big data could be used to develop a demand curve. Second, there are significant benefits to ride-sharing, certainly for those folks who use the service. Third, unrelated to this talk directly, it's my impression that both business and

governments are sitting on a treasure trove of information and have only scratched the service in terms of measuring the benefits of things like these Uber services. And I sit on a commission on evidence-based policy which is aimed at unlocking some of that information for academics. And finally, I believe that the social benefits of autonomous vehicles are likely to be substantial. I would even say huge. But we need to think very carefully about the losers in this transition.

Okay, this time it's for real, Ted. Thank you.

(Applause)

MR. GAYER: Okay. I think, while they get mic-ed up, I took initiative and tried to put it on myself. You can tell me how I do wrong. I'm going to get started. Thank you, again, everyone, for being here. And thank you to our presenters?

I think as they were talking I had a little midlife crisis, maybe because I'm solidly now middle age, or maybe because my oldest son is an adolescent, just entering adolescence. I feel like I'm the techno pessimist of the group a little bit, and so I'd like to flesh some of that out first with our two presenters, and then I'm going to open it up to two additional panelists. I was so tempted to start with Cliff's first comment being: your instrument isn't plausibly exogenous, but I don't know who (Inaudible) Gardner is, so I don't want to risk it. He can fill me in later.

But I'm going to set this up for both Bob and Cliff, my first question on a well-known study, I think getting a lot of attention in economics called The China Shock, by a number of authors including David Autor. And The China Shock paper looks at local communities that were exposed to something transformative, in this case, trade from China, and saw a pretty substantial labor market impacts over a pretty substantial amount of time. I'm not a kind of card-carrying economist, and gains from trade lead to positive net benefits, but with some transition costs of people who were dislocated based on the job composition. And in this case it was an eye-opening about how large those transition costs could come.

So, that's my motivation kind of approaching these, whenever we have something which, potentially, and this question here could be transformative: what are the implications, or what are the downsides? And Bob referred to this, on his side, he had a drivers' lost wages, and jobs on the negative side, meaning a bad thing on that.

So, let me just start with the Bob. I love the paper; the paper is a very clever way, in that diagram, that regression discontinuity diagram I think is beautiful. It shows how you can kind of tease the data in a quasi-experimental approach to look at how much people are benefiting. What are they willing to pay for ride-sharing -- for a ride-sharing as opposed to a different ride, and compared to the price, you get the difference being the consumer surplus?

As Bob knows, when we talk about welfare analysis, or the wellbeing of different markets, we look at -- there's a bigger story. It's consumer surplus, tax revenue and producer surplus, makes the total benefits in that demand supply figure that he showed up there, but then we have a phrase called general equilibrium, which is other markets are affected. And so with the understanding, a lot of what we are going to do up here is kind of what I would call informed conjecture, I'd like to just ask Bob, that negative side: How much should we worry about that?

In the sense that you can imagine a world where consumers are benefiting tremendously from the convenience and the low cost of being able to pull out their phone and grab a ride with Uber and Lyft, but there's got to be -- some of that is induced new demand, maybe I wouldn't have traveled that way before, I would have driven my own car; some of it is, I would have taken a taxi. And so if you look at the consumer and producer surplus, and the tax revenue from the taxi side, again, informed conjecture, how much are we worried -- how is that substituting away from that?

MR. WINSTON: You don't even Metro as an alternative anymore?

MR. GAYER: Oh, Metro, yeah. I don't Metro very often, sorry. Yeah, that wouldn't help my question.

MR. HAHN: And so I don't think we know much is substituting away from it, but my sense it's a large portion of that is, essentially, new benefits. But I would turn the question back to you and say: What's the alternative here? Do we want to try to put the genie back in the bottle? So I certainly see two phases of this. One, there's been a steady growth of employment of what Uber likes to call these driver partners, you know. I mentioned the number half-a-million, I think that was in 2015, and I think that's a great thing for a variety of reasons. But when we actually move to driverless cars; that's going to evaporate.

MR. GAYER: Yeah. That was my follow-up question.

MR. HAHN: Okay. So, yeah, I think we are going to think hard about that, but I don't think I want to put the genie back in the bottle.

MR. GAYER: That is, the genie back in the bottle, again, I'll come back to the trade paper, because I think it's illustrative also. There is, if you look at that paper, I think the implications are quite stark with the labor market effects for -- but the question is: What could have we done different? Right? So in this example you have a very large country, China, liberalizing.

There's only so much you can do to prevent that from another -- you can maybe tap the brakes and do some policies, and so I think that leads to some of these policy questions, and Cliff's framework, maybe that's more of a government failure, over-response. But I do think, especially what we see with the trade debate now, we have to be at least worry of what that response might be. It could be good, it could be an over-response.

Cliff, just a follow up on yours, I do want to just ask you, this is a techno question on the (inaudible) makers, you said the paper goes into it, and if I could get a couple lines here, "This instrument, taxes work only in so far as the local community instituting this tax, is doing so not for economic reasons, and the tax doesn't affect the local economy. Is that correct?

MR. WINSTON: Yeah, yeah, yeah. Sure.

MR. GAYER: And do you think -- Why would the taxes not, I mean --

MR. WINSTON: It's a very small tax. It's a very small tax.

MR. GAYER: But enough to in fact adjust it?

MR. WINSTON: It's 0.5 percent, our sales tax. Well, the way we do it is we use the cumulative tax revenue as ultimately our instrument, so at any one time, it's small and it takes a long time, and that's what we point out in the paper for this tax revenue to build up for it to complement federal and state money that they are getting, if they oftentimes pass these taxes that could have an effect on congestion.

So, it's not a question that you really can count on this tax itself to do super-big things, because highways are so expensive, and the amount of money they are raising is small, but they accumulate enough of it that at some point in the future, that actually could have some effect, and especially if it's complementing the state and federal money. Can I make a quick comment, by the way, on this Autor Paper?

MR. GAYER: Sure. Based on your paper?

MR. WINSTON: It really -- Yeah. This is something I said at the every beginning of the presentation, so I just want to at least make sure -- make it clear why I mentioned this. Now, I know the distinction between micro policies dealing with efficiencies or government failures, and policies dealing with redistribution. Okay? So this is just classic; and I just don't understand why. Here, we are really talking about the efficiency phenomena, a new technology. All right?

And I'm going to, and I'm presenting results that suggest that we could talk about GDP growth just from this innovation alone that could approach 2 percent just from that. And so what happens, instead of either celebrating that potential phenomenon or saying: Okay, how can we have this? We turn all of this into a social policy question. What about redistribution of labor? Right? And this inevitably happens. These are two different things.

There is no market failure going on here. Right? The fact that labor loses, that happens all the time. We have a new product, we have a new innovation, demand shifts, less support for this product, you are going to cut labor. No efficiency there. Right? It's then something that's turned into a social policy problem, but how many more of these do we have to have. We have an infinite number of these, and they almost seem to add as soon as you get inefficiency effect that has any redistribution involved, we have to bring the government in to worry about the social policy problem.

