

How countries and companies are reshaping their supply chains

Goldman Sachs Exchanges

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Allison Nathan: The pandemic highlighted the vulnerability of global supply chains spurring countries and companies to reshape them for a new era of global trade. But how significant are these changes?

Luke Barrs: It's happening, and it's a significant change. And when we look at it today and we think about the key drivers of corporate and government capital investment over the coming couple of decades, we actually think the push to domestic supply chains, to build greater security in supply chains, and especially in critical technology and resources actually is one of the biggest drivers of potential demand in growth that we're likely to see across the public equity landscape.

Allison Nathan: I'm Allison Nathan and this is Goldman Sachs Exchanges.

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In this special episode, we'll break down the macro pressures and geopolitics that are forcing countries and companies to remake their supply chains. And how that's changing the investment landscape. To do that, I'm speaking with Andrew Tilton, chief Asia Pacific economist in Goldman Sachs Research, and Luke Barrs, from the Fundamental Equity business in Goldman Sachs Asset Management. We also speak with semiconductor industry veteran Richard Hill, chairman of the board at Marvell Technology for his take on how the changes are affecting the industry.

I first turn to Andrew Tilton to understand the macro trends affecting global supply chains given the important role that the Asia Pacific region plays in these supply chains.

Allison Nathan: Andrew, welcome back to the program.

Andrew Tilton: Thank you.

Allison Nathan: So, at a high level, first just explain to us the role that the Asia Pacific region plays in the global supply chain.

Andrew Tilton: Well, it's an essential role. And you have more than half the world population, a significant chunk of global demand, a very large established manufacturing base, a dominant role in global semiconductor production, particularly in Taiwan and Korea in terms of the most advanced chips, and China playing a significant role in the broader chip production. China also, of course, playing a very large role across a wide range of manufactured goods, except for some of the most advanced applications. So, Asia's an absolutely critical part of the global supply chain.

Allison Nathan: So, give us some context. Why are we seeing this shift in supply chains and focus on shifting supply chains now?

Andrew Tilton: I don't think it's just US/China frictions, although that's the thing that gets the most attention. It's

the COVID pandemic and the disruption that it caused to supply in many areas. It's the natural disasters we had, such as the earthquake leading to the Fukushima accident in Japan a number of years ago. Or huge flooding in Thailand which was a key sourcing site for many companies.

So, I think it's a cumulative effect of a lot of different disruptions historically to supply chains over the past decade and the prospect of more of such disruptions given current geopolitical tensions that has motivated firms to think about diversifying their supply chains, and particularly diversifying them beyond China.

Allison Nathan: There have been so many headlines about the end of globalization in recent years. What are you observing from your seat in Asia? Do you see any evidence that that's actually happening?

Andrew Tilton: If we look across trends in trade, investment, immigration and so on, we really don't see a consistent story across the board in terms of deglobalization. Clearly, there have been big disruptions over the past decade. You know, most recently the COVID

pandemic and policy changes like US tariffs on China that have caused multinationals to rethink their vulnerabilities in supply chain. But in many areas like data flows, we're actually seeing acceleration in globalization.

So, with the more traditional areas, goods trade and capital flows, we're seeing a slowing down, we'd say, in the rate of globalization. But not a widespread reversal.

Allison Nathan: So, let's drill down into those shifts a bit more. Give us a bit more detail on how trade flows and foreign direct investment and cross border capital flows are shifting?

Andrew Tilton: Sure. Certainly, in the trade area we've seen impacts from, say, US tariffs on China where imports into tariff categories have gone down. But the US is still importing half a trillion dollars worth of goods from China each year. And we're seeing increased Chinese exports to, say, southeast Asia, which are then exported further to the US. So, one example of this is solar panels where it's well-known that Chinese companies are exporting solar panels to southeast Asia, Vietnam in particular, where they're being assembled and exported onto the US. So, in terms of

good flows, we see some diversion, but not really a dramatic reduction.

