THE BROOKINGS INSTITUTION

FALK AUDITORIUM

STRENGTHENING US SEMICONDUCTOR SUPPLY CHAIN RESILIENCE

Washington, D.C.

Friday, September 22, 2023

UNCORRECTED TRANSCRIPT

PANEL DISCUSSION:

JASON HSU
Edward Mason Fellow
Harvard Kennedy School

CHRIS MESEROLE
Fellow and Director, Artificial Intelligence and Emerging Technology Initiative
The Brookings Institution

MELANIE W. SISSON
Fellow, Strobe Talbott Center for Security, Strategy, and Technology
The Brookings Institution

ANDREW YEO
SK-Korea Foundation Chair in Korea Studies
The Brookings Institution

MODERATOR: RYAN HASS
Chen-Fu and Cecilia Yen Koo Chair in Taiwan Studies, Senior Fellow and Director, John L. Thornton China Center, The Brookings Institution

* * * * *

HASS: Good morning, everyone. Thank you for joining us on this beautiful Friday here in Washington. And thank you to our audience from around the world who's joining us online. We're here today to explore semiconductor supply chain resilience: how it's working, what's working, what isn't working, does the United States have the right tools in place to reach its goals? We plan to examine this question holistically, looking at it from a military national security perspective, a regional perspective, a technology perspective, as well as a Taiwan angle, given Taiwan's role as sort of the epicenter of semiconductor production today. To help inform our discussion, we have a tremendous group of experts. Joining us, Melanie Sisson is a fellow in the Talbott Center here at Brookings, and she's an expert on U.S. national security strategy, as well as the military applications of emerging technology. Andrew Yeo is the SK-Korea Foundation chair at Brookings, who is an expert both on developments on the Korean Peninsula, but as well as regional affairs in Asia. Chris Meserole is the director of the Brookings Artificial Intelligence and Emerging Technology Initiative. And Jason Hsu is-- has joined us from Boston today. He flew down for today's event. He is at the Harvard Kennedy School, but he is also a former Taiwan legislator, as well as a technology entrepreneur himself.

Today's event is live. It's on the record. I'm going to begin by asking our experts a few questions. And then after that, we will turn the floor over to you to help guide and direct the discussion. But just to get us started, I'd like to ask all four of you in a couple of sentences, how would you describe the United States' strategy for fostering greater semiconductor supply chain resilience? Maybe we can start with Melanie and work our way down.

SISSON: Sure, sounds good. Thank you, Ryan, for inviting me here to think out loud with this really excellent group of thinkers. I do want to point out that one of these gentlemen arrived today without a necktie on. I won't reveal which one, but I had a moment of being, you know, having the pleasure of not bowing to pressure myself and refraining from adding to what I was wearing. So, the morning started off well for me. So, Ryan, you also asked a question that I think gets really to the substance and sort of cuts to the arteries of the thing. And so, I'll try to respond in kind. I think that there-- when we think about the goals of the U.S. strategy, there's two levels at which we will we'll need to look at it. And the first is at the operational level where I see four goals. And those really have to do with the factors of production. I am not going to go into great deal of great detail about those things because nobody needs a political scientist who studies strategy to talk about the economics of production in the semiconductor industry. But even at my level, I can see, I think four identifiable

goals. And the first is to decrease the startup costs for the industry here in the United States. The second is to increase the pool of available human talent and to increase also the interest of that talent working in the industry. The third is to extend, expand, and diversify the sourcing networks for the materials and inputs that the industry needs to manufacture. And then the fourth goal is really to do all of these things in a way that creates a virtuous cycle and a path into the future. And it does all of those things, I think, for two general strategic ends. The first one is to minimize, to the greatest extent possible, China's footprint in the semiconductor supply chain, specifically to the United States, but beyond that as well. And then the second strategic goal is really, I think, oriented around establishing the United States as the technology leader of the future.

HASS: Thank you. Andrew, how do you see it?

YEO: Well, thanks for having me here, Ryan. And good morning to everyone. Melanie, I thought you were going to steal my answer. You said that you were going to look at this at two levels. I also look at it two levels, but really at the domestic and global level in terms of the U.S. strategy on semiconductors. So, on the domestic front, we want to build the U.S. production and innovation capabilities. And on-- and globally then, it means also working with allies and partners to decrease vulnerabilities in the global supply chain.

HASS: Chris.

MESEROLE: Yeah. I mean, I would echo everything that's already been said. I think there's-- one kind of major goal is to reduce the dependency of the U.S. and our allies in North America and Europe on semiconductor fabrication plants within East Asia. Specifically, I want to-- I want to emphasize it's reduce. It's not eliminate that dependency at all, it's just reduce the dependency. The flip side of that is to make sure that we domestically have at least, you know, a critical mass of experts and engineers who can create a semiconductor-- vibrant semiconductor ecosystem within the United States. The goal is not to supplant what's happening everywhere else around the world, it's just to make sure that we have at least some domestic capacity to produce high-end chips.

HASS: Jason.

HSU: Yeah. Thank you, Ryan. It's great to be here. I think from Taiwan's perspective, the entire semiconductor should be viewed as an ecosystem. And obviously, when U.S. attempts to onboard the semiconductors from Taiwan, U.S. is thinking about foundries only as the-- what the CHIPS Act is addressing. I feel that's sort of a missing important piece, which is the entire ecosystem.