Well, frankly my answer is, it's completely irrelevant, totally irrelevant. I wouldn't care about it, I don't think we should care about it, but most importantly this will ultimately be political decision at the ballot box, and I don't think voters are going to care about it at all. No one is going to get elected thinking policies to protect people who are going to lose jobs because of the introduction of autonomous vehicles.

MR. GAYER: All right. Could I ask a follow-up question, Chris?

MR. WINSTON: All right.

MR. GAYER: First of all, I disagree on so many levels. One --

MR. WINSTON: You are a liberal. You are a liberal.

MR. GAYER: No -- Whatever it may be, well, most empirically I disagree with the last one which is, I do think if you talk about truck drivers, taxi drivers, insurance companies, car manufacturers, auto workers, those -- whether or not you think that's efficient or not, whether or not that's in your social welfare function, your last line was: nobody will care. I have a sneaking suspicion that people care. I mean, we just saw a whole week of, you know, saving 600 jobs, or 1,000 jobs from crossing the border, there's something akin, that was a lot of oxygen take up politically for a little number of jobs, and we are talking quite a bit.

I want to get back to just one other part of your paper, which is, you have a very nice instrumental variable research design, and as you put in your presentation, there's an assumption of what is the congestion effects of introducing autonomous

vehicles? And I guess, I just want to tease that out, because what I just heard Bob tell me is, at least from the self-driving part, for now, that is not crowding out other driving so much as it's adding new driving, and people are just taking up the stuff more, which if anything -- So, do you have that, and then you have the countervailing effects that these things operate efficiently, and then there's going to be an algorithm, and all the rest.

You know, I understood you use the word assumption very carefully. Any sense of, you know, blind people -- I don't how many blind people out there, blind people might be driving more, people who don't drive or feel uncomfortable driving might be driving more. I use the driving in -- we need a new word. Self-driving? I don't know. Every time I say "driving" in this context I have to quotation marks. What's that?

SPEAKER: Travelling.

MR. GAYER: Travelling, thank you. Yeah, but -- Yeah, I guess traveling is good, traveling by vehicle, instead of aircraft. Any sense? I mean, how much kind of weight do you want to put on that? Or what are the (inaudible) -- We can't do an estimate here, give me the pluses and the minuses, kind of roughly.

MR. WINSTON: Let me first characterize though, some of the concerns you have about what the autonomous vehicles do. Remember that the problem of congestion is peak period driving, right. So we are looking at different times of day when, you know, we have excess demand on the available capacity. Okay? So, set aside the fact that road capacity itself could be increased independent of the vehicle, but the fact that we probably don't need the breakdown lane any more, we could have narrower lanes, that will help with the capacity.

But independent of that, think of the kinds of people who will be induced. So what the phenomenon you are talking about is called induced driving. So, now people who didn't drive during peak, who didn't drive at all, because now the cost of driving less, or less onerous, might want to drive.

My guess is, is that for non-work trips, the people you were talking about

maybe who are blind, or elderly, whatever, probably are going to be going outside the peak. Not necessarily a reason that they have to go peak period, and so that won't necessarily increase a lot of induced demand there. The issue about, though, other people who, let's say, you should take metro and now, you know, the end of that mode could be forthcoming and they start using their autonomous vehicles, the question there again, is the flexibility on work schedule.

So, if you realize, well, I can work in my car, I might adjust my departure time and say, well, I don't have to leave as early as I did. My work day starts the minute I get in my autonomous vehicles, and I'm going to leave a little later, but I'm going to start working away. Or say, look, you know, I'm going eat breakfast in my car, and that will alter my departure time. So there are those behavioral aspects that could greatly have an effect on how much induced demand there is.

But also let's get back to what I keep pushing, the government theory. If one has got a concern about induced demand, we have a policy that actually the Congressman has even represented, that is there to address it, congestion pricing. Right? And it's easier to implement in autonomous vehicles, and will certainly contribute to spreading out the peak.

So the problem to the extent that there is going to be one with induced demand, is something that policy can easily address and I would even suggest that in this environment, it will probably be easier to address because a lot of people won't even own cars. And you'll use your autonomous vehicles, and there happens to be a peak toll, it's like when you are in a taxi and have to pay some airport charge or something like that.

MR. GAYER: Thanks. We do agree with congestion pricing. Emily, I want to turn to Emily and bring her into this conversation. Okay, so right now I live about 10 minutes from here, I've thought about it, and concluded it's not worth it, for me to not buy a car, and instead take a lift or an Uber. That calculus, presumably, would change if they were driving themselves, because the cost goes fairly down.

I'm trying to get a sense from a market perspective and, again, a lot of this is just informed conjecture, where is the economics of this heading? Where can you imagine if the -- you know, assuming the technology, who is going to be taking this up, generationally, geographically? And we can get into the jobs displacement if you want but kind of, economically, what you do you think that means for the industry? I should remind everybody that Emily is Chief Economist at Ford.

So, what does that mean for industry which right now is, predicated on me buying my car, as opposed to maybe once they are driving themselves, and again, I'm 10 minutes from work, it's pretty close, and in fact, particularly easy technologically. I live right (inaudible), so it's just one straight shot. You could why I don't take the bus, but anyway. What are the implications, I think, for the industry? The timing of that, to the extent do you have any thoughts on what are the implications for the industry on that?

MS. KOLINSKI MORRIS: Sure. Let me take a couple minutes.

MR. GAYER: Sure, please.

MS. KOLINSKI MORRIS: There are a lot of tales to that question.

MR. GAYER: Yes. Yes.

MS. KOLINSKI MORRIS: First, you are absolutely right that the take-up rates are going to vary depending, what kind of environment you are living in. Right?

MR. GAYER: Mm-hmm.

MS. KOLINSKI MORRIS: If you look at where the population of the country is centered, you have a lot of population living in urban areas, you can just, I mean, envision the county map of the election results that we are all just -- we re staring at in the beginning of November. Right? Those places that are in your urban centers are going to be ones where the autonomous vehicles are going to be an attractive alternative.

Parking is relatively expensive, congestion is relatively worse. You know, we've developed some estimates of the cost of an autonomous vehicle, so taking, sort of, the driver out of the ride-share equation, and that takes the price down to

something that kind of brackets the cost per mile of owning your own personal vehicle. So that says that, you know, for some people it's going to make sense, for some people, just on a cost perspective, it may not make sense in sort of the forecast horizon that we have.

The other thing to remember is it's not just a cost determination. New vehicle buyers are, on average, above median income, they are making this choice not just on cost, but also on the convenience of having, you know, their own personal vehicle. And again that's something that your decision on that may vary depending, you know, where you live. I may be the outlier here. I live, you know, in the suburban areas of Detroit, and for me, you know, it's hard to imagine living without a vehicle.

And I'll break the cardinal rule of social science, right, and use myself as an anecdote here but, you know, when you think about the number of stops you make on the home, the way that a lot of us use our vehicles as sort of a mobile storage unit. You know, that makes the -- I suppose the convenience of an autonomous vehicle may not -- someone like that may not see it as, universally, a step up from what they have today.