In terms of investment, similarly, COVID disrupted some cross-border investment flows. But we expect to see some revival there in over the medium term, certainly foreign direct investment flows we expect to see a broadening out of those flows, maybe not as focused on China specifically, but not a significant reversal.

Allison Nathan: That being said, we hear also a lot about rising geopolitical tensions between the US and China. And I would say even globally there are just a lot of worries that investors have. So, have you seen those types of tensions beginning to impact how these flows are taking place?

Andrew Tilton: Certainly, the potential for geopolitical tensions and other factors to disrupt supply chains has caused a shift in thinking, I think, about the relative importance of cost versus other factors, resilience in the supply chain. So, you are seeing some companies holding more inventory in the supply chain because of risks of such disruptions. Others, perhaps, a bit less likely to expand existing facilities. And maybe looking for additional

sourcing options. So, trading off scale versus resiliency.

In the China context, this is often the focus on US policies vis-à-vis China and the possibility that firms may move out of China. But we think of it more as less of a move out of China and more as a rethinking of where the incremental new investment goes. Sometimes people refer to that as China plus one.

Allison Nathan: And how are government policies and regulatory changes shaping economic policy and incentives for domestic production in many countries around the world?

Andrew Tilton: A huge range of new policies in recent years to incentivize domestic production, kind of piggy backing on these big shocks to the global supply chain.

Just to give a couple of examples, in the US you of course have the CHIPS Act providing tax benefits and other subsidies for manufacturing semiconductors in the US. We've had the Inflation Reduction Act with various investment and production tax credits for green investment.

And in Asia, India has rolled out the so-called Production Linked Incentives as trying to attract more manufacturing capacity in light of firms looking to diversify their supply chains. And maybe one other Asia example, on a related but slightly different note, Indonesia has made an effort to incentivize domestic refining of ores and metals. So, instead of exporting raw ore to other countries, creating incentives for that refining to occur onshore. So, really the manufacturing stage to occur onshore before exporting.

Allison Nathan: So are these shifts that we've been discussing bad news for the Asia Pacific region in terms of economic growth prospects?

Andrew Tilton: Economic impact, regionally, we think Asia will be fine. I think one way to get a sense of where we may go is to look at some of the shifts in global trade in recent years. And what we see is actually that a number of Asian economies continue to gain some share globally. A broad set of Asian economies actually.

We don't really see the region as a whole losing out. We do see, as I noted earlier, some effort to diversify sourcing

locations and some move to southeast Asia and perhaps India as potential new sources of supply. And for their own domestic markets in their own right. So, there's a broadening out, I think, of the focus of new investment relative to, perhaps, a more China-centric view some years ago.

Allison Nathan: And are there some countries that stand out as beneficiaries of these shifts?

Andrew Tilton: Well, for example, Vietnam has seen a big increase in bilateral trade with China and big increase in exports to the US. So, it's playing a role in a number of sectors, including some electronics manufacturing, including solar panels, a number of other areas.

India is starting to see some material new investments. I think a long way is still to go there. Certainly, relative to the size of the Indian economy. But the government is taking a number of steps to try to increase the attractiveness of India as a manufacturing location. So, that's another one to watch.

Allison Nathan: And are there sectors of the economy

that have been particularly affected by these shifts?

Andrew Tilton: A couple of sectors that are particularly important are semiconductors, given the geopolitical implications. You've seen the U.S. put export controls on advanced semiconductor technologies going into China. Now, China already has a large industry manufacturing so called legacy semiconductors, which are very important in a lot of applications. But in the more advanced chips, the US actions could restrict the flow of semiconductor manufacturing equipment and some other technologies into China. So that could keep parts of the semiconductor supply chain outside of China. So, that's one very important area.

And of course, the U.S. also trying to incentivize some domestic semiconductor manufacturing capacity via the CHIPS Act.

Another key area is green investment with wind, solar, electric vehicles, and again, a number of incentives put in place by US policy, the Inflation Reduction Act. We actually think those could materially benefit certain suppliers. So, we recently wrote a report about Korea and the potential

for an increased role in the electric vehicle supply chain in the US to ultimately drive Korean growth higher by as much as a third of a point a year.

