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**WILLIAM  
BONVILLIAN:**

In some ways, today's class, it's the most challenging of the semester. These are really complicated, difficult threshold issues. And we're just starting to see the powerful ramifications of having gotten a number of things wrong in this space and what it does. So I try to put the manufacturing stuff in early so you'd see that there are real issues here, not just kind of abstract science policy questions, but real issues that have big implications.

So let me start with Samuelson. And you're all probably familiar with him, but probably among a handful of the most famous economists of the 20th century-- one of MIT'S great stars, an amazing figure, lived well into his 90s.

I heard him talk just a few years ago, before he died. And he was incredibly sharp and funny and astute-- just a phenomenal figure. And he really rethought-- really was a foundational creator of neoclassical economics-- the attempt to bring discipline metrics to economic thinking.

So then he writes this surprising piece in 2004, which takes on mainstream economics. Now, he had actually done writing on this topic, coming to somewhat similar conclusions much, much earlier in his career. But he comes back to it in this piece.

And it took everybody aback, right. Mainstream economics had thought this was a completely settled territory. Mainstream economists like Greenspan, Jagdish Bhagwati, Gregory Mankiw, they were arguing-- and this is a quote from Mankiw-- "Yes, good jobs may be lost in the short run, but still total US net national product must, by economic laws of comparative advantage, be raised in the long run-- and in China, too. Never forget the real gains of consumers alongside admitted possible losses of some producers in this working out of what Schumpeter called 'creative capitalist destruction.'

Correct economic law recognizes that some American groups can be hurt by dynamic free trade. But correct economic law vindicates the word 'creative' destruction by its proof that the gains of the American winners are big enough to more than compensate for the losers."

And then Samuelson concludes, "The last paragraph can only be in innuendo, for it is dead wrong about the necessary supply of winnings over losings." So here is the guy who created mainstream economics taking on the whole economic mainstream assumption about the benefits and gains of trade. And it's a startling moment. This article was like a bombshell in 2004.

So how could the US be a loser in competition with a low wage, lower cost competitor like China-- obviously, there's others-- despite David Ricardo's theory of comparative advantage? And remember, we talked in the first class about Ricardo's theory of comparative advantage.

We had the example of Portugal and England. England gets a lot of rain, and it has a lot of grass. It grows sheep. Portugal has a lot more sun and a lot less rain. It grows grapes. It produces wine and port. Each side trades to their comparative advantage.

Now, he's thinking of a resource advantage, right. He's not thinking about a comparative innovation advantage. So what happens in the time from Ricardo to the present, is that nations begin building a comparative innovation advantage through building strong innovation systems, right. And arguably, the US leads that effort, coming out of World War II to develop a comparative innovation advantage.

And Samuelson goes on to argue that if China or another comparable country begins to make productivity-enhancing gains in its production and couples that with a wage advantage, it can capture some of the comparative advantage that had belonged to a competitor like the US. So in a Ricardo sense, there's never unemployment that lasts forever from trade. It will eventually sort itself out, right.

But the way in which it's been sorting itself out is that, as he puts it, real wages have been lowered by this version of dynamic fair trade. So to compete, wages come down, right, in the US. And that's what's been going on.

So wages can drop after a time to a point where a productivity enhancement or productivity advantage in another country is offset. But these are still net harmful terms of trade.

And this is not a new story, right. This story has been going on for a long time, Samuelson argues. So farming moves from the eastern part of the United States to the Midwest.

That's a straight comparative advantage-- the ability to scale up agricultural production in the

Midwest, as opposed to the more crowded East and hillier East and rockier East. We can see it. We understand why agricultural production shifts to the Midwest.

Textile and shoe manufacturing moved from New England to the lower wage South early at the beginning of the 20th century. English manufacturing leadership shifts to the US, starting in the middle of the 19th century, right. We develop the early stages of mass production through interchangeable, machine-made parts, not Britain. And we'll talk more about that in a later class.

So as Samuelson puts it, even where the leaders continue to progress in absolute growth, their rate of growth tended to be attenuated by an adverse headwind generated from lower wage competitors and other technical imitators in each one of these examples. Right, so this is an old economic story that he's raising.

So a productivity gain in one country can benefit that country alone, while permanently hurting the other country by reducing the gains from trade that are possible between the two countries. And all of this, he acknowledges, is long-run Schumpeterian effects-- creative destruction of capitalism effects. And he concludes that in effect is a roulette wheel of evolving comparative advantage.

Now his warning is a powerful one. If you respond with tariffs and protectionism, you will be breeding economic arterial sclerosis. You will be limiting your ability to effectively and efficiently compete. So that's not a fix in his mind.