So, we've definitely thought about the business in a different way, with the advent of this technology, and one thing is one that was sort of touched on already, which is, we are very used to thinking in terms of unit vehicle sales, something that we have to think about in this world, is to think more in terms of the demand for miles traveled by vehicle. And that then is something that's important to remember is the second word of autonomous vehicle is still vehicle, so we are still talking about driving around on something that has, you know, probably four wheels, and look like some sort of box.

MR. GAYER: Maybe not a steering wheel though.

MS. KOLINSKI MORRIS: Maybe not a steering wheel, you know, I think we'll get to that point. So, if you think about, let's say, the same or a higher number of miles traveled per vehicle being demanded, you may be spreading that over a larger or

smaller vehicle stock, and if you look Wall Street Analyst Reports, over the past year, you can find estimates ranging from anywhere to a 5 percent reduction in vehicles on the road, to a 50 percent reduction in the number of vehicles on the road.

Now the transition in the latter would be a lot more painful than the transition in the former case, but ultimately you get to a vehicle stock that's going to be utilized at faster or slower rates in returning the vehicles over faster, if there are fewer of them. The miles traveled, I would argue would probably be the same or slightly higher, because you are taking something and reducing the cost of it. So, you know, ultimately I think it's still a very vibrant industry.

MR. GAYER: Yes. Just on the last point, I don't know how much you can speak about this, but the kind of competitive climate right now, and this is sort of what I call consumer (inaudible) informed -- moderately informed observer. You've got the ride-sharing technologies which are incredibly slick technologies and utilizing right now kind of the gig economy. You have Google which bought Waze, Waze is something that, another slick -- you know, for a techno pessimist I use all these things. So, Cliff can take me to the wood shed on that later.

And the whole notion of kind of efficient routing, especially as you get into carpooling, and how you pick everybody up, which I assume is much more complex in the self-drive car. And then you have the manufacturers. And so, there is a question, it's like: Who wins? It's kind of an unfair question, but is there -- certainly you guys are planning this -- is there a model of the future where it's like one, you guys are providing products for a supplier that's essentially a fleet? Or, is it sort of what we have now, just more of it, you know, of just, I don't know, incentive -- individuals in the rural parts buying their cars, within urban parts relying on Uber.

Again, maybe, I'm not sure how deeply you can go on it, any conjecture on what that looks like and, kind of, what are -- You know, I read a quote recently, I think it's the CEO of Uber said, "Getting the technology right for self-driving cars, was

existential for them." Is there an existential question for Ford in this?

MS. KOLINSKI MORRIS: I suppose, and I don't think we'd put it that way, but I think to maybe get, you know, technical, in terms of what we've said publicly, and the way we think this evolves. We do think that the ramp up to autonomous vehicles does likely start with a fleet sort of application. So, we would be selling, you know, the vehicles to someone who would be operating them in some sort of ride-sharing or ride-hailing capacity.

That's a first step, the adoption curve for the customers is going to depend on both the cost, and as I said, how customers decide they want to use this technology to make their lives better. So that's probably -- oh, I don't want to say on the business model.

MR. GAYER: Fair enough. Let me just turn to Ken. As I mentioned before, he directs Intelligent Transportation System's Joint Program Office, at DOT. So, I'd like to kind of draw in on a couple things. One is, maybe give a little bit of what your office is about, and the role that it plays in all these technologies and on the research side. And two, I want you to distinguish a little bit, there are different technologies out there, so imagine a world, and some point you can project if you want, when this world happens, of self-driving cars.

What is the role, if any, of self-driving vehicles and something that your office is focused on, vehicle-to-vehicle communication? How important it is from a safety standpoint that these vehicles talk to each other, especially if you want to get the deep penetration that Cliff alluded to, about 50 percent?

MR. LEONARD: Well, in the Joint Program Office we have a pretty broad portfolio. So you mentioned the Connected Vehicle Program.

MR. GAYER: Yes.

MR. LEONARD: We actually do have a rulemaking that's pending, to allow that technology to kind of be universally available. We've worked with the

automotive manufacturers, and we've demonstrated it in Harbor where we had eight manufacturers who built the equipment. And it's a simple technology using Wi-Fi that allows the cars to talk to each other, and gives the operator a greater chance of avoiding collisions. And we think that technology alone has the potential to eliminate 80 percent of the unimpaired collisions.

MR. GAYER: 80 percent, say it again.

MR. LEONARD: 80 percent of the unimpaired collusions, not all collusions are from unimpaired drivers though; 30 to 40 percent are impaired drivers. Now, I do think there's a space where self-driving vehicles may be able to help more with those impaired vehicles, getting people who may be inebriated out from behind the driver wheel and into the back seat in a self-driving car is going to be a safer scenario than having somebody drive in a condition that they (inaudible).

You also mentioned people, for example, who are -- how many blind people there are, how many people might be able to gain access. I think that that's an area where the self-driving capabilities are really going to increase the number of miles that are driven. I did some very quick back-of-the-envelope calculations about the number of people collecting social security disability benefits, who said the transportation is their single obstacle to whether or not they can get a job.

SPEAKER: Sure.

MR. LEONARD: And there's probably $300 million a year spent in benefits to that population, so if self-driving becomes an option for those people, and won't necessarily for the whole group of them, but there's a group of people who can go from receiving benefits to earning income and paying taxes. And so those kinds of mobility benefits for people who would like to work but transportation is the barrier, is a great benefit. But, you know, at Joint Program Office, we are working on these connected vehicles which we see evolving and being a critical component of autonomy, or of automated vehicles. We don't really think of them as autonomous because of taking

the technology to scale.

If you want to see the safety benefits, if you want to see the mobility benefits that can come from through self-driving technologies, you are going to have that collision-avoidance technology which comes from low wait-and-see communications, and other communications as well. And then we really wouldn't have time to get into the whole smart cities concept and some of that, but we are also some work in connected and autonomous vehicles, so when we put out at Columbus, so --

MR. GAYER: And just one -- I'm going to make one suggestion, so forgive me. So, we've seen over decades a pretty steady decline in traffic accidents and traffic fatalities per mile driven. I think in the last few years we've seen an uptick, this gets back to being the father of an adolescent, of that uptick I think it's due to texting, which is something I (inaudible), incessant texting.

Everything you just talked about now, induced demand, lots of benefits for people who are impeded now because they don't have access to transportation, presumably a lot more driving going on. With the technology, whenever it comes to fruition, do you see that trend, that long-term trend staying, not going down, meaning it's safer to be on the road 20 years from now, than it is now?

MR. LEONARD: I think that's one of the things that we have to pay particularly attention to. Not just in government but an industry that's developing the technologies and the cars. If you look at what the fatality rates were on America's highways 40 years ago, if we had that same fatality rate, we would be losing 150,000 people a year on American roadways. Right now that number has -- it has gone up about almost 10 percent to 35,000, and we were on a 10-year decline. There are a number of factors, distraction, in particular, but also pedestrian, and I think some of this has distracted pedestrians. So I think that's an issue we are going to have to deal with.