Allison Nathan: But if you put this into perspective, these are longer-term trends as I understand it that are playing out. But how does that sit alongside some of the more recent trends we're seeing in China? There've been some concerns about the economic recovery slowing a bit. How do you put this all together to think about your view for China growth, at least this year and into next year?

Andrew Tilton: In the short term we've seen a meaningful recovery in the first quarter this year in China because of the lifting of COVID controls, which are a huge weight to the economy. But over the longer term, what's really going to drive growth are key sectors like housing and exports, which have been important forces driving a high growth in the past.

In that respect, and connected to the rest of this discussion, the export outlook looks relatively modest for China. It already has a big share of global exports. And it's facing slower global growth. You know, somewhat more

restrictions, particularly from the US. So, we're not expecting as much external goods demand as much from manufacturing sector growth as we have seen in past China expansions. It's likely to be more inward focused and more services oriented.

Allison Nathan: And is that really being driven primarily by these broader shifts in the supply chains that have been kicked off by the exogenous pandemic shock and so forth? Or is that being driven by domestic policy goals shifting within China?

Andrew Tilton: Those two are really intertwined. The COVID pandemic, the frictions with the US have probably accentuated the leadership's desire to reduce its dependency on foreign sources of supply. And foreign sources of demand. And actually, try to develop its own internal demand, particularly via the consumer sector over time so as to be somewhat less subject to the vicissitudes of the global economy and a little bit more in control of its own growth trajectory, its own destiny, if you will.

Allison Nathan: We next turn to Luke Barrs to explain the investor implications of this new era for supply chains.

So, much has been discussed recently regarding the evolution of supply chains. But let me first ask you, is that really happening? Or is that narrative that supply chains around the world are shifting overblown?

Luke Barrs: Simple answer? It's happening. And it's a significant change. And when we look at it today and we think about the key drivers of corporate and government capital investment over the coming couple of decades, we actually think the push to domestic supply chains, to build greater security in supply chains, and especially in critical technology and resources, actually is one of the biggest drivers of potential demand in growth that we're likely to see across the public equity landscape.

Allison Nathan: But will this be an enduring trend? Or is this just a cyclical trend and a response to the very recent events?

Luke Barrs: We see it very much as an enduring trend. And there are three key reasons why it's happening now. First and foremost, you did see significant disruption through COVID. Companies that were dependent on, especially China, and the magnitude of the lockdowns we

saw in China really suffered from access to either components or, frankly, just end product. And so, just the logic of having, at very least, a China plus one strategy or in areas of critical focus, having domestication of those manufacturing capabilities is very crucial.

I think what we've seen more recently is the acceleration of some of those trends. So, to your question of whether it's an enduring trend, the fact that geopolitical tensions between US and China are a little bit more strained, the fact that there are areas specifically as we'll talk about in aspects of technology where you want to make sure you have direct control of that supply chain, that is pushing governments to focus on capital investment in those areas in a much more significant fashion than we've seen recently.

And I think on the resource side of things, and again, we can talk about this in due course, but the Russia/Ukraine conflict clearly changes the dynamic for Europe in terms of how do you think about resource security and access to those critical resources that are going to underpin economic viability and stability over the coming decades?

Allison Nathan: And it seems like there may be some national security reasons behind some of the supply chain restructuring. Talk to us a little bit about how that factors in.

Luke Barrs: Well, I think that is a critical catalyst for why we're seeing such clear government focus on these areas. The dependency risk that countries have, especially on slightly less politically aligned counterparts, is really driving that focus on domestication of critical technology and resource access and control.

I think it is also flowing through into what we see in terms of national security. So, you look at national security budgets in the US and in Europe. You think about what's happened, especially off the back of Russia and Ukraine in terms of NATO budgets and commitment from European countries to fund military development, that is a growth area.

Now, we have to be thoughtful in terms of how you position yourself within that space. But a lot of the higher quality businesses in that space are benefiting from significant uptick in government commitment and government

investment in those areas.

