EconoFact Chats: The CHIPS Act and Onshoring Semiconductor Production
Chris Miller, The Fletcher School at Tufts University
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I'm Michael Klein, executive editor of EconoFact, a non-partisan web-based publication of the Fletcher School at Tufts University. At EconoFact, we bring key facts and incisive analysis to the national debate on economic and social policies, publishing work from leading economists across the country. You can learn more about us and see our work at www.econofact.org.

Michael Klein
In August 2022, the Creating Helpful Incentives to Produce Semiconductors in Science Act was signed into law. The acronym for this is, of course, CHIPS, and the law is meant to bring microchip manufacturing back to the United States after decades when the fabrication of semiconductors moved to places like Taiwan and South Korea. The impetus for the CHIPS Act was the prevalent role that microchips play in the economy, and the fact that they are found in everything from smartphones and personal computers to cars, watches, and medical devices. Now, almost two years into the CHIPS Act, how successful has it been in bringing semiconductor fabrication to the United States? Why is it important to onshore this production? And what will be the ultimate effect of this legislation? My guest today, Professor Chris Miller, is well positioned to answer these questions. He is the author of the bestselling 2022 book, Chip War, The Fight for the World's Most Critical Technology. The book won the Financial Times Business Book of the Year Award. Chris is my colleague at the Fletcher School at Tufts University, and I'm very pleased to welcome him back to EconoFact Chats. Chris, thanks for joining me today.

Chris Miller
Thank you for the invitation.

Michael Klein
Chris, to begin with, can you briefly describe what microchips are and how pervasively they're found in products today?

Chris Miller
A chip is, in most cases, a tiny piece of silicon, which provide almost all of the computing and communications and sensing capabilities that we rely on. As you said in the introduction, they're certainly in our phones and in our computers, but they're also in almost every good today that has an on-off switch, whether it's household appliances like refrigerators or dishwashers, whether it's industrial equipment, airplanes, cars, medical devices. We rely on thousands of chips just going about our daily lives. The trend as systems get more advanced is that they have more chips inside
of them. Today, it's not just the tech sector that needs chips. It's basically every segment of the economy.

**Michael Klein**
I don't have as a consumer good, any military hardware in my house, but they're vital for military uses as well, correct?

**Chris Miller**
That's right. The first chips that were invented were initially used for guidance computers in military applications. Today, militaries are relatively small consumers of chips in comparison to civilian markets. Around one or two percent of chips that are produced each year go to military applications, but for advanced technologies, they're critically important. That's why, just like in the past, today as well, the military remains a important funder of research into high-end chips.

**Michael Klein**
Chris, I was really impressed by your book, Chip War, as were the judges at the Financial Times who selected it to be the Business Book of the Year in 2022. One of the things that really struck me was how complicated it is to produce microchips, and how that technology has evolved since the 1960s. Can you briefly recount this?

**Chris Miller**
To make chips more advanced, our technique has been to shrink ever smaller the components that are on chips. Today, if you buy a new smartphone and look at the primary chip inside, you'll find that it has at least 10 billion microscopic components that are carved into the silicon. Today, these components are often the size of a virus or even smaller. To make billions of virus-sized components at a commercially viable price point has required some of the most complex supply chains that have ever been put together. And so today, advanced chipmaking requires extraordinarily precise tools, ultra-purified chemicals, very unique software capabilities that are sourced from multiple different countries, from Japan, from the U.S., from Europe, and often brought all together in Taiwan and Korea where most of the advanced chips are made. So today, if you look at where chips come from, it's usually from East Asia like Taiwan or Korea, but they're only possible to make at the cutting edge level, taking advantage of components and inputs that are sourced from all the other of the world’s leading advanced economies.

**Michael Klein**
How much would a fabrication plant cost to construct?

**Chris Miller**
A single plant costs, if it's at the cutting edge, over $20 billion. Right now, there are a couple of big plants in construction phase in the United States right now. Samsung is building a plant in
Texas. That's the second largest foreign investment project in U.S. history, and TSMC, a Taiwanese company, is in the midst of the largest foreign direct investment in U.S. history via a major plant in Arizona. Every new chip plant that is made at the cutting edge level ends up being the most expensive factory in human history because they get more expensive every single year.

**Michael Klein**
So you mentioned TSMC, which is in Taiwan, and Samsung is in South Korea. These aren't the most stable regions in the whole world in terms of political, and perhaps military conflict, right?