And I'm very pleased to see that U.S. government is now addressing these issues by increasing more policy measures to bring in a more ecosystem approach to this idea. We have to think about Taiwan's semiconductor has been a result of 40 years of ecosystem building. So, it's not a overnight success. So, I hope that if U.S. can continue what it does with CHIPS Act and other measures in terms of policy, both soft power policy and as well as other resources that have been planted for the semiconductor industry. I would like to see a second or third edition of the CHIPS Act to be continued, and that can incorporate the ecosystem approach that Taiwan has been building for years and also develop a talent exchange and then technology development exchange that builds a stronger and deeper alliance between U.S. and Taiwan.

HASS: Well, Jason, thank you for talking about the particular complementarities between United States and Taiwan. I want to come back to that in a minute. But before we do, Melanie, fostering supply chain resilience in semiconductors is not cheap. It costs considerable sums of money. What is the national imperative for the United States to invest so significantly in this sector right now?

SISSON: Well, so when we hear the words national and security together, I think we, you know, certainly in the United States have a tendency to default to thinking about the Department of Defense implications and addressing military threats. And that's certainly part of the conversation here. So, I don't want to minimize that. But but in this case, we also have to consider very much how that kind of imperative is linked to the economics of the matter. And that we are increasingly thinking about national security, also in terms about economic fragility, economic threats, economic stability. And so, in the short term, the national security rationale for supply chain resilience, I think, focuses primarily on the idea that a disruption or cut off of access for the United States and for others, of course, to semiconductors would have really severe consequences for the economy. We experienced some of this in the COVID pandemic, where a naturally occurring exogenous shock disrupted the equilibrium of supply and demand. And among the things that we learned that we really don't like in the pandemic, one of those things that we learned is that we don't like the extent of dependence and vulnerability that we had on outflows of semiconductors from other places.

But of course, policymakers aren't worried just about naturally occurring shocks to the system. They're also worried about human-made shocks to the system and about those that can result from intentional government activities and actions. And so, in particular, the United States, here-- the

policymakers here are very worried about the kinds of actions the Chinese government might take, and those could include disrupting the supply of materials and inputs into the process or compromising their quality and their security. The most dramatic scenario that I'm sure most people are well aware of is the concern that one of the actions the Chinese government might choose to take is to threaten or to act forcibly against Taiwan, where I think the numbers now are — and these smart folks will correct me if I'm wrong — roughly 60% of the mature chips are produced and more than 90% of those really sophisticated high-end nodes are produced. And so, you know, disruption of the 60% would have an enormous economic reverberation in the United States and globally. And losing access to that 90% matters because those sophisticated chips are the ones that are involved in evolving and advancing artificial intelligence and the AI-enabled technologies that they can then be embedded in. And those are the ones that we all sort of have a sense, even if it's not in the specifics, that they're going to be really important, economically, in terms, you know, in every facet of our of our day-to-day lives. Productivity, the way we move, the way we take care of our health, all of those things. And there's also the idea that they will have potentially important military applications.

And so, in the short term, diversification would do two things. It would reduce the extent of vulnerability that's based just on geography if there were to be a natural disaster in a particular part of the world. It also decreases-- it would decrease the effect that the Chinese government could expect to have on U.S. policy by manipulating its its threats and coercion against the island of Taiwan. And I want to be really clear that there are many good reasons that the United States is attentive to China's behavior around Taiwan, and that's irrespective of semiconductors. What I would say is that removing semiconductors and vulnerability in the supply chain from that equation would remove one tool that China has to manipulate both parties and really keep the conversation where it should be, which is on the important substance and quality of the relationship between the United States and Taiwan.

So quickly, I'll just address the long-term national security concerns. And primarily it's that policymakers believe that the prosperity and security of the United States requires that we have technological advantage over China, and that's for purposes of economics. It's also for purposes of military superiority. And so, to do this, I think they believe that we need secure access to chips, not just today and tomorrow, but also after tomorrow and that we have to be the leaders in evolving technology beyond that. That we need to be the country that's making new discoveries and finding new applications and thereby getting steps and potentially even leaps ahead towards that. And I'd say

keep in mind that the CHIPS Act, which we may talk about further, devotes 50 to 53 billion to building fabs and 200 billion dollars to building knowledge. And we want to do that so that we can have military advantage. We want to do that so we can have a central role in the global economy, and also for demonstration power to demonstrate that democratic politics and liberal economics are a winning combination for human health, wealth, and well-being.

HASS: Thank you.

HSU: Yeah, I just want to comment on what Melanie said about the red line of the U.S. and China. It's not the chips, it's actually the Taiwan independence. If Taiwan pursue a de jure independence, that's the real red line. But chips, it's actually a strategic signal that will deter how China views the competitiveness of both U.S. and Taiwan. And the point I'm trying to make here is we need to ensure, especially from talking with our American friends, that TSMC's effort in Arizona is a successful endeavor. Right now, TSMC, after it announced its plant in Arizona, building two fabs, over 40 billion dollars in the next 3 to 5 years, has met with significant and substantial challenges in the labor shortage and other complex issues. And the delay of the plant is actually perceived as a weakening of U.S. efforts to empower the chips industry to the U.S. And that also make TSMC look a bit difficult when dealing with the Chinese government. So, we need to make sure that the signal that U.S. sends or the efforts to ensure the chips is met with full support to TSMC, and as well as the entire ecosystem can be built. Because as we speak now, China and Taiwan still has a very tight and interdependent semiconductor ecosystem. In the year 2021, our trade surplus with China is 130 billion trade surplus, and 90% of our trade items are semiconductor components. So, we need to ensure that the supply chain is resilient and also the onboarding and onshoring is successful. And this is-- this has a lot to do with how U.S. think about the semiconductor as a continuous process to build up its resilience and as well as the entire ecosystem. And I think this require a very thought-through policy ranging from the immigration policy, industrial policy, technological development, and etc.