I would say where it's also very relevant from a corporate investment standpoint, and for us as public equity investors, is thinking about cyber security threats. And that is something that is now fairly ubiquitous as a concern.

If you poll CIOs and CEOs as we speak to management teams over the last few years, the number one area that they're not stepping back from in terms of capital investment is as it relates to cybersecurity, for very obvious reasons.

Now, that is a very complicated space where it's not as simple as just saying, "Hey, I built you a cybersecurity framework that can protect you." It's an ever-evolving space where, actually for the higher quality players in that environment, you have to give people the opportunity to try and expose where the weaknesses are. And then be able to adapt quick enough to defend the business from a cybersecurity attack. So, some of the enterprise cyber businesses actually are very well placed to benefit from significant company and corporate investment as we see

that as a growing challenge.

Allison Nathan: Let's talk a little bit more about resource security, which you mentioned as another key trend here. You mentioned the war in Ukraine generating a lot of concern about resource security. Talk to us a little bit more about what you're seeing in that trend and how it's shifting supply chains.

Luke Barrs: So it's not a new trend, evidently. If we think about energy independence and the narrative we've seen in the US for the last decade plus, that's been a huge focus. Making sure we have control of resources. Especially oil and gas, which are so crucial to, at least today, the economic development and forward-looking growth path.

Now, what's accelerated that is what you've seen in Russia and Ukraine. For Europe, that's a political and economic challenge that they have to manage through over the coming few years because they don't want that dependency.

Now, is it easy to change that quickly? No. We've seen very clearly over the last few years you can't break that supply

instantaneously. But there is significant commitment through the REPowerEU Act to try and push capital into developing domestic sources of energy in Europe.

Long term, we think that a very bullish signal for the renewable power space, whether it's renewable utility companies. Whether it's the technology businesses involved in storage, infrastructure development, and grid build out. But actually, we have to recognize it's actually a 10-year agenda. That doesn't happen in the course of the next one or two years. And so, over the short to medium term, we actually think the opportunity lies in US onshore LNG as a substitution for traditional Russian natural gas.

So, thinking about US onshore production capacity going up. Think about European utilities contracting out that capacity over the coming five years, actually is a really interesting story. And again, picks and shovels logic to this being what are the infrastructure plays that need to be developed to facilitate that transition? So, your liquefaction capacity on the US eastern seaboard. Your gasification infrastructure in Europe. Your grid infrastructure that has to facilitate the transition and transport of that natural gas. That's all crucial to this longer-term political and economic

agenda.

So, we see that as a very interesting dynamic that is being accelerated by what's happening in Russia and Ukraine.

Allison Nathan: But are you seeing investments going in that direction at this point already?

Luke Barrs: We're starting to see it quite substantially. You look at the European utility space and you look at some of the big contracts that have been written for future capacity, that is a pretty clear signal that substitution from Russia natural gas is leading to pick up in demand for US onshore natural gas.

Now, there will be other nuances to this. We know that Qatar for example is going to significantly increase natural gas capacity in the next couple of years. That's going to be another source of potential natural gas supply for places in Europe. But right now, as we look at the dynamic, US is the critical beneficiary.

It just can't be turned on overnight. As much as US onshore natural gas is a rapid response industry and you

can turn that production up quite quickly, it's the infrastructure that's the gating capacity constraint. And so, as we build that infrastructure, that will not only be a very interesting investment opportunity because these are high quality, real asset exposures where you have take or pay contracts, inflation linkage, that gives you a long-term opportunity tied to that production volume growth with some security in a higher inflationary environment. But actually, you also have this dynamic of Europe having to significantly restructure their supply chain in the resource space.

Allison Nathan: What about other critical natural resources? We hear a lot about the rare earths and other minerals that are going to be critical to the green energy transition. So, are we seeing more investment opportunities there as well?

Luke Barrs: It's a really good question. And I think, actually, something that hasn't yet been focused on in maybe the magnitude it needs to be focused on. And I say that because if you look at direct and indirect control of the supply of key rare earths and minerals, be it copper, lithium, cobalt, China is the dominant player in that space.