**Chris Miller**
Well, that's right, and that's part of the reason why there's been concern about the structure of the chip industry's manufacturing base. And on the one hand, it's become clear over the past couple of decades that there are huge economies of scale that accrue to firms that are able to build bigger and bigger facilities. And that's why right now there are just a couple of companies in just a handful of countries that can produce chips close to the cutting edge. And that's economically rational to produce chips in as concentrated a fashion as possible, given the economies of scale. But the problem is that this production has not been taking place in places like Switzerland, but rather almost all in East Asia, and in particular in Taiwan, which of course faces regular potential threats from China.

**Michael Klein**
So during the pandemic, were there any events that indicate to us what the effects of a chip shortage would be?

**Chris Miller**
Well, the pandemic did indeed give us a sort of dry run of a chip shortage when certain types of chips were in short supply. What most people don't actually realize is that the pandemic era chip shortages occurred at a time when actually the world was producing more chips. We produced more chips collectively in 2020 than in 2019 before the pandemic, even more still in 2021. But because of weird supply and demand imbalances that were caused by the pandemic, for example, a lot of people bought new computers as they prepared to work from home. There were certain types of chips that were in shortage. And these were often chips that are used in cars or industrial equipment. And it caused delays and manufacturing issues across the economy. So, the auto sector, for example, globally, auto companies are estimated to have lost several hundred billion dollars in sales of cars that they couldn't produce or couldn't finish due to chip shortages. The same is true for agricultural equipment, for medical devices, for many other segments of the economy that you might not think of as being reliant on semiconductors. But today they can't make the products without lots of chips.
Michael Klein
So, some of the stated purposes of the CHIPS Act are to bring this manufacturing onshore to the United States for both national security and employment reasons. But you're talking about how incredibly complicated and sophisticated the manufacturing process is. So, given that, how realistic is that goal? And would manufacturing chips in the United States be more like leapfrogging the advances learned elsewhere, or would it be more like trying to play catch-up?

Chris Miller
Well, I think if you listen to some political leaders, they will talk about jobs created, and they'll talk about self-sufficiency. In reality, the number of people employed by a cutting-edge chip plant is pretty small because they're highly automated. And so, I think we've got to differentiate a bit between some of the political rhetoric and some of the actual causes of why the CHIPS Act was passed. To me, I think the primary cause, the reason that Congress decided it was wise to spend $50 billion of taxpayer money to subsidize a profitable industry was concern about concentration in East Asia. I think onshoring is a not inaccurate way to describe the trend, but it's really about diversification. I think the U.S. government and the Japanese government and the European governments, they've all been actually working together a fair degree to support diversified supply chains, and you've seen officials from all those countries be verbally supportive, and I think practically supportive of projects in those countries, too, on the grounds that it provides a more diversified manufacturing base. The challenge is that for many types of chips, the most efficient places in the world to produce them are either in Taiwan or Korea, not because of labor costs. Labor costs are actually a pretty small share of the total cost of running a chip plant, but because the scale of investment that has gone into both of these countries over the past several decades means that they have the densest availability of materials and chemical suppliers, of experts in fixing different types of tools that are necessary, and construction workers that have already built 10 different chip plants, and so the 11th, they can be very efficient in the production of. It's that ecosystem dynamic that explains the cost differential in Taiwan or Korea, which is why if you want more chip plants built somewhere else, you've got to subsidize, and that's essentially what the CHIPS Act is intended to do.

Michael Klein
So, as I mentioned in the introduction, the CHIPS Act was passed in August 2022. Almost two years in, what has been the impact of that act? Are fabrication facilities being built in the United States? You alluded to some before. How pervasive is that?

Chris Miller
You know, I think the data we have thus far is that there has been a tremendous upsurge of investment in chip making facilities. There's different data sources that you can consult, but whatever you look at, you see something around a 10 times increase in investment relative to the trend over the prior decades. There's been a huge response, and the scale of facilities that are
underway are quite large, among the largest construction projects underway in the world right now. In some ways, that's not surprising. If you subsidize something, you'll get more of it, but I think the amount of investment that has come relative to the size of the subsidies is probably on the higher end of expectations. I think for people in the U.S. government who were worried about geopolitical risks around places like China and Taiwan, this surge of investment is seen as a data point suggesting that the CHIPS Act has been successful.