HASS: So Chris, Melanie has spoken eloquently about the national [inaudible] imperative and also for our long-term economic competitiveness. Jason has noted that perhaps the project in Arizona hasn't gone as smoothly as some of its proponents would have hoped for. Can you help us sort of walk through where are we right now? What's working in America's efforts to strengthen supply chain resiliency for semiconductors in the United States? What isn't? What what issues do you see on the horizon that we are not yet attentive to but need to be focusing on?

MESEROLE: Yeah, I would say overall we were moving in the right direction, but we do have one, I think, glaring Achilles heel, which I'll come to. The first point I want to make though, is I want to really just distinguish between the design of high-end semiconductor manufacturing chips and the manufacture of those chips. That's the real-- and assembly of those chips. That's the real challenge that we have in the United States. It's not like-- our firms, you know, Intel, AMD, Nvidia, we are at the fore-- you know, in the United States, American firms, by and large, are at the forefront of designing these chips, just that we don't manufacture them here. Most of the manufacturing happens elsewhere and in particular in Taiwan, as Melanie and others have mentioned. What I want to say, though, on the manufacturing of chips side, is there's three kinds of buckets of chips that you should be thinking about when it comes to the resilience of the U.S. semiconductor ecosystem. There's military chips, right? So, chips that are going to go into the military and that serve direct national security needs. There's high-end or leading-edge kind of nodes. So, the advanced chips that would be in a new iPhone, for example, or the chips that NVIDIA uses to allow people to train sophisticated AI models, right? So, there's these leading-edge chips. And then, there's mature or lagging node chips. Those are the chips that end up in your microwave, and your cars, etc., that really kind of power the economy for the most part. And I think we get a different grade on each of those types of chips as far as how we're how we're moving forward.

I'll start with the military side. About about 20 years ago-- years ago or so, the U.S. realized that we needed to be able to manufacture some of our-- some of the chips that were going into our most sophisticated weapons systems directly here at home for a whole host of security reasons. They started what's called the Trusted Foundry program, and it's been a successful program in many ways. The problem is the scale and the need that the military has for sophisticated chips has vastly outstripped what can be produced domestically, just because the consolidation in the semiconductor industry, the expense required to launch a new fab at a leading-edge node, its just dramatically outpaced what the Trusted Foundries were able to do. Given that the military is only, maybe at most, 1% of demand for all semiconductors. So, the Trusted Foundry program, as of a couple of years ago, only supplied about 2% of the chips that were-- that the military was procuring.

What the CHIPS Act has enabled is-- you know, the Intel plant that's going to be built in Ohio, it's been publicly revealed, will be providing some chips for the military. That plant will operate at about a five-nanometer process. So, they'll be getting at-- they'll provide leading-edge capabilities for the military to produce kind of custom chips from the leading edge. That's not a capability that we currently have, right? If the United States right now, the DOD the Pentagon wants a chip that's that's at the leading edge of where semiconductor manufacturing is, we have to get it from primarily Taiwan, also South Korea. That's not, I think, one of the ways that we do that. The military often has kind of very custom needs for the kinds of circuits that they need to build. They produce things called field programable gate arrays or FPGAs. What happens is those get produced in Taiwan or South Korea, they then get shipped to the United States and they get programed in the United States. What the military wants to do is be able to actually just manufacture custom [inaudible] directly in the United States, and we should be able to do that going forward.

So, I think that the CHIPS Act is a success in terms of being able to increase the resiliency of the national security ecosystem-- ecosystem semiconductor needs for leading-edge nodes. Which is a good, you know, it's a good story. I think we're on the right trajectory there. The leading-edge nodes more broadly, this is where TSMC's work in Arizona is coming into play. That plant will primarily service iPhones, frankly. For us, it's beneficial to have the talent and the ecosystem that's going to be building out around the TSMC plant in the United States. I think it's a great first step. The challenge is, I think one thing that that plant has made clear, is that we do not currently have the talent we need or the ecosystem in place. We need to be competitive at the forefront of this technology. It's, you know, it's not a good sign that TSMC has to fly in a thousand of their leading engineers to Arizona because we aren't-- we aren't able to meet those needs ourselves. They've tried and it's not working, right? So, we need to redouble, I think, our efforts on the education side, on the procurement of talent, you know, to be able to get the kinds of people we need to both build the plant and then operate it once, once it's successful.

So that one, I would say it's kind of more of a middling grade where we're we're doing the right things. But without, you know, follow-on investments to really make sure that we have the talent base that we need, it's not going to be as successful as we want in the long run. We desperately need it. Just to underscore a point that was just made, we need that plant to succeed so that players like TSMC view it as economically viable to to mass-produce commercial chips in the United States. So

that that's kind of again, a middling story on leading-edge nodes. The Achilles heel, though, and where we haven't really improved our resilience, is mature nodes.

And I think if there was one-- there's two issues at play here. One is on the CHIPS Act itself. It did not incentivize the creation of mature node fabrication plant in the United States, Meaning if there's a crisis outside the United States-- and again, if there's a COVID-type crisis, we are going to be right back where we were where there was a huge, you know, used car sales went through the roof because new car manufacturing basically slowed to a halt because we couldn't get the chips that would go into those cars, right? We have not solved that problem domestically. I would also say we've actually exacerbated it, because one thing our export control regime has done by focusing on the technology recently, is it's actually incentivized China to double down on mature node fabrication processes within China and make them basically mass produce mature node chips so that they can flood the market and kind of create a glut on it, and create more dependence on China's market for immature node chips than there otherwise would be. So, we've kind of-- I think that's probably, you know, I mentioned an Achilles heel earlier. I think that you know, for the most part, our strategy has been working. But that's why, you know, if there's a concern or a major concern I have about the strategy so far, it's it's you know, ironically, it's at the lagging edge, kind of the less technically sophisticated chips where we have our biggest flaw.