And so, as we think about the dependency between the Western world and China, US and China in particular, and we think about the green transition, everything we've just said about the 10-year agenda for renewable growth, there is a dependency that still exists.

Now, the optimist in me says hopefully that helps bind China and US together. I think as Graham Allison said on this podcast recently, a rivalry partnership where actually you can have both countries accept that there is a tacit need to continue that trade linkage.

But actually, if we think bigger picture, there is still going to be this anxiety in US and Europe around how do we control or have access to that key supply?

So, short term, I don't think it's something the market is necessarily focused on. I think longer term, it will become much more critical to the dynamics and the stability we see as we push through that green transition. It's one of the reasons that we're very focused on potential new sources of supply in those areas.

So, again, just anecdotally, we've seen some evidence that in the US and in Canada, there might be some interesting rare earth deposits. Saudi Arabia has started to signal that they think they have a quite significant supply. It's going to take a long time to bring that to market and to essentially make that supply accessible. But it is something that's potentially a big economic driver in those areas, as well as helping to avoid that dependency risk that you have at this point.

Allison Nathan: And so, what are the investment implications of these changes, especially in terms of the equity landscape?

Luke Barrs: Well, so, first and foremost when we look at the investment landscape for us across the equity space, we have to understand what is going to drive demand in growth? So, if we think about the change in supply chains, that is disruptive. So, it's not necessarily the headline a positive universally. We think about deglobalization, and we think about what has happened over the last 20 years in the impact that that's had on corporate margins. And trying to reverse that trend. That can be costly. And think that that can have an impact on generic market returns.

Now, whilst that is a challenge at the headline level, it actually for us as an active investor makes a very fruitful landscape because you're going to see dispersion in a much greater magnitude at the stock level than you have done over the last 10-year bull market.

Specifically, as we drill into what are the investment opportunities that we see, I'd say at the forefront of that is the semi cap equipment space and the reshoring of semiconductor manufacturing capacity, especially into the US.

Taking a step back, what is the logic behind that? Well, let's look at leading edge semiconductor manufacture and design. 92 percent of the world's supply comes from one country. Specifically, TSMC in Taiwan. That is a dependency that, frankly, all other countries are having to deal with. We think about semiconductors, especially at that leading edge, as being foundational technology in all critical technology themes, whether it's AI, VR, AR, autonomous driving. If you think about what's happening in the Cloud computing space. We're dependent on that supply of semiconductors.

And so, for countries to be reliant on supply from some other part of the world, not least of which off the back of what happened in COVID, makes it very challenging to build long-term strategic plans behind that.

And so, the US CHIPS Act, some of the other government driven investment objectives that we're seeing in US Inflation Reduction Act in terms of the US Competes Act is really trying to bring that supply back onshore.

Now, from the investment standpoint, is it easy to say at this point whether the US legacy chip manufacturers will be the winners in that? That's hard to say. I would point to TSMC building capacity onshore in the US. There's a very strong indication of their desire to maintain that market share. But the picks and shovels businesses, the semi cap equipment businesses, the automation businesses that are going to help drive that manufacturing locally in the US should be significant beneficiaries.

And given the concerns we're seeing at the moment around cyclical demand trends and around some of the other broader recession fears, these are businesses that are still

materially undervalued despite that very significant long-term opportunity.

Allison Nathan: If you speak to long-term veterans in the semiconductor industry as we are on this podcast, Rick Hill, they're really skeptical that we are going to be able to generate any type of self-sufficiency in the semiconductor space, despite the CHIPS Act and all of the support around it just given the advantages that exist in Taiwan today in terms of the concentration of capacity. So, what's your response to that? Ultimately, how do you see this evolving? And do you think it's feasible that the US and other countries actually develop this capacity in any way that really meets our needs?

Luke Barrs: Well, so I think that skepticism is fair. Taiwan and TSMC specifically have accelerated way beyond anything we see in the developed market space at this point in terms of technical design, capacity and expertise. But again, coming backwards and saying the picks and shovels businesses that are going to be involved in building out that capacity, whether or not it is US chip manufacturers who succeed in accelerating past what we see in Taiwan today doesn't matter so much because the

capital investment commitment is there.