Michael Klein
Chris, you have a recent article in the Financial Times, and in that article you use the term ‘foundational chips.’ I guess that means that they're the most basic ones, is that correct? What can and can't those chips do as compared to perhaps more sophisticated ones? Finally, are the fabrication facilities that are being built in the United States only manufacturing these foundational chips, or the more advanced ones as well?

Chris Miller
You can divide types of chips on two different axes. First, they're chips that do different types of things. They are processor chips, memory chips, and sensors, for example. You can also define them based on the precision of the manufacturing process. Every year we get better and better at manufacturing. For certain types of applications, like AI training or managing the processor in your smartphone, you really want the most cutting-edge manufacturing because it's so computationally intensive. For other use cases, like in your refrigerator, you don't necessarily need high-end computation, so you use older and cheaper manufacturing processes. These are called foundational chips. They provide the foundation on which the rest of the manufacturing base depends. The CHIPS Act has provided subsidies for investments in both the cutting-edge and the more foundational chips, on the ground that you probably want a bit of both. You need chips for AI, but you also want chips that are going into household appliances and cars and industrial equipment. There's a concern right now in Western countries that, although the U.S. and Japan and Europe are subsidizing the production of foundational chip making facilities, actually the scale of investment going on in China right now is multiple times the level of the scale of subsidization in the West. There's some concern that actually Western firms won't be investing as much as they otherwise might because of the level of subsidy in China. This is an emerging area of debate. We saw just a couple of weeks ago the Biden administration announced higher tariffs on chips imported from China driven by concerns over this issue.

Michael Klein
I imagine that in these other countries, the reasons for government support of the semiconductor industries and the incentives being put in place are similar to the reasons that the American government has. Is that right?
Chris Miller
I think that's generally true. If you look at Europe, if you look at Japan, there's a desire for diversification and more supply chain resilience. I think the exceptions are countries like India, which historically has not been a major producer of semiconductors, and the government has been extraordinarily generous in putting up incentives for building a chip fabs with the goal, not just of strengthening the industry and expanding it, but actually creating a chip industry. That's less about supply chain diversification. It's more about trying to stand up a new industry that the Indian government hopes will be profitable in the long run. I think that's a different type of industrial policy challenge, if you will, than the aspirations that we see among U.S. or Japanese or European policymakers.

Michael Klein
So if all these countries are successful in creating greater fabrication facilities, what would that do to supply chains, and how would the landscape for chip manufacturing and the manufacturing of other things that use chips look in the future?

Chris Miller
Well, I think there's no doubt that we're going to get a lot more chip manufacturing facilities built in China, and a whole lot more built in the United States. You already basically see this because factories take so long to build. We more or less know right now the amount of capacity that will be coming online in a couple of years time. And so certainly the industry will have bigger footprints in both China and the U.S., and the U.S. particularly at the higher end, where the U.S. can have much larger capacity to produce the types of cutting-edge chips like those that are used in AI training. China more in the more foundational chip space because that's the type of technology that China is currently able to build at scale. And I think it means that some of the existing players like Taiwan and Korea do to some extent feel squeezed in between because it's difficult for them to match the level of subsidy, and because many of their customers already feel like they're already plenty reliant on production in Taiwan and Korea, and might like a bit more diversification for resilience reasons.

Michael Klein
So some people have voiced concern that there could be an oversupply of chips. What would the problem be in that case, and how real is that concern?

Chris Miller
Well, I think it is a real concern. The good news is that we're going to need a lot more chips in the future. And so, every private sector projection that you look at envisions the world consuming far larger numbers of chips in 10 years time than it does today, driven by digitalization, driven by AI, driven by a lot of these big economic factors. But the fact that basically every major economy is subsidizing, I think, does raise concerns that there will be
non-economic decision making by companies when they decide to invest. I worry a bit less about this in the United States, for example. In the U.S., the CHIPS Act is going to fund ballpark 10% or 15% of the capital cost of most projects, which means that companies are still on the hook for 85% of the costs. And so, this could lead to a bit more production than you otherwise have. But I think if I put myself in the mind of the TSMC leadership or the Samsung leadership, they still have tens of billions of dollars at stake in making sure these projects pan out. And that's a pretty strong incentive not to overproduce. I think the primary concern is actually not in the U.S., but in the production of foundational chips in China, where you've got very large dollar volumes going, being invested, and where historically there's been much less focus on building profitable and effective businesses. And so, unlike the U.S., where you've already got companies regularly being asked by their investors on quarterly earnings calls, for example, are you worried about overcapacity? What's your strategy? In China, that dynamic is much less present. And so, I think the highest likelihood of overcapacity is in foundational chip capacity produced in China. And I think this is why we've seen the U.S. and Europe and Japan begin to think about policy responses in reaction to this.