HSU: Just, I would just add a little bit of what Chris been saying. I think the whole ecosystem approach, not just the foundry — and foundry is obviously what U.S. is focusing on— but you also have the design, which U.S. is excellent at. You know, you have Nvidia, AMD, and these are all great IC design firms, but then you also need packaging. Right now, the the weakest link we are seeing is for every chip made in Arizona. If we don't build out that ecosystem, it needs to be shipped back to Taiwan for testing and packaging. Now that this defeats the purpose of onshoring that the chips to the United States. And we also need to figure out-- the chips industry go through ups and downs, and they are downturn when the the market is overflowing with inventory. And according to the founder of TSMC, Dr. Morris Chang, if U.S.' major concern is national security and defense, you need probably two or three percent of the advanced chips made manufactured by TSMC. And so, the whole effort of building out a fab —which basically is a result of 30 years of experience in Taiwan — to the US, I think it will require a much more sort of well-rounded thinking to execute it. Right now, I don't see it being fully executed in a level that would achieve the type of cost-effectiveness and-- or the

excellence of the yield rate that TSMC needs to have. For every chip made in the U.S., it's going to be 150% to 200% more expensive than they are made in Asia because of the supply chain and integration of the entire components. So, we need to figure this out and to ensure that TSMC is up and running smoothly in Arizona and as well as they can deal with the other geopolitical pressure they've faced, either with the U.S. and China tension, and or other diversifying efforts that TSMC is attempting to endeavor either in Japan or Germany. These are the two places they've have announced their recent foundry rebuilding efforts.

HASS: Thank you. So, it sounds like packaging and talent are areas that we need to keep a close eye on and try to address as vulnerabilities or weaknesses going forward. If I could just pivot a bit, Andrew, I want to bring you in to talk about what impact this shift in value chains is having upon our allies and partners in Asia.

YEO: Sure. So first, let me just comment on something Chris had mentioned, because I think the focus has been so much on high-end chips or military-grade chips, that we've sort of lost, not really paid too much attention to some of the lower-end chips. And I think that's a real eye-opener, at least for me. And noticing that that's a-- that's an area that we have to watch for. In terms of semiconductor policy, and you know, how, how and where that implicates allies, I mean, I do think U.S. semiconductor policy has brought into sharper focus the geopolitical implications of the U.S.-China tech competition, the need to diversify risk, which means looking at different aspects of the value chain. Now I do think we've pushed allies and partners like Korea, Japan, and Taiwan to invest more outside of China, and whether that's in Southeast Asia or in Europe, or right here in the United States. And so, for those reasons, I think that's that's actually a positive benefit. I anticipate several U.S. allies will benefit from legislation like the CHIPS and Science Act. The TSMCs, the Samsungs, the SKs that have invested in producing chips and also batteries for the U.S. market to provide Americans with the goods and products we need is a-- is a good step. You know, the October 7th export controls that has also awakened allies and partners encouraging, or perhaps forcing them, to have more frank conversations related to supply chains, supply chain vulnerabilities, and exploring ways to minimize risk. So, in terms of the allied cooperation aspect here, these are some of the positive steps.

But at the same time, semiconductor policy has also brought some headaches for allies as well, too. It forces countries to make difficult choices and long-term bets in a still unpredictable

environment. These are investments that, you know, that may-- the investments in the U.S., for instance, the TSMC factory in Arizona, well, that paid dividends 10 to 15 years down the road. I think that was some of the exchange between Jason and Chris that that we were trying to address. Well, decisions which to diminish market access to the Chinese market will result in losses for our ally. So, it brings in-- U.S. policy has brought in more unpredictability, and it also gives the impression that, I think, the U.S. needs-- U.S. needs and interests sometimes trump those of our allies. So, that October 7th export controls, they were presented to allies as if, you know, "Here are the rules. Now everyone should fall in line and get into the program." And so that, you know, that kind of policy may further entrench what many see as a bifurcated semiconductor ecosystem. So I think in terms of policies, you know, there's steps that the U.S. has taken that is, I think overall, for the good. But it doesn't mean that we haven't brought on headaches to our allies.

HASS: Right. So China is a topic that has come up throughout our conversation. I just want to center on China for a second. We'll set aside the trailing edge node question for a little bit later. But on advanced node chips, what do you assess is China's capacity to either produce or acquire advanced node chips? What is sort of a best-case, worst-case scenario from a U.S. perspective in regard to this question? If we could start with Jason and maybe just quickly work our way down.

HSU: Yeah. So, Huawei just announced the Mate Pro 60, the latest smartphone that uses a five-nanometer chip. It's a completely indigenously made and also made by China. And actually, when the phone ships, Japan actually took the phone and unpack it and analyze every single component within the phone. And it is indeed a chip that made by Huawei, but it's a different type of technology that TSMC uses. It's because Huawei can't get that EUV, the EUV machinery that would make the sophisticated and also high-yield performance chips. So right now, they are quite stuck with what they have, the entire ecosystem. But they ship the phone more as a political gesture to say to the people in China, that we are still capable of producing high-end chips, cutting-edge nodes and we can still ship Huawei advanced phones.