I think technology helps us bring about the kind of safety benefits. I think it would be tragic if we introduce automated vehicles and don't use that as an opportunity

to bring down the fatality rates at the same time, while making sure that we increase the mobility options for people. I think we can do both, if we are thoughtful in how we introduce the technology.

MR. GAYER: We have time for questions from the crowd. So, if you have a question I ask that you, first of all, raise your hand, wait for the microphone, state who you are, and make it a question, a nice, short concise question. Start right there.

MR. MANZOLILLO: Yes. John Manzolillo from the CEP Group. And this is an open question to the panel. Have any of you looked at specifically the area of autonomous vehicles in the logistics sector?

MR. GAYER: The logistics sector?

SPEAKER: Trucking, he means trucking?

MR. LEONARD: Well, we know that there's a lot of work ongoing. Many of you may have seen the auto truck demonstration recently, where they did an automated vehicle making a delivery. The technology, I think there's tremendous potential benefits in that sector for autonomy, and particularly if you can shift some freight and logistics deliveries to nighttime, which would be easier to do with automation. It also potentially addresses driver shortage issues.

But I do think eventually we do have to deal with some of the disruptive aspects in the labor markets, I mean, we have to deal with them as a society one way or another, whether it's a government activity, or whether we just recognize that that's part of what happens out of technology change. But I think logistics and freight in particular is a tremendous opportunity for self-driving.

MR. GAYER: And presumably that's where you would, I guess see this technology in the earlier stages, right. Dedicated lanes, trucks on highways seem a lot easier technologically than, you know, lots of individual cars on the road, in the middle of the city.

MR. LEONARD: It's always a debate as to which sector is going to --

MR. GAYER: I think the economics favor the commercial sector.

SPEAKER: Thank you very much. I'm June O'Connor. And I'd like to -- the focus is often on large cities, but I want to ask you all, particularly Emily and Bob, about studying the impact of driverless cars and the shared economy in places like Bend, Oregon, or Florence, Oregon, not Portland. Marinette, Menomineee in Michigan, Green Bay area of Wisconsin, all are places in which, if you cannot drive a car, you are hosed, because taxi cabs cost more there than here. And so, I guess I'm saying, what about the non-big cities? How do you see Uber and shared vehicles playing out in those places?

MR. GAYER: Emily, do you want to start?

MS. KOLINSKI MORRIS: Sure. I'd be happy to take a start at that. I think, first of all, from our perspective, you know, we serve a wide spectrum of customers, and so it's very important for us to think about the transportation network, not just in an urban context. That said, I think when you look at the business case for a service provider, as well as the use-case for customers in less-densely populated areas, you know, those calculations look very different. So, you might be able to have a ride-sharing service either with or without a driver, but you would have to have customers that were willing to tolerate, for example, a longer wait time, you know, for that ride to come and get them.

If your alternative is having your own car parked in the driveway; that may not be tolerable; if your alternative is that you are not able to drive, and you don't otherwise have access to transportation then that might be a perfectly attractive alternative. So, I think there are lots of applications for all the technologies we are talking about, not just autonomous vehicles, that will affect, you know, non-urban areas, but that model, you know, will look a little bit different than the one that we typically hear talked about.

MR. GAYER: And Bob, remind us. When you looked at four cities, I guess the question is, Uber is in smaller markets as well. You could replicate the results

for smaller markets as well?

MR. HAHN: Yes. So you could replicate it, but I think the point you make is a good one, that these technologies lend themselves to scale economies, however, there are scale economies associated with these technologies, so it's going to take longer to get -- I could use Bend, Oregon, and to Emily's point, it may not be at quite the same level of (inaudible) --

MR. GAYER: Bob, I don't know if you know the answer to this, it's a question I have on the surge pricing. So, one could design a surge pricing algorithm such that I never have to wait more than X minutes for a vehicle, right, because if it's, let's say, 5 minutes. Because if it's 10 minutes they could just up the surge and bring on supply and bring down quantity demanded, and I guess it doesn't -- and maybe this gets into kind of equity efficiency tradeoffs, or perceptional issues; it doesn't quite seem that that's how it's designed. Do you have any insights of that?

MR. HAHN: I don't know the details of the surge pricing algorithm, but just from -- and there may be people here from ride-sharing platforms who can shed some light on that. But in talking to people and asking them about wait times, because this was a part of our paper, they do try to develop the algorithm with a certain expected wait time.

MR. GAYER: I see. I see. Okay. Right here, in the middle row, about four or five back?

SPEAKER: Hi, everybody. Thanks for your talk. My name is Truman. Just interested in what you are talking about. I have a question about making transportation policy and infrastructure projects for the short and middle term. I'm making a couple assumptions, one that we don't know exactly how long it will be between now and when we have a world in which 50 percent of cars are driverless. And two, that will need to make different policies for a world in which 50 percent of cars are driverless and have different kinds of infrastructure projects.

So, I'm just wondering in the short term, since there's a lot of talk about infrastructure spending especially with the new administration, how do we think about gearing that policy towards -- or like interest now, in the middle and long term?

MR. GAYER: I think, well Cliff already started congestion pricing. But, Cliff, do you have any other thoughts.

MR. WINSTON: Well, again, there's the normative and the positive, that is what we ought to do and what is. I mean, again, just to reinforce what I was talking about, you know, I've pretty much written that off as serious, you know, constructive conversation that government really is going to think seriously about constructive policies, and the track record is clear, the status quo bias is understood.

And I think, you know, we could talk about congestion pricing, we can talk about X weight pricing for trucks. We can talk about improving the efficiency of highway design. We could look about, you know, how can we reduce production costs and building things, transit? You know, all these sorts of inefficiencies there that we can talk about. Maybe we should get rid of weight-based landing fees at airports, so private planes would pay nothing, you know, coming in, you know, forget it.

I mean, there's a huge list of things. And, again, you're probably too young, but there's a New Yorker cartoon, and you see somebody saying things like this, pricing, production, whatever, and there's a dog, and it's what you say, and what the dog hears. And so you say all these things and all the dog hears is, ruff-ruff-ruff. And, you know, we've been saying this forever. You know, what should be done, even short term or medium term and, you know, you have to look at the observed responses. You know, we have ways of doing things, and that’s how we are going to continue to do them.

MR. GAYER: Go ahead.

MS. KOLINSKI MORRIS: I think something that would be really helpful in that context and, you know, you guys have made great progress on this, is to have a unified national framework, when we think about how these vehicles are going to be

rolled out and used. And that will, you know, give everyone sort of, you know, an understanding of where they are starting from and where they are trying to get to. I think that's probably a really good first step to the issues that you're talking about.

MR. GAYER: Ken --

MR. LEONARD: And specifically the National Highway Traffic Safety Administration just put out a policy document on automated vehicles, and soliciting public comment on it. And I think it's just the start of -- we want to encourage the technology, but at the same time we want to make sure that it's rolled out safely, but we don't want to stifle innovation in the field.

MR. GAYER: Bob, did you have a comment?