And so, as we talk about this as an enduring trend, through US CHIPS Act, through some of the other big government initiatives we're seeing in Europe and US, you're going to see that money coming into the space to build that capacity.

And so, if you think about the equipment manufacturers, as we said, some of the automation manufacturers, the robotics businesses, in a higher cost of labor environment that we have in the Western world, you have to invest in that technology to facilitate the build out of those underlying industries. And so, if you can play it through those picks and shovels businesses, the semi cap equipment businesses, actually the opportunity is very substantial.

And without being too flippant, it doesn't matter if we get to that end point in 20 years' time where the US has been able to build critical domestic capacity, you're going to see that significant capital investment over the coming decade that drives demand for these intermediary businesses in quite a significant capacity.

Allison Nathan: So, we talked about the US and Europe as key players in this shift in global supply chains. What about the wider reshoring discussion? Are there other countries that are benefiting structurally from these changes?

Luke Barrs: Well so, when we've talked about the restructuring supply chains and we've talked about reshoring and we've talked about building domestic capacity in critical industries to reduce that dependency risk, it has been focused on what is the US doing to make sure they have access to critical technology? What is Europe doing to make sure they have access to critical resources?

But actually, there are other significant net beneficiaries. So, we mentioned it previously, but this China plus one strategy, again, moving away from critical technology and resource industries, but just generically speaking across the manufacturing space, manufacturers who had exclusive supply chain footprint in China really suffered through COVID because of the ongoing lockdowns and just the lack of clarity over how that would evolve. And so, that

China plus one strategy is effectively saying I need to at very least diversify that supply chain base.

And so, at this point we see two significant beneficiaries of that. One is Mexico because the near shoring of traditional manufacturing for US corporates is really helping to drive increased manufacturing capacity in Mexico. Now, again, you can't necessarily invest in that directly because these are subsidiaries of US corporates. If you think about the auto space. If you think about some of the construction commodities, cement as an example. They are very much tied into broader US-listed businesses.

But the impact that has on domestic demand in Mexico, so you think about the consumer and the banking space benefiting from this in quite a significant fashion.

On a longer-term basis, actually the biggest beneficiary that we see is India. Now India, I think, is sometimes critiqued in the context of why has India not accelerated as much as China has in the last 30 years? And the push back has been it hasn't built that manufacturing supply base.

You look at what India has done in terms of structure reform over the last 10 years under the Modi BJP government, that has actually been very substantial in terms of giving them the opportunity to start to build that manufacturing capacity whether it's the reduction in bureaucracy, increased ease of doing business. Whether it's bankruptcy reform, labor reform. And most crucially, tax reform in the last five years. Not only simplifying tax structure for companies operating in India, but actually in 2019 reducing corporate taxes on new investment in critical areas of manufacturing.

So, as we think about area of hardware technology and how they're building their supply chains and that China plus one strategy, we think India is a very significant beneficiary of that over the next 10 years.

Allison Nathan: And have we begun to see more investment flowing into India?

Luke Barrs: We've just started to see it. We've seen the signal from a number of large technology hardware businesses that that is where they're going to build out their footprint. Again, in terms of the investment

implications, you're still at the early stage of that. You're not seeing that growth in domestic demand flowing from that manufacturing build out.

But as we look forwards and we think about domestic businesses in India benefiting from that trend, we think this could be the catalyst that puts India on an accelerating path whereas we just said, India's fallen behind China in terms of economic development over the last 30 years. But can it catch up as you build that critical manufacturing base in the next five or 10 years? We think that's a very interesting investment opportunity.

Allison Nathan: If a key part of this global supply chain restructuring involves moving out of China, how is China adapting to those changes?