But I think the issue we need to look is probably needs to be broader. Now, China is pushing its own technology standards, not to the West and its allies, but it's pushing to its appeal in rural coverage countries and countries that they have political and economic influence. So, they are-- they can effectively ship the phone to Global South or other African countries that it has the political and economic leverage, and probably impose their technical standard or whatever framework that the

Huawei ecosystem's building. Not-- they are not just phones, but they are also other connected devices. like your Wi-Fi stations or your future autonomous driving cars, would also be using in Huawei chips. And those are the chips that would be used in second or third-tier generations of EVs or very cheap phones, but they are able to power with Huawei chips.

So, the issue we should look at is not just how competitive Chinese technology can be or whether U.S. can outcompete China in certain areas of critical technology, it's what is China's motivation agenda behind this. Why do they choose to ship the phones at this time when they are-- they already suffer from the export control and couldn't get EUV and DUV? So, I think we need to look at the motivation behind the Huawei's action recently. So, they might do more things around other technology, such as satellite communication, the undersea submarine cable communication by using their chips. So, I feel the question should be more geared towards why China still sends a signal, either domestically that they can ship a high-end phone, but also the influence that it tried to project to the country that it has leverage.

HASS: Chris.

MESEROLE: I would build on that. You know, I think they're trying to project strength with that phone. But I also think that they recognize that there's fundamental limits that they're not, you know, they're not going to be able to go beyond. And so, I think it might be worth just doing some scene setting to explain the technologies that are at play here and why and how they bear on, on Huawei's new phone. So, for those of you who haven't kind of taken an electrical engineering class or a semiconductor class, what-- you'll often hear references to silicon or silicon wafers or, you know, semiconductors, etc. Here's what a chip actually is. A silicon chip is somebody basically went to the beach, got some sand, melted the sand down, it's a pure silicon, right? And they've got a silicon wafer. It's kind of like a grape, except a lot less tasty. It's 12-- 12 inches, pure silicon. It's about, you know, maybe a little bit thicker than a grape. Then they dope it. They put a layer of chemicals on top of that layer, that wafer of silicon or that crepe of silicon, and those chemicals will react with light. So, if light strikes that that surface, it will leave a mark in the surface of the silicon. And that's what's used to etch the circuits of a chip.

The question is, well, how do you get the circuits etched really really small on a chip? And the way that you do that is you take really, really like small bandwidth light, right? Really high energy small bandwidth light as your light source and you use a bunch of mirrors, and you reflect the circuit

onto the chip. And that's how you actually manufacture chips on silicon. The-- you know, for most of the last couple of decades, really the last decade-plus, the best way to do this with something called deep ultraviolet lithography machines, right? So, they would take a light source. That light source was 193 nanometers wavelength light. And we figured out through a whole bunch of really complicated physics and other things how to get a 193-nanometer light source to produce seven nanometer-wide circuits, right? So, it's about a 15 to 17 ex, on kind of what you would naturally be able to do with 193 nanometer light. The problem is you can't really go beyond that with that light source. You're not going to get below seven nanometers basically, which is-- Huawei when they produced that chip, they were using 193 nanometer light. They're using the U.V. technology. They're basically at the very frontier of what is physically possible using-- using that light source.

There's a newer technology called extreme ultraviolet light lithography. That light source is 13.5 nanometers. And that's what's used to, you know, for five-nanometer chips, for three-nanometer chips that are that are kind of the leading edge now. China has no access to that machinery. And so, it's very unclear to me how China will go beyond the Huawei phone. I think when they released that, they they released it, you know, at the same time Raimondo was in Beijing, it was meant to send a political signal. If you paid attention a year ago, you know, they announced that they were capable of doing this a year ago. The whole thing has been in motion prior to the export controls that were announced last October.

I don't think-- I think we're kind of overstating the case for, you know, China being able to keep pace fully with the manufacturing capabilities of Taiwan and South Korea, the United States, and others who have access to EUV technology. So, I don't think they're going to be able to keep pace in the long run with us if they don't have access to EUV. They are also going to increasingly be denied access to the deep ultraviolet machines. They already have some that they've procured in the past. But the October 7th export control regime that came in-- into place last fall, that was actually targeted at DUV. EUV had already been banned. And so, the goal with doing that is to deny them access to new DUV machines. Also, make it impossible-- these things break down, right? They're really complicated. You think about your printer at home and how often that thing breaks. An EUV or DUV machine, I can assure you, is a thousand times more complicated and has a lot of-- a lot of issues that come up as well. They're not going to be able to be serviced, right? So ASML is no longer going to be able to service the machines that they have sold to China in the future. So even though they

may have the capability now, it's actually not even clear to me that they'll be able to maintain that capability over time without some new source of machinery, which-- so far at least, they have not demonstrated the capability to build the machines that build the chips. And I think the administration strategy so far has really been about trying to leverage that. And, you know, I think they're probably right to be fairly optimistic that they will be able to do so going forward.

HASS: Andrew.

YEO: I remember having a conversation with Chris on a bus because I was asking about semiconductors — he may not remember — about how far ahead is the United States from China and whether China can catch up. And I mean, I think Chris right here just highlighted that in some ways that's a good-- a good case scenario that that we're pretty far ahead and it's going to be very difficult for China to acquire or develop these sorts of technologies. But you said also to think about the worst-case scenarios. And one thing that the Chinese do well is that they're good at stealing technology and intellectual property. And I wouldn't write off the Chinese so quickly. And so, in a worst-case scenario for me, it's that we have created policies that have really upset China and the CCP and that they could use that as a way to galvanize nationalism. And so, if you tell the Chinese that you can't do this, that we're putting it down, well, that mobilizes the Chinese to find ways to develop their own homegrown technology. Now Chris says that we're-- it's pretty far ahead. And even if they steal the technology, would they be able to service it?