MR. HAHN: So, I have a slightly different take on this than Cliff does. I think ideas do matter, you know, and yes, it sometimes feeling like we are talking to the talking to the dog, and then we are going ruff-ruff-ruff. But, you know, if you look at a place like San Francisco, for example, now versus 30 years ago, where just -- my sense is the congestion is a lot worse, they don't have a lot of room to build more roads. I think they are going to be thinking about things like congestion pricing at some point. Can I say when? I have no idea, but I think they will think about it.

MR. GAYER: Okay; one unscientific exit question for everybody. I talked about my adolescent son just starting. I have a 5-year-old, is he going to learn how to drive a car? What do you think? Bob, go ahead. Give me an answer.

MR. HAHN: Sorry Ted, it's not my (crosstalk) --

MR. GAYER: You don't have -- no answer? Do you think he'll be driving a car?

MR. WINSTON: Five, oh, yeah -- No. No, no, I mean I defer to the industry, but everyone but everyone who I've heard talk about this in the private sector is saying, you know, this is going to be sooner rather than later, and it's also encouraging --

MR. GAYER: And he lives in the city, you know, 10 minutes from the

school.

MR. WINSTON: -- you know, encouraging all the things that you see. Now every other day, there's a new development, and we now hear Apple is expressing interest in autonomous cars, I don't know how excited Ford is to having Apple join in. I mean, I think the rate of knowledge and, you know, all the resources going in from this huge sector into this, suggest that we are going to see this sooner rather than later.

MR. GAYER: Emily?

MS. KOLINSKI MORRIS: Again, I think it does depend a lot where he decides to settle --

MR. GAYER: Yes.

MS. KOLINSKI MORRIS: -- where his first job may be, but the --

MR. GAYER: You mean, not in my basement? (Laughter) We can all agree on that.

MS. KOLINSKI MORRIS: Very sharp reasoning there. You know, we've talked about 2030 under what we would consider a sort of a moderate adoption scenario for autonomous vehicles, and in that scenario we've talked about up to 10 percent of miles traveled, up to 20 percent of vehicle sales being autonomous, so I mean there is still a lot of people, who may or may not be your son, but a lot of people who will still need to know how to drive a car.

MR. GAYER: All right.

MR. LEONARD: And I would agree. I think you probably will learn to drive a car but certainly not necessarily at the age of 16 or 17 living in the city, it maybe when he goes to school, or finds himself in a situation (inaudible) because he's living in (inaudible).

MR. GAYER: Okay. And with that, please join me in thanking the panel; thank you, everybody. (Applause)

(Keynote Speech)

MR. GAYER: Okay. And now to the next session on this event; and I want to introduce our Keynote Speaker, Representative Blumenauer. He is of Oregon, has focused on Innovate Transportation Policy, which is why we are especially glad that that he's with us today. After his election to Congress in 1996, he served on the Transportation and Infrastructure Committee for 10 years before moving to Ways and Means to focus on transportation funding.

He has introduced legislation to increase the federal tax, gas tax for the first time in 23 years, and he helped pass a bill to fund state pilot projects that city replaced in the gas tax with the mileage-based user fee, that congestion tax that Cliff was referring to. This was building on demonstrations in Oregon and California. He has helped passed the most recent five years Surface Transportation Bill that provides modest funding increases for transportation projects.

He is also the Co-Chair of the Intelligent Transportation System Caucus, and is making sure -- to make sure that Congress encourages emerging smart mobility technologies as a way to create livable and equitable communities. He wrote a recent piece in Wired Magazine, which I recommend to all of you, on the role of self-driving cars to help America's infrastructure.

We look forward to a -- pardon me -- I just want to thank him again for agreeing to share his thoughts today. And remind everyone that my colleague, Amy Liu, will be interviewing him and taking questions from all of you after his talk. So, please join me in welcoming Congressman Blumenauer. (Applause)

MR. BLUMENAUER: Thanks, Ted. Well I think your son may get a driver's license, but it will be a choice not an imperative, either socially --

MR. GAYER: (Crosstalk) or his choice?

MR. BLUMENAUER: His choice. I deeply appreciate the opportunity to have this conversation, appreciate Brookings, again, being on the cutting edge of time, pieces together, and I find that little subjects that I get involved with you folks on have a

tendency to metastasize. We were here debating, whether -- actually in this room -- whether or not marijuana should continue to be a schedule 1 controlled substance.

And it morphed into Black Lives Matter, health care in the new economy, justice reform. And, likewise, I think this conversation today has many profound aspects that tie together things that we've been working with you at Brookings on for years; in terms of metropolitan policy, in terms of transportation and infrastructure, economic activities. What I'd like to do if I could, just before kind of launching into what I think the federal government's role should be, I'd like to just set the context in terms of what I think is happening out there.

Because I do believe that the change that has been talked about is going to be profound and is going to happen much more rapidly than others think that it will. But at the same time, we are still going to be dependent on much of what the existing transportation infrastructure is. And it is currently inadequate and falling apart. So we are going to have to be on a dual track, but I think the good news is, we have a chance to do that. Part of what is driving this, goes beyond just simply congestion. People are awakening to the fact that we've got 250 million cars that are used 3, 4, 5, 6 percent of the time, it's an average cost that is approaching $10,000 a year per car.

We have somewhere between 500 and 700 million parking spaces. I find that interesting there really isn't a good census on the number of parking spaces. We are having challenges in communities that are attractive, that are drawing millennials who are well educated. That’s a problem in Portland, and Seattle. I mean, they are driving up housing cost although it's a problem that is better than the problems of decay, but nonetheless it is -- the realization from these people that there are more things involved.

A critically expensive part of the housing crisis is the policies regarding parking. And that’s 2-, $300 a month per apartment. It's 40- or $50,000 for a condo, something like 20 percent of our houses in 2015 had three or more car garages, that’s

big money, and it distorts the market. We are looking at what I think is a more profound political crisis. I forget who had said that he didn't think anybody is going to lose their job over a few positions, driving or not.

Boy, that's not my message from this last campaign. There are 12 million people, probably more whose livelihood depends on the manufacture, design, sales, care and feeding of the automobile, operating automobiles, 12 million. And probably the largest source of employment for men with less than a college degree, is driving those vehicles. And that's going to be profoundly changed.

So looking at the big picture here, in terms of the volume of change that's involved; and Emily, I spend enough time in Detroit to know that it's hard to imagine living there without your own individual car, but that's in part because Detroit is probably the best example of a city that as destroyed by the automobile. Indiscriminate planning and design, that you don't have a decent mass transit system, and voters turned -- I mean, you look at an area that is designed to fail, to add those extra costs, to compromise the urban environment, and I would suggest that Detroit is Exhibit A.

Although it's fun for me to watch what's going on there in Detroit, they are building a street car, there was an effort to have a transit system, there will be urban revitalization. And if we are able to have autonomous vehicles and more application of Uber and Lyft type technology it will free people from the cost, the burdens and the problems of individual automobile ownership. And in fact, you may be able to skip some of the transit or fixed route solutions, and go to something that is more decentralized and works better.