So this is one of the most important economists of the last century, and a good part of this, weighing in on an historic conclusion that economics came to about the overall benefits of trade, and saying it's a much more complicated story than that. So it was a powerful message when he put this out.

So I just finished talking about Samuelson. So we're all set up for you to do us your view of Samuelson and lead us into some Q&A.

**AUDIENCE:**

He sounded very certain of all of this, right. And this was something that a lot of people actually asked about as well, is if he's so sure if this is something that's regarded to be pretty substantial, why did it take the mainstream and why did it take economists at large a lot of years to start changing their mentality?

And I remember last week, we were talking about the US's hesitation as a country to change

their economic outlook in certain ways. So I was wondering if anyone thought that those two were related somehow. So it's kind of two separate questions. Why did it take forever for people to start adopting his views? And does it have something to do with cultural factors in the United States or any other factors?

**AUDIENCE:** Yeah, I have a comment. It's Lilly. I was thinking about the timeline. So Samuelson starts to put forward earlier than the 1970s or even in the '60s? Because he got the Nobel Prize in '72, and in his speech he talks about it.

**WILLIAM BONVILLIAN:** Yeah. And this is not the main work for which he's been recognized for. But with an economist named Wolfgang Stolfer, the two of them put out a doctrine on advantages and disadvantages of trading regimes pretty early in their career. And I'm thinking the '50s, but I'd have to go back and check the actual dates.

**AUDIENCE:** OK.

**WILLIAM BONVILLIAN:** So he kind of launches that theoretical, highly mathematical framework. He returns to it in 2004 because, in his view, the mainstream of economics, which, of course, he created, has taken a departing path by assuming the continuing eternal benefits of free trading system without really analyzing the competitive processes that are going on here.

**AUDIENCE:** Yeah.

**WILLIAM BONVILLIAN:** And just add one more thing, Lilly, there's an economist at MIT named David Autor who is doing startling work-- and I refer to them in some of the other readings we got into-- but doing startling work on these very significant trade impacts.

**AUDIENCE:** Yeah, I listened to some of his interviews. But I'm kind of wondering what precipitated Samuelson to write this sort of explosive article. I'm trying to think back. And I think Alan Greenspan-- wasn't he the economic advisor during the Clinton era? So he would have been--

**WILLIAM BONVILLIAN:** No, he was in the Bush--

**BONVILLIAN:**

**AUDIENCE:** He was?

**WILLIAM BONVILLIAN:** --II regime.

**BONVILLIAN:**

**AUDIENCE:** OK.

**WILLIAM** Right.

**BONVILLIAN:**

**AUDIENCE:** OK. OK, so then NAFTA pre-dated Greenspan. But yeah, I'm just wondering about the timing of this article and what really prompted Samuelson to finally be like, listen, everyone, this is completely wrong. Yeah, maybe people weren't paying attention until post-NAFTA or other trade agreements, and then it started to become really more noticeable?

**[AUDIENCE:** I mean, we'd discussed before that the US doesn't really respond until things start going south, right. So. **[CHUCKLES]**

**WILLIAM** Yeah, our motto could be "be unprepared."

**BONVILLIAN:**

**AUDIENCE:** Or I would have loved for Mankiw to say that quote, like, OK, yeah, tell that to the losers. **(LAUGHING)** Like, it's totally fine. Don't worry. The winners are going to win higher than the losers are going to lose, so it's OK.

**WILLIAM** Right. And it's not that there haven't been a significant net gains, right. Consumers are, no  
**BONVILLIAN:** question about it, significant beneficiaries of the regime. But there just are dramatic effects, is what Samuelson is arguing.

**AUDIENCE:** And I think it sort of assumed in creative destruction that like, the winners win bigger than the losers are going to lose. And then you center the winners-- I don't know. Maybe in the US we've just been the winners for like a lot of these consecutive creative destruction periods or cycles.

And then we have to deal with sort of competing productivity rates, I guess, **[INAUDIBLE]**. And then now it's probably a little bit more of an issue in China.

And so the losing end starts expanding towards Samuelson's sphere of influence, which is probably inside the US. And he writes this in, what, in like 2004? And so China is really becoming sort of the forefront of what we're considering.

And I guess, I think Greenspan-- I just looked him up-- he's like chairman of the Fed at this

time, from '87 to 2006. So he sees all of this, but he's just probably not in a position to respond.

And he can't really kind of shift everybody's opinion here, because there's a lot of, I guess, sort of like gravity in the way that mainstream economics is thinking that he's just got to follow that, I would say.