But again, my my point, though, is that maybe we shouldn't write off the Chinese too, too quickly. And-- no, if they are in the long run, the concern here is that what if China then begins to produce its own technology domestically and then they create their own ecosystem and we have no more points of leverage because they're not interdependent, they're not dependent on the U.S. or allies. So, you create, in some ways, I referred to as a monster. So, is the policies that we're imposing today creating unintended consequences with China, actually, maybe five, seven years, you know, maybe down at some point are they creating something that we're not really aware about? And will it come to haunt us further down the road? That's a worst-case scenario. I'm not suggesting that's happening. But just to provide a counterpoint to Chris's excellent comments.

HASS: So, Melanie, we've heard a best-case scenario, a worst-case scenario. Where do you come out?

SISSON: Yeah. Well, so, you know, you've asked obviously in this question, sort of it's the 70 billion dollar question that we all want to know. is will this work or not? And I have to say I am more in line with Andrew than I am with Chris. I'm not as optimistic. And I think in part that, you know, the the fact of the Huawei phone and the manufacturer of that chip by a Chinese company has gotten a lot of attention. It started conversation about those equipment maintenance sort of companies that aren't just as small, and you know, sort of the entirety of the ecosystem that-- that now I've exhausted my entire set of knowledge about. But the people who really know this stuff seem concerned. And it's not to say that Chris isn't either. And I think you make some really important points about it. And I-- and I will say that I hope you're mostly correct. I think my perception is a little bit colored by two things that Andrew also mentioned. So, I just can't help but think that a really well-funded, motivated, nationalistic Chinese workforce is likely to disappoint our hopes and exceed our expectations.

And so, I think, you know, when we think about what the idea of the best cases of these policies, we're looking at a system that slows Chinese industry down, at the same time that accelerates U.S. industry. And so we can extend a lead, right? We can take advantage and make the gap between those capabilities bigger. Neither side of that equation is assured. It's certainly not assured that this will slow the Chinese down in the way that we would anticipate, maybe because of second or third-order effects, as Andrew mentioned. It's also not guaranteed that we're going to do so well in, you know, in building our own capabilities, and that's part of the equation too. But my worst-case scenario, and I think it resonates with what Andrew has said. It isn't the opposite of that. It isn't that, you know, China goes faster, and we go slower than than we had hoped as a result of these policies.

My worst case scenario is in part — so I have a daughter who, in her summer camp, one of the very smart counselors trying to exhaust children at the end of the day, set up a challenge and said, "If you can run around this track one time in one minute and 30 seconds or less, you get $10," right? And so, my daughter diligently tried. She fell for it every day, you know, and ran and ran her little heart out. And so, the last day of camp comes, and I say, "You know, hey, you know, how did it go today? Did you make it?" And she looked at me and she said, "No, no, I didn't do it." And I said," Hey, you know, proud of you for trying. You know, I'm sorry you didn't get it this time." And she said, "Hey, you know what, Mom? It's okay. Because one thing I know about life is that it is always changing. And maybe next year I'll be faster. And maybe next year the price will be $15, you know?"

And so, life is always changing. So, my worst-case scenario is actually that we're going to have a dynamic where you see necessity and nationalism combined to be the parents of real invention and that the Chinese will end up doing what we really mean when we say innovation, which is push design or production in new directions, really new and different directions, unexpected directions. And that would really change the entirety of the industry and put China at the center of it. So, that's my worst case.

HASS: So one thing that people who work in this space talk about a lot is a “small yard and a high fence,” in addition to [inaudible] production and things like that. So, Chris and Melanie, can you just help us understand when people are using that term, what does that mean, a small yard and high fence? And is the yard going to stay small or will events that Andrew and Melanie have been foreshadowing cause the yard to expand?

MESEROLE: Well, yeah. Well, so I think the, you know, the hope of a “small yard and high fence” kind of policy when it comes to semiconductors and advanced technologies, more broadly, is that we're able to be very targeted in the kinds of technologies that we're denying China access to. I think that's-- the whole point is we don't want to have a full decoupling, which I think the administration and others are aware would be, you know, have pretty catastrophic consequences for the global economy. We do want to cut off, you know, China from specific capabilities that we feel like would be detrimental to the interests of the United States. So what they've come up with is this, you know, as Jake Sullivan, the national security advisor, has described it, the “small yard, high fence” strategy of restrictions where we're going to-- we're going to create a very narrow subset of technologies and we're going to build as high of fence as we can around that so that China can't jump over it. My fear is that that strategy is going to be very difficult to sustain over time. We've started out fairly narrowly tailored to, you know, advanced lithography machinery and certain kind of high-end chips that Nvidia and other ma-- other companies make.

The biggest question I have, there's two kind of fundamental issues going forward as far as this small—“small yard, high fence” strategy are concerned. The first is technology is just going to keep improving, right? And so right now we've banned, you know, the DUV and EUV machines for sale to China. We've banned the sale of certain high-end chips, today's leading-edge kind of server, GPU server that Nvidia, you know, has produced is an extraordinary piece of machinery in terms of the computations it can do. I fully expect a decade from now it will seem obsolete, right? And the

question is, does the administration delist certain technologies over time or does it just maintain once it's on there, indefinitely it will always be on there. And if the answer is the latter, then inevitably this yard is just going to grow and grow and grow until at some point 10 or 20 or 30 years from now, we basically have two entirely separate yards. We have-- we have a Chinese ecosystem and a U.S. and non-Chinese one. And that I think in the long run would be detrimental to what the what the administration's trying to do.