Kids today no longer are obsessed with a driver's license. It was a rite of passage for some of us boomer -- You know, we camped out at the DMV the night before we turned 16. Now, 16-year-olds are less -- are half as likely to have a license, and that they are more interested in access and experiences that being tethered to the ownership of a vehicle. They have better choices.

Well, I think the way that the automobile destroyed metropolitan Detroit while it enriched it, I think we are on the verge of looking at ways to revitalize and reshape American communities that all, to a significant extent, were defined by the automobile century. But now there are other choices and opportunities. And I think it going to affect where we live, move, work, the nature of the communities, the economy. It's not just in terms of the congestion issue and the -- it's all of these pieces put together.

We've got a chance to reorder priorities in the communities, we can be more purposeful in dealing with the transportation network and how it fits together, unlike the automobile age, where we just sort of backed into it. There isn't any comprehensive effort to think about the pieces fit together, it was a series of incremental decisions that were easy at the time, driven by the love affair for the automobile, driven by the convenience, driven by the economic engine that it created.

We've got a chance now to be more purposeful about it. And I would suggest, we have to be more purposeful about it, because if we don't do this right, there will be all sorts of unintended consequences, in terms of having -- remember I said, we had to maintain both these systems, well, if we don't do this right, we won't be able to maintain both those systems and pay for it. One of the things that we've not talked about to this point, is how the bottom is about to fall out of the transportation funding system.

Now, as was referenced, I've been trying for 20 years to raise the flipping gas tax. Something I will say, that it's interesting that eight red Republican states were able to do this calendar year, but I can never persuade our legislative leadership or the President to embrace. We'd be a lot better off if we had done some of that.

But now, it's no longer optional, because the 40 percent of the purchasing power of the Highway Trust Fund, that has been lost due to change in driving patterns and to inflation is about to tank, because these autonomous vehicles will be electric, they are not going to be diesel or internal combustion engine. And they will use far less energy and people will pay no gas tax. These autonomous vehicles are safer,

and put aside for the moment that we are going to save 10, 20, 30,000 lives a year, and hundreds of thousands of injuries, or more, but we are not going to be having as many speeding fines, we are not going to be having as many parking fees, and they are not going to be paying fuel taxes.

That's how we finance the system, and you look at how hard it has been at the federal level to fool around with trying to patch an inadequate transportation bill, it's going to get a lot worse a lot faster. That's going to force a reevaluation. The dozens of companies that are working on this now are in a race to be able to perfect this stuff.

And the last couple of years that I had been visiting with people in various companies, technology, looking at manufacturing trucks, boy, I am stunned at the revolutionary pace that is taking place, and what the incremental improvements are possible. Daimler trucks are headquartered -- their American subsidiary -- headquartered in my district. Talking to the CEO last week, talking about how it's going to be possible, very soon, to be able to have trucks travel in tandem with only one, sort of, at the wheel.

This is stuff that can happen in a matter of months. The question I guess that I want to address is: How we are going to deal with this in a policy perspective? Are we going to be able to welcome, guide and manage the transition? Or, whether it's going to be driven offshore, I mean, I think Ford is testing in London now, autonomous vehicles. Do I have that right?

SPEAKER: -- as well.

MR. BLUMENAUER: But this is not something that's -- There was a convoy of Volvo trucks going across Germany this spring, it's not just Otto, O-T-T-O, delivering beer in Colorado. I looked at what happened with our inability to really manage the transition with drone technology, and the FAA deals with 300,000 airplanes. How do you land this jumbo jet safely? Now they are tasked with dealing with drones, which is basically a smart phone that flies. (Laughter)

And we are looking -- they're dealing with 300,000 planes, add they are

going to be looking at almost 3 million drones, if not more, that are registered, and I don't know how many rogue drones will be out there. You know, or 1,000 bucks you can order one from China, get it delivered by Amazon, not yet by a drone. We don't want to be in a situation where it just passed us by.

I also think that it is important to utilize this transition to be able to deal with the financing at the same time we deal with congestion pricing. There is a relatively small step between having a road user charge that is uniform and that is collected automatically for using your vehicle, Oregon has been testing this for the last 11 years, it's appropriate that the state that gave you the first gas tax dedicated to highway construction in 1919 at this century mark will be able, I think, to be having a large-scale application of a road user charge. But it's going on in other states, and in the fast act we have four years of additional pilot projects.

There are eight that are underway right now, financed by the federal government. This needs to employ, I think, sooner rather than later, congestion pricing. And it can be function -- it can be designed in a way that everybody benefits. Right now congestion is the largest driver of cost in our transportation system, that's where we throw most of our highways dollars, is trying to deal with congestion.

Being able to have a modest price for congestion will enable us to be able to incent consumer behavior so that they can save money if they all don't have to be going across the Bay Bridge at 8:30 on a weekday morning. It's something that can be embraced by liberals and conservatives alike, and it is something that works, as we see around the globe. But at the same time, by pricing congestion, we can also reorder what the charges are for other people in the system.

I hear repeatedly from friends of mine. Well, this doesn't work in Montana because we drive a lot. Well, if we are going to continue to have a system that is based on gallons of fuel consumed, people in Montana are going to get screwed, they tend to use more gasoline than my gas-sipping Prius drivers in Portlandia, who don't

drive as much, and actually don't even need a car. There can be an adjustment for the rate nationally, for people who are not suffering from massive congestion.

There could be a lower rate in rural and small town America, higher rate where the congestion really is, and we can have the revenues that are necessary to be able to get into the new system and to be able to rebuild and renew what we've got. And I've got to stop, because I'm going to rattle on. We might get at some of this in the questions.

But, basically my agenda for Congress is to guide and encourage what's largely happening in the States right now, and that there ought to be a lighter regulatory touch rather heavier. I think it is important for us to be able to help people have perspective notwithstanding the last campaign, I think the truth matters. I think it's important to try and help people evaluate risks and rewards. I find it mind-numbing that there was more attention paid to one death in a Tesla, than all the ink for the 10 percent increase in traffic fatalities, thousands of people.

People can't evaluate risk; we need to be able to help them understand what it is. It is critical that the federal government gets behind this revolution. Now you are aware of some of the DARPA tests on the autonomous vehicles, and how rapidly that improvement is taking place. Well, there's a reason that the military cares about autonomous vehicles. You know, it costs us $400 a gallon to deliver fuel in Iraq and Afghanistan, and the people driving those trucks might as well have a great, big bull's eye on their back.

An autonomous vehicle can have the same operational application advantage for the military as drones can have. But it goes beyond the military. Let's get the post office with -- I forget how many hundred thousand vehicles they have -- converted to electric and autonomous vehicles, and be able to be approving ground on certain routes that they were involved with. Let's have GSA contract with Uber or Lyft, in exchange for getting rid of a motor pool. Why have parking, inventory, maintenance, the

scheduling problems when there's the capacity to deal with private operations, that can provide the same service for less money, less capital investment and do so more efficiently. Let's start experimenting with that.