Luke Barrs: Again, a very good question. I think what we've intimated through this is that there are challenges and disruptions that are caused for China through this restructuring of supply chains. But we shouldn't come to the conclusion that all of this is net negative for China. Yes, the US and Europe will be sensitive around giving China access to critical technologies. Yes, there are going to

be businesses that build their supply chains outside of China. In a previous example, they would have just focused on China as their core supply base.

But China is also thinking about it in a very similar fashion where they know that for their economic success, they need to build domestic demand, domestic supply of critical technologies. So, in areas like hardware technology, software technologies, as well as some of the green technologies, China is actually accelerating government investment in those areas.

And so, whilst you might see a net decline in traditional light manufacturing export from China. It would actually be compensated from quite a significant uptick in manufacturing capacity in critical areas of high-end technology.

And from a China strategic standpoint, that's actually aligned to their longer-term ambitions. They want to uplift the economy to be a middle-income economy. They need to move away from being the light manufacturer exporter to the world, to being focused on some of these higher end technologies. And within that, you can create this virtuous

domestic demand growth because that's a much more high value add, high productivity investment opportunity.

Allison Nathan: So, this is not necessarily a net negative for the Chinese economy?

Luke Barrs: We don't think it has to be a zero-sum game. Yes, it will be costly and there will be an inflationary impact of restructuring supply chains. Because we know over the last 20 years, deglobalization has helped to bolster margins for Western companies in particular. And China has benefited from that growth in export demand.

But if we can selectively look through the investment landscape and say who are going to be the beneficiaries of that captive investment on both sides of the page, US and Europe, as well as in China, we think there's significant demand growth that they can benefit from over the coming cycle.

Allison Nathan: Finally, I spoke with Richard Hill chairman of the board at Marvell Technology about the supply chain shifts he is and isn't expecting in the semiconductor space where a lot of attention has been

focused. Here's an excerpt of our interview, which was also one of our recent Top of Mind reports.

Allison Nathan: Obviously, there's a ton of focus on revitalizing semiconductor manufacturing in the US. The CHIPS Act aims to do that. Is it feasible for the US to develop a semiconductor industry on the scale that would be required to meet our needs?

Richard Hill: I think the problem from the United States is semiconductors really originated here and in Europe. They didn't originate in Asia. But Asia did a great job, starting with Japan, of copying everything we do. I was working at Motorola when the Japanese were coming through the factories and taking cameras and taking pictures. And I remember asking one of my supervisors if they thought that it was really a good idea to let these people take pictures. And my supervisor said, "Oh, they'll never get anything out of the pictures." We know that story. They basically took over the memory market. And this is circa the late '80s, the beginning of the '90s. Okay? And the semiconductor industry started to change.

And then about 30 years ago, Morris Chang out of TI

decided he was going to help Taiwan get into the semiconductor industry in a very big way and a very different way. And frankly, I remember it very clearly because I spoke with him back then because I was running a tech development company. And I couldn't imagine the idea of having all sorts of semiconductor production companies all in the same physical area because we all know that at lunchtime, the people can walk out and go over to the other company.

And what I underestimated was the efficiency that you could gain in the infrastructure required to operate a semiconductor plant by having it centrally located in one area. And that's basically the brilliance of Morris Chang and what he did. And, obviously, TSMC dominates that industry, both from a technological standpoint and an efficiency of production standpoint. And I don't think it's possible for us to get that back in the United States.

Allison Nathan: And so, if you start rank ordering what the constraints are to get it back, is it also about labor? Is it about the cost? How would you rank the constraint?

Richard Hill: Well, I think first and foremost in the United

States we have let our most important asset atrophy. And that's the education of our population. Semiconductors is not making steel. It's not a physical prowess business. It's an intellectual business. Even if you're talking about operators having the ability to be able to follow recipes, do the recipes, and make no mistake, we've automated them tremendously. But having the discipline to be able to implement these processes on a routine basis and work as hard as you need to work in the semiconductor business, that has long been gone and dropped in the United States. Period.

You couldn't hire kids out of high school anymore that have the math skills to be operators on a semiconductor line. That's a big challenge that TSMC will face in Phoenix. And they've had that experience before when they had WaferTech up in Camas, Washington. They had the difficulty. They couldn't get people who had the discipline and the work ethic to run a factory the way they wanted to run a factory. 24 hours a day. Seven days a week.