The second area where this is going to get really complicated —as complicated as semiconductors have been, this is about to get even more complicated — because what you're really trying to do from a strategic perspective is to deny China access to particular capabilities. It's not about the actual semiconductors themselves. We don't want them to have semiconductors, so they can't use them to then train models that we think would be more capable than we're comfortable with them having. Which means we're going to start having to have a serious set of conversations around things like export licensing controls, and regimes for cloud computing, potentially even for open-source software, when it comes to the trained A.I. models that these chips allow for. That, in my view, is where this “small yard, high fence” strategy is going to be hard to maintain in the pure semiconductor realm. When you get to the actual A.I. capability realm, which a lot of this is meant to address, it's going to get very, very thorny, very quickly, in particular, because so much of the innovation ecosystem that's been built up around A.I. and advanced manufacturing is open source in its nature, right? And so the administration is going to have to weigh the national security concerns of, do we want advanced capabilities kind of circulating freely around around the world that China can then just download, even if they can't produce them themselves versus maintaining the open source innovation, architecture and ecosystem that we've built up and that has been so successful to driving growth and the competitiveness of our of our economy going forward. So those are the two areas where, you know, I think the smart iPhone strategy is, you know, it's well-intended, but it's going to face two really difficult challenges in the years to come.

SISSON: And I would just say, actually, I don't think the yard was ever small. You know, I don't dispute the fact that the restrictions are cut very narrowly and they're enormously technical. But when I think about the yard of interest, it's not the one that holds the sort of intent at the level of specification like that. It's the one that holds the effect. And I think the effect yard of these policies has has always been very big. And that's because, you know, China's interest in semiconductors is the

same as ours. Yes, there's interest in the military applications. There's also a lot of interest in the socioeconomic applications and those are numerous and make a yard that that, again, is just very big and and wide and very deep. I also think that the other way in which the yard was was big from the get-go has to do with what it communicated about the way in which the United States is approaching its relationship, its bilateral relationship, its global relationship, its geopolitical relationship with China. And that that that that message in terms of trying to slow China down in these important areas and accelerate our progress, that message is not, I don't think, lost on Beijing.

HASS: I want to turn the conversation to our audience here in a moment. But if I could, just in 30 seconds, ask two quick questions to Andrew and Jason. Andrew, the United States has successfully exploited its control over choke point technologies around semiconductors, as we've been discussing for the past several minutes. Is this a model that is replicable to other technological fields?

YEO: You know, semiconductors are so unique because they're critical to everything we do in life and including warfare. And chips are essential to unlocking the next generation of technology. And it's really because our allies, the United States and its allies, have such an edge over peer competitors in this area that we can build these choke points. We can block access to high-end chips, we can block access to U.S. chip design software or block access to manufacturing equipment. We have these multiple choke points, but I'm not sure if there's any other technology or if there's another sector out there that this can really be replicated, at least not at this moment. But that's not to say that in the future down the road, that there may be another sector where this this can be tried again. But for now, I think it's quite, quite unique.

HASS: Yeah. And Jason, we were-- many of us were in Taiwan recently. We hear from some of our Taiwan friends a concern that that once America develops a capacity to produce semiconductors indigenously inside the United States, we will hollow out Taiwan semiconductor sector and then we will lose interest in Taiwan. And we would be willing to abandon or forego our support for Taiwan security. Is this a concern that you share? And if not, why not?

HSU: I don't-- I don't think U.S. is hollowing out Taiwan's semiconductor industry because it tried to onshore TSMC. But I think we should view this question more from, how should U.S. and Taiwan collaborate, collaborate more closely to ensure that the effort is successful. Right now, there are a lot of rumors and noises about us hollowing out Taiwan or the so-called Americas skepticism.

This is all linked to the somewhat difficult efforts that's being played out because of TSMC's challenges in Arizona. And obviously, this also gives China an excuse or somewhat a leverage to plant misinformation, fake news to Taiwan domestic audience, and particularly when election is coming up just in a few months' time. They could use the the fact that TSMC is fumbling in the U.S., and to say that "Look, if Taiwan sides more with the U.S., the U.S. will continue to weaken Taiwan's competitiveness in the long run and the U.S. support to Taiwan is not substantiated." So, the question that we should be asking ourselves is: How should we ensure that effort is successful, that this this offshoring chips to the U.S. is cater to the interests of both Taiwan and and the US, and also projecting a positive signal to our allies who are joining this alliance to build a more cohesive and a comprehensive global semiconductor supply chain and integration. So, I don't think U.S. effort to onshore chips is hollowing out Taiwan, but I think that more efforts needs to be done to ensure that effort is successful, and the project can be carried out successfully.

HASS: Thank you. The floor is now open to you to ask anything that is on your mind to this group of experts. We will try to start here with this gentleman. And I'd like to also bring a woman into the conversation as well.

AUDIENCE MEMBER: Hello, can-- perfect. Hello, my name is Gabriel Cabanas. I am a research associate at the Council on Foreign Relations. I appreciate this discussion. And my question has to do with the export controls against China. You know, we heard a lot about how some of these export controls may backfire in the U.S., may increase innovation within China, completely warping our perception of what we want-- the U.S. wants to do with these export controls. My question is, the other countries that are involved in these export controls, I'm thinking mainly the Netherlands. Japan, and South Korea, with elections in those countries as well, and political dynamics that are different from those within the U.S. or Taiwan. Where can we see those countries in the future still following within the footsteps of the U.S. in these export controls? Or do you think that political dynamics within those countries economic changes may shift their opinion on whether or not to keep following these controls wherever they may lead, under U.S. leadership?