I think it is important that we focus on cyber security. Now, I don't know how many votes the Russians influenced in the last election, but I do know that there's the capacity right now for a sophisticated hacker to stop an automobile's engine, lock the doors, deploy the airbags. I mean, I was at a conference two years ago at Harvard, where a CEO of another unnamed large automobile manufacturer, basically described the product as big computers with wheels, there will be more inter relationships, more opportunities for mischief, more opportunities for problems, we are going to need all sorts of expansion of bandwidth, to be able to deal with the demands that this will bring about.

We have an opportunity to redirect now employment with some of the savings and the revenues that we are able to generate. I'm serious about thinking that many of these 12 million jobs will be at risk, and we need to be deploying our resources and our energy to be able to capture those folks and be able to move -- not capture -- help them redirect their energies for positions that will be involved with rebuilding and renewing the country.

Those are very labor intensive. If we are going to need a fraction of the parking spaces we have now, being able to redesign the streetscape, widen the sidewalks, be able to reclaim that massive amount of urban acreage for other purposes. How many municipal parking garages in the next 10 years will be unable to service their debt payments because of a drop in utilization, if we do this right?

There's a lot of opportunity to repurpose them for maybe affordable housing or congregate care for Geezer baby boomers. There is a really exciting possibility of reimagining what our communities are going to look like, giving people meaningful work to make these communities work better for individuals, have a better flow of transportation that is safer, and be able to have an equitable treatment for people

in rural and small-town America, not just for an autonomous vehicle that may be able to help them not be stranded if they can no longer afford to drive, or be able to drive.

But be able to balance out the equities. I think this is one of the most profound developments that we are going to be looking at for the next 20 years. It will challenge our ability to get policies right, but we have an opportunity to structure it with more carrots than sticks, to make sure that the vast majority of people benefit from this and that the public is able to see communities that work better, where people are healthier, safer and more economically secure.

I appreciate Brookings convening this conversation, and look forward to where Amy takes it. (Applause)

MS. LIU: (inaudible no mic) champion for cities that are livable, sustainable, equitable for more citizens, and you can see that vision and energy from him this morning. So we are really lucky to have you. Ted said at the -- in his moderating that he was a techno pessimist. I think of myself at this issue as an urban pragmatist, in the sense that a lot of these new technologies, particularly the experience between Uber and Lyft, and that really come through cities.

And a lot of the reforms and the regulatory frameworks that enabled these technologies and the experimentation that's going on, is happening city by city, state by state, negotiating, enabling this technology to be supported and allowed, so it's been disrupting the way we live, but certainly disrupting a lot of the legal frameworks in many communities, and so in many respects, I think that we are going to -- there's literally a rubber hits the road, and how this technology gets adopted and as you said, how we prepare for this in our communities.

And so I see a lot of what you are talking about, is how do we prepare for this new technology, and this new environment, but also probably anticipate enormous disruption and enormous amount of adjustment to what you call a dual system, of people who retain car ownership, retain that choice and privacy and convenience that it wants

with a lot of the other benefits of this new technology. And so I think it's going to be a really interesting time.

I wanted to use my questions to just explore more deeply some of the impacts of why sharing and autonomous vehicles on the impact on financing, which you talked about, the impact on other modes, which you raised, and go a little bit deeper on the implications on planning and the built environment. And then we'll open up the floor for many of you.

So, I think you are absolutely right that we are in a really urgent mode right now around how we pay for infrastructure, while we are bringing our new -- there's new time to incorporate this new technology into our built environment, we are also facing a public infrastructure system that is in severe state of disrepair. And we can't even finance the existing public infrastructure, let alone trying to modernize it and prepare for the new technologies. And ironically I think the new technologies are cannibalizing the very revenues that could support that public infrastructure.

And so you talked a lot about the Portland experiment, you talked a little bit about congestion pricing, but tell us more. How do we realistically support the need to modernize our public infrastructure system? And also prepare for this new technology with financing; do you see some reforms happening, city by city, state by state that we can learn from?

MR. BLUMENAUER: Well, certainly there's a great deal of activity at the local level. We had I think it was 37 initiatives that were approved at the ballot box in November, totaling about $200 billion. Local voters are willing to be supportive if they see that there are results in the offing that they understand and they are comfortable with it. I referenced eight Republican legislatures -- one of them was Democratic with a Republican Governor that raised the gas tax this year.

There is the capacity to do this, there's a willingness to do it if people feel comfortable about the results. And I mean, what I said, that I think we ought to make

sure that we share the benefits, and that we are able to make clear what it is that is actually happening. I think the key to this is to be able to have a more equitable and sustainable financing system and let people understand what the benefits will be for rural and small town America as well as the big cities that have some of the most serious congestion problems.

Rather than run away from congestion pricing, I think we ought to face it head on, because the alternative is going to be a complete collapse of the transportation infrastructure funding model. And I think it's time for maybe a little bit of courage. We have an administration that wants to spend -- incoming administration that wants to spend $1 trillion on infrastructure which is a good start, but congestion pricing does not have to be ideological, it is something that libertarian friends can -- friends who are economists, people who are pragmatist, I think by being honest and direct; and being able to tie it to these jobs for rebuilding and (inaudible) America, we could create several million family wage jobs in a matter of months if we were able to undertake this.

And there is a laundry list in every community, not just surface transportation, but water and sewer. There are opportunities to put people to work in tangible ways, and many of these projects can be self-financed if there is -- if we can give the people assurance that they are going to get the benefit of the investment.

MS. LIU: And let me talk about -- ask you about your vision of a multimodal system, I guess, with autonomous vehicles, because you've been a big champion of it, you've been -- I think you bike to work almost every day now, have been for many years, you are a big champion of transit. But I also see an era where, if driving becomes easier, more convenient, allows you -- it gives back your time, right, that all the incentives that once drove people to walk and bike and take a transit has been removed, because now I can get into a self-driving vehicle, I can get my work done, I can, you know, the tolerance for congestion is a little bit easier.

Do you see autonomous vehicle fitting with other modes? Or do you see

it over time, actually reducing demand for other forms of transportation?

MR. BLUMENAUER: Well, I made a reference that we sort of backed into the automobile century. We didn't really carefully think through the impact that -- what happened in Detroit in terms of all this massive highway construction tearing up neighborhoods, isolating people, and not giving choices for those who didn't want to drive, couldn't drive, couldn't afford to drive.

What I see happening is the autonomous vehicle fitting into a mixture of choices that will give people more choices. If somebody wants to drive to work every day, so be it, but they ought to pay for it. It should be subsidized by everybody -- I want to end socialism for the car, let me just say that. I think that what we are seeing with younger people, when they are given choices a lot of them, the majority still ultimately get their drivers' licenses, but they are much less enamored of owning their own car.

They know how to get access to CarShare or Car2Go, Uber, Lyft, they manipulate it into a -- in many instances -- a seamless system. They know how to get from point A to point B based on the experience they want and the cost. What I envision happening here is that we develop with a nationwide road user charge, we have a technological framework that can enable us with our smart phone to drive if we want and pay tolls, to pay for parking, find out where the closest parking space is; to hop on Metro or Bike Share, or M-Track, so that we'll be giving people more choices.