**Michael Klein**

Well, you alluded earlier to the fact that the Biden administration has put tariffs on imports of chips from China. It doubled the tariff rate from 25% to 50%. Why do they do this, and what do you think the impact of that will be?

**Chris Miller**

Well, I think they're driven by concerns about overproduction in China that is not conditioned by economic factors, companies that don't need to make money over the long run, companies that are responding to either government diktat, or just not facing real market dynamics and so can produce in uneconomic ways over a long period of time. I think the actual impact of the tariff rate increase is not going to be that significant on its own. The U.S. actually doesn't import very many chips from China. It imports a lot of Chinese chips, but they're assembled into electronic devices in Vietnam or in Thailand. The supply chains are very complex, and so most of the Chinese chips currently used in the U.S. are actually imported from third countries where the devices in question are assembled. The number of chips that will be impacted by these tariff rate increases is going to be pretty small, but I think the administration intended this as a signal that it's willing to take more dramatic steps. A signal both to Beijing, but also, I think, to Western companies, where it's hoping that Western companies will choose not to become bigger buyers of Chinese chips, because if they do, they might face higher tariff rates, for example, or more regulation in the future. And so, I think it's an open question as to how effective this strategy will be, but I think it's probably the first step of what will be a multi-pronged effort to limit Western firms' purchases of Chinese chips.
**Michael Klein**
And the concern is that that would hurt chip producers in the United States, but it would be an advantage if the chips were cheap for car manufacturers or refrigerator manufacturers if there was a big glut of chips and the price went down, right?

**Chris Miller**
Yeah, that's right. That's right, and that's part of the debate. I think if you talk to policymakers, they are concerned about the impact on chipmakers in the U.S., for example, and you've already seen a number of instances where U.S. chip makers have been accused by their investors of over-investing on the grounds that more capacity is coming online in China and therefore prices are going to fall. So that dynamic is already present in the market. But I think actually what's more important in driving U.S. policymakers is concerns about what's increasingly referred to as economic security issues. In other words, if the pandemic illustrated that U.S. car companies could face over $200 billion in lost sales due to chip shortages, the U.S. is concerned that if more manufacturers become reliant on, in some cases, single-sourced suppliers of chips in China, that this could provide China with leverage, sort of like the leverage that Russia tried to exercise over Germany with regard to national gas. I think the Russians learned that natural gas being a commodity is actually not a great source of leverage. But by contrast, the chip industry, because it's actually not commoditized, every chip is totally different, we learned during the pandemic that actually the costs to manufacturers are quite large. I think this is actually the primary concern that is driving U.S. policymakers to respond in this sphere.

**Michael Klein**
Yeah, when you make the argument of not having the government intervene, it's often based on the idea of relatively easy exit and entry into an industry. And with what you were describing, it's anything but with chip manufacturers where you have these incredibly complicated and sophisticated plans. So, I guess that's the argument behind the argument in terms of why there should be government incentives to help boost this industry.

**Chris Miller**
Yeah, and I think we sort of saw that during the pandemic shortages. You would have thought that a component shortage that cost auto manufacturers billions and billions of dollars would be solvable by money alone, because they ought to have been willing to pay billions and billions of dollars to get new supply online. The reality was it just isn't easy to bring supply online rapidly. And so, it took almost two full years to get the auto shortages sorted out. And in the meantime, the cost to manufacturers was really substantial.

**Michael Klein**
So, Chris, the last time I interviewed you for EconoFact Chats, it was when Chip War first came out. And I quoted a blurb from Larry Summers for your book, in which he said, “semiconductors
will be for the 21st century, what oil was to the 20th century, a central and integral part of the world's economy.” Your book, Chip War, helped millions of people understand why. And I think this conversation will help our listeners understand the government's efforts to foster this industry. So, thanks, Chris, for joining me once again on EconoFact Chats.

**Michael Klein**
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