And then, while Samuelson doesn't really have these restrictions or rules [INAUDIBLE]. He's got the backing of having created and the legitimacy of having created mainstream economics. So I think it's pretty OK to disagree with yourself. But it's probably a little bit harder to disagree with the massive wave of folks, which is why it might have taken these other folks a little bit more time to respond,

**AUDIENCE:**

He always wanted to break the status quo, it seems, with economics. Well, regarding the winners-and-losers discussion, I think people also mentioned that that sort of thought process might drive a wedge, too, that could create income inequality.

And the question was, does this model of international trade-- does free trade inherently create that income inequality? Or are there other things that contribute to that?

**AUDIENCE:**

Yeah. But what I would add to that is, so maybe we do make more money than we lose, right. But the distribution will be affected, because most likely it will be-- I think I made this point last week with one of the Intel founders, where it was like, you end up making way more money, but you're not going to spread the wealth, because those jobs that amass the middle wealth aren't here. So I think, yeah.

**WILLIAM**

Yeah, that was your quote, Martin, from Andy Grove of Intel. It was a great quote.

**BONVILLIAN:**

**AUDIENCE:**

And so I think that's a big problem. Especially with like, Apple, most of the manufacturing work is outside the US. And the other problem, too, that we haven't gotten to is taxes. A lot of times companies use tax loopholes effectively. So maybe that money should be coming here.

And I think I made this point when I was making my notes on this piece, is there's a lot of hidden variables. And the author constrained his variables in such a way to make a certain point. And there's a lot of variables that he didn't take into account for how people actually do things. So theoretically, it might work out. But in terms of the actual, how it gets done in practice, I don't think it does.

**AUDIENCE:** Does Autor take into account, maybe in his mathematical laws a couple of these tax loopholes and how people are actually sort of using these systems, rather than kind of ignoring them as variables to kind of make their point here? Because I wonder if Autor is analyzing the way that people actually and effectively use these trade laws in this kind of globalized system. Like, will he arrive at the same result? Or will we end up getting that income inequality?

**AUDIENCE:** But like, one of the papers that he wrote looks at specific communities or areas that were heavily focused on an industry that's now gone. So it's looking at real people and how their real incomes have changed. So I think it was like furniture in North Carolina or something like that.

And so you can prove just by looking at that group of people before and after that there has been income changes and that the support that they're receiving from the government hasn't made up for those changes in income that they're getting. So if you use that as an example, that can show that those income inequalities remain.

**AUDIENCE:** OK, well, I think a lot of the economists who are mainstream economists who are providing globalization, when they talk about net gains being made, they talk about [INAUDIBLE] they almost necessitate this assumption that they all get spread out. But we don't necessarily see that for sure.

I do feel like [INAUDIBLE] like it was a little bit of a contrived example. But I think that is to the point that what he was doing was specifically showing that current ideas about globalization always being good isn't always true. And he only really needed to provide a single example there to explain why China and India were [INAUDIBLE]

**AUDIENCE:** Just to add, I think that another point was that a lot of this debate is kind of predicated on the idea of trickle down. And I think going back to the question of why now, or why are we [doing this now, is that you've kind of been successively proving that trickle down has some limitations-- has a lot of limitations-- especially considering developments in other countries and how the market clearing wage rate of the United States has just been subject to a natural reduction due to increased capital and innovation in other countries. And so the gap between the winners and the losers kind of has a widened and has made that trickle-down process even less [INAUDIBLE].

**WILLIAM**

So why don't we dive into the next reading, which was Gary Pisano and Willy Shih. And that's yours, too, Kevin, right? OK, great. I'll just summarize very quickly. And you can add more.

**BONVILLIAN:**

But this is an article they wrote. They later turned this into quite a well-known book. And in this article-- and they later expand on it-- they look at a whole set of technology areas.

But they start from the Kindle 2 and point out that very large portions of that technology can no longer be produced in the United States. This is the source for a number of the components, that it can only be made in various countries abroad.

So they argue that there's an eroding US ability to create virtually every brand of notebook computer, except Apple. And mobile handheld designs are now largely in Asia, as well.

So then they look at a whole series of technology fields, right, and find that there's been a lot of erosion in US leadership in a series of these areas, from advanced materials to computing and communications. They identify fields that are gone. And they identify fields that remain competitive and at risk. Same story for energy technologies and storage, for different aspects of semiconductor industry and for the display sector.

So the erosion of these industrial capabilities, they essentially portray. So they help us take the Samuelson theory and