Allison Nathan: Also, there are critical materials involved. Correct? There's other constraints.

Richard Hill: Exactly. They start from sand, right? You have to have the quality of silicon necessarily. You have to have photo resist. The equipment. And it's all being developed all over the world. It's not in the United States any longer.

Allison Nathan: But so, even with these types of constraints, we saw some companies announce new capacity in the US. So, is that just symbolic?

Richard Hill: They announce it because they can get money by announcing it, correct? If you're going to build a factory and somebody's willing to pay for half the factory, you've got to pencil that out and see if it's economically feasible at all. Does that half really make a big difference?

And they're very large investments. So, if somebody's going to give you money, it can sway you one way or another.

Allison Nathan: How insufficient or sufficient are the CHIPS Act subsidies relative to what these companies have to do?

Richard Hill: They're a drop in the bucket. I would say to

develop a 5nm process, a company like TSMC would probably have to spend \$250 to \$300 billion to develop a process that would yield at reasonable yield. That's how much they'd have to spend.

I don't understand how they think that process will ever make money. What application has the volume and the ASP umbrella that makes the volume times the ASP get a return on \$250 billion? I don't know how many applications that are like that.

Allison Nathan: The entire CHIPS Act is a fifth of that amount.

Richard Hill: Of one company.

Allison Nathan: And so, do you think there are going to be more companies making these announcements? Or do you think it was this kind of flurry around CHIPS Act?

Richard Hill: Well, obviously, it's a flurry around the CHIPS Act. And then when you read what they're going to require the companies to do that take the money, I think you'd have to be crazy to take the money. Can you imagine

not selling in China? There's a billion and a half people in China. Why would you ever ignore that market? And what does China do to respond to the CHIPS Act? If I were China, I wouldn't do a thing. I'd let the United States waste their money.

Allison Nathan: We haven't really seen them do anything at this point, correct?

Richard Hill: Not a thing. Nor do I think they will.

Allison Nathan: Is China in any better position to develop their own semiconductor industry?

Richard Hill: No. They're nowhere in the equipment business. And they've been trying to get into the equipment business for 25 years.

Allison Nathan: Why have they made no progress?

Richard Hill: The equipment business is a lot different than the semiconductor industry, if you will, making a semiconductor. The equipment industry requires partnering with a semiconductor manufacturer. And it's a

very iterative process. And you have to be able to work with manufacturers all over the world. And for whatever reason, the US and Europe have developed those interactions all around the world. And China hasn't.

Part of it is a fear that every time China gets involved in something, they want to take the technology. They don't have the historical tentacles with all the manufacturers in Europe, all the manufacturers in the United States, in Singapore, they don't have those tentacles. And so, it'll make it harder for them to develop an equipment business.

Allison Nathan: So your prediction having known this industry backwards and forwards for many decades, we're not on the verge of a big shift in how the semiconductor industry looks and how the supply chain works because it's just not feasible for the US or China to really move in that direction?

Richard Hill: Yeah. I don't think we'll see that.

Allison Nathan: We're having these policy constraints that are making life more difficult for both the US and China, then what are the implications of this policy?

Richard Hill: The implications are costs will go up for the consumer. Because largely this technology is targeted at consumers. It's already astronomically expensive. And this will just make it more expensive.

Allison Nathan: So, we're not going to redirect supply chains. We're just going to make it more expensive for all of us?

Richard Hill: Yeah, pretty much.

Allison Nathan: Thanks for joining us for another episode of Goldman Sachs Exchanges.

And before you go, we'd like to introduce a new podcast from Goldman Sachs Exchanges. It's called The Markets. Each week in just 10 minutes or less, we'll be breaking down the key issues moving markets that week, giving you the information you need to stay ahead.

On June 16th, The Markets will be leaving our Exchanges feed. So, make sure to search for The Markets and follow its new podcasting feed wherever you get your podcasts.

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