I think there will always be some who will, you know, you'll have to pry their fingers, their cold-dead fingers off the steering wheel. But a lot of people are making choices right now to have fewer cars, or no car, for what's right for them. And in a country that's going to have another 100 million people by mid-century, being able to refine those choices, make them easy transparent and be able to even out the cost in subsidies, I think is going to go a long way towards empowering people to do what's right for them. And if they want to drive so be it, but I think everybody ought to have choices, and the funding ought to be equitable.

MS. LIU: Do you know what's interesting, I always think about how, you know, folks talk about young folks prefer to live in the city, they might prefer to user Uber, but everyone goes through a lifecycle, and the moment that young person has a child, has two strollers, has all the bags, and you start to take your family trips, you know, intercity travel. If we think about Uber as really short trips, but intercity travels, to see your in-laws, people don't what that moving storage as you talked about. So I do think that having a system that's going to realistically support, you know, all these different lifestyle, the phases --

MR. BLUMENAUER: But I honestly think we are reaching a point where we may be able to have a more robust, reasonable set of challenges. I recently took my two grandsons, one just 4, one almost 4, we flew to Seattle, a short little trip, and they had the window seats, and it was quite exciting. And then we took Light Rail to Seattle Center, we took Monorail to the Space Needle. I would have liked to have been able to do that on M-Track.

I am hopeful that America gets to the point where we have a range of choices like most other civilized countries have, and then people can choose what makes more sense for them. If they want to be trapped in the car with two 4-year-olds, or they want them to walk the aisles or, you know, let's give people reasonable choices that actually enhance quality of life and economic opportunities.

MS. LIU: Let's talk about the built environment and then I'm going to open up to the audience. You've used the word, let's be more intentional. Tell me what it means to be more intentional about how to plan, physically plan or communities to incorporate now more self-driving technologies. What do we see in the future in the built environment?

MR. BLUMENAUER: Well, I think we are looking at a revolution in thinking about how we use urban space. Detroit is an example in terms of what's happening there. I would think that what we need to do for autonomous vehicles is the

same thing we ought to do for people. We ought to minimize, where we can, hard infrastructure. We ought to be able to have multiple benefits of it. You see, I think there are other reasons that people want to walk or bike than just necessity. It is a much healthier alternative to be able to stroll to make that purchase.

It's a social interaction. The exercise of cycling, watching the community at 15 kilometers an hour. I think when we are going to make sure that we take advantage of the reduced demand for parking which I think will be revolutionary, that we are able to soften the landscape, we can make greener cities. It helps us deal with heat islands, it helps us deal with storm water runoff, we tend to get more rain when we don't want it, it's not there when we do.

But be able to take an urban environment that is more pleasant, that is more functional, that is more sustainable, that will enable autonomous vehicles to be able, along with the platforms for things like Uber and Lyft, that they'll have a place that works for them, but it is not dominated, as it is today in too many cities, by single-occupant vehicles, that have to be tended, parked, and accommodated on an ongoing basis, at great expense and damage to the environment.

MS. LIU: You know there's -- on this point, there are articles that are saying that autonomous vehicles will enable sprawl, that it will enable folks to now live further distances, and not again incur cost of the long commuting before. What's your thought on that?

MR. BLUMENAUER: But that's why, Amy, that this should be intentional. Every region should have thoughtful land use planning. We ought to be able to have the housing types that people want, that's well designed, convenient, and affordable, that we protect farm and forest land. There are other values at work here, and maybe I'm biased. I come from a state where every square inch is zoned planned and mapped. But we've been able to protect farm land, we've been able to maintain urban growth boundaries, we've been able revitalize inner urban neighborhoods, and

people can still raise families, and make a living.

I think when we would look at what's going in places like Houston now, that are rediscovering some of these principles, I think we are going to see more people moving towards thoughtful planning, rather than just mindless sprawl, problems with utility cost, water availability, and extending roadways.

MS. LIU: And so what you are saying is with AV, their technology there, it doesn't remove the values that we've been all talking about for a long in our communities?

MR. BLUMENAUER: It will enable more people to benefit from them I think.

MS. LIU: Yeah. That's great. I think we have time for one question.

MR. BLUMENAUER: I'm sorry.

MS. LIU: That's all right. But a nice hand up, right there in the back, can you introduce yourself?

MR. KENTON: Hi. My name is Malcolm Kenton. I'm a freelance writer. So, there's -- many who say that, you know, the driverless cars are imminent, like within the next 10 years there will be widespread adoption, particularly in metro areas. And there are some who would say it's maybe 30, 40 years, if they even become, you know, widespread adopted. So, how should policymakers and others interested in this, what sort of timeframe should we be operating under given the wide disagreements amongst people who are -- concerning the subject on how imminent the adoption is?

MR. BLUMENAUER: Well, the best way to resolve it is by letting people try it. And I think we ought to be encouraging experiments. Maybe if Las Vegas wants to take a large section of the Strip, dedicate it to low speed, autonomous vehicles, let them go. What's going in Pittsburg or San Francisco, other communities can and should be encouraged to find applications that make sense.

I personally believe you're going to see much more rapid adaption. I

think there's going to be changes like I mentioned in terms of the tracking industry, just like we are seeing dealing with personal vehicles, cabs that are going to accelerate quickly if we allow it. I think we need to be careful about the terms under which it is conducted. I think we need to be mindful about how people are treated, who work in this environment both in terms of those who will drive, or those who are competing with things like Uber and Lyft.

But I think these are issues that we can reconcile, and that we can work through, and some cities are doing this now with some of the organizations like Lyft and Uber. But let's allow this to happen. Let's have some rural experiments to find out how we can change he lives of people who are trapped if they don't have -- if they can't drive a vehicle, but who may want to stay in Lander, Wyoming, and still get to the doctor, or the post office.

I think the more we encourage with a gentle regulatory hand, and be mindful of cost and consequences, I think the better off we will be, and I think the spirit in Washington, D.C., over the next couple years, should be something that will encourage these thousand flowers to blossom, so that we can learn from that experience and then we can do the minimum that we need for safety, security and for the financing mechanism.

MS. LIU: I'm going to take my moderator prerogative and ask you one question, final question, give you 30 seconds to answer, which is: What is your estimation about a major infrastructure bill happening in the next Congress and the new Trump administration? Will it be in the first 100 days?

MR. BLUMENAUER: I don't think there will be a major infrastructure bill. I think there is a chance to do some major infrastructure finance, but there, as you know, are fiercely differing opinions about exactly who benefits, and how much of it should be real money for real projects. As opposed to simply tax credits for some projects that may already -- being built. If we can resolve that, I think the odds are very good, but I think

that trends that we've discussed here this morning make it very likely that the next reauthorization in five years is fundamentally different and very exciting.

MS. LIU: That is great. Please join me in thanking, Congressman Blumenauer for joining us this afternoon. (Applause) And thank you for spending this morning with us. Have a great day.

MR. BLUMENAUER: Thanks Amy.

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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.

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