HASS: Thank you. If possible, I'd like to take one more question. Is there--?

AUDIENCE MEMBER: Hello, my name is Shalala. I'm a student student at the American University Washington College of Law. And my topic basically covers legal consequences of expert-- experts licensing controls on semiconductors. But I will cover like domestic, international, and third

countries for this topic. So my question is about, what is your expectation about legal consequences for export controls? I'm just-- want to have a brainstorming on this. Thank you.

HASS: Thank you. So, we have two questions. The first is about the durability of support from allies of partners. The other is the legal ramifications of the export control regime. Let's see where we want to come in on either of these.

HSU: Maybe I can talk about the Chip 4 Alliance because Taiwan is included and and also Japan and South Korea are included. I just return a trip from both Tokyo and Seoul, speaking with the semiconductor people there. I think the export control is effective as we speak today, but it would have a repercussion in days to come if the U.S. doesn't address the overall issue that industry is facing in terms of whether it is economic to continue this trend for industries to complying with export control. But I think at the moment the national security concern precedes the business concern. So from Taiwan perspective, we will comply with export control, but we also need to know what U.S. contingency plan is. And would there be a second or third wave of export control? And if that backfire at industry, how would U.S. help support the loss that were incurred because of that export control? And maybe I would make one more point. Even though export control is imposed on China, and China now cannot get the machinery that ASML makes for EUV and DUV machineries, but they can still get chips for some reason. They still in Shenzhen or Hong Kong, there are still chips being smuggled through these coastal cities into China. So, one thing we might have to look at is how would U.S. address the technological espionage program that's very rampant, both in Taiwan and other parts of the world, that are still delivering high-end chips to China. So, I think this is quite critical as well.

HASS: Andrew.

YEO: Sure. On the question on domestic politics, I'll speak about South Korea, which is the country I know best. So, there are sensitivities, I think, within-- and certainly companies, Korean companies are sensitive to these U.S. export controls because they have a lot invested in China and the Chinese market. But if you look at domestic sentiment towards China, it's like close to 80% anti negative sentiments towards China. So, they're tracking much more-- historically more, they have more negative attitudes towards China than probably any time I can remember since they normalized relations with the People's Republic of China. So, I don't think it's going to hurt in terms of election chances. This is the current Yoon government. I don't think it's going to hurt his party so much in the

upcoming midterm elections or parliamentary elections in April, just because of the negative sentiments towards China at the moment. And regarding the legal consequences on export controls, I mean, there's many different directions that you can take this. But if you're looking at sort of little legal consequences in terms of international trade rules and norms, I think this has all been kind of rewritten or rewired. So-- and in some case, if countries are upset because of these export controls and you want to, you know, take another country to court or if you file a complaint, I don't know if that's going to be effective these days because I think these norms are shifting in terms of what how we think about export controls in the realm of of international trade these days.

HASS: We have time for one final question. This gentleman here.

AUDIENCE MEMBER: [Inaudible] in the USMCA initiative. I had a question more so related to North America as a region, this small-- what was it? “High fence, small yard” strategy? You know, there's clearly some compatibility there, with Mexico thinking, Mexico's labor force is quite capable of some human capital, and they could take over some of the packaging and testing side of semiconductor production, and especially with USMCA coming into a review process in 2026. Have you given--could you share some ideas on how that process could help ensure resilience in the supply chains?

HASS: Great.

AUDIENCE MEMBER: Thank you.

HASS: So, is Mexico capable of filling the void in packaging and testing? Jason, you've brought this issue up before, so maybe we'll start with you, and we'll go down the line to give everyone a final parting shot.

HSU: Yeah, the fact is 90% of the packaging and testing are now in China. Even the top-- world's top ten packaging companies, six or seven of them are from Taiwan, but the rest of them are actually are Chinese companies. And the Taiwanese packaging and testing company also shipped the chips to China to be packaged. So, it's considered a low-end part of the semiconductor supply chain. But what TSMC is doing is they are inventing a new technology called 3D packaging. And so, they are able to effectively packaged onsite, and tested, and actually shipped the finished products. So, it doesn't have to go through the whole loop, coming back to Asia, and to be ready for the final use of the chips. But the question regarding whether Mexico would be a good site to to to onboard packaging, I think for the Taiwan perspective, is that it's always it's always about a cost. The the

nature of the packaging segment of the supply chain, it's very low margin. It's unlike the foundry or the chip's design. The margin is up to like 60% of the profit or even higher. But the packaging and the testing is very low. And so, we will need to see tax incentive or other industrial policy that will make it conducive for packaging companies to be relocated to Mexico. But I think Mexico could be a good location because it's closer to the U.S., and I think you would have some treaty benefits to be located to Mexico. And I know some companies from Taiwan are considering relocating to Mexico for their packaging and their testing capabilities.

MESEROLE: Yeah, I would-- I would echo everything that was just said. I mean, I think if Mexico is going to be a player, it would probably be on low end, kind of mature, no packaging. And I think there's a real demand for it. And if they can supply it, then I think it will be a win.

HASS: Any final thoughts, parting shots?

SISSON: Well, I can't add anything informative to that, but so instead what I'll just say is, I'll say thanks to my colleagues for continuing my education on these matters. And to compliment everyone on their neckties.

HASS: Well, thank you all for joining us. I think that this conversation has exposed a lot of new insights, but also a lot of questions that need to be discussed and explored further. So, stay tuned. I'm going to try to drag these people back to the stage to talk about mature nanotechnologies and a variety of other issues that have have come to the surface over the course of this conversation. But thank you all for being with us and happy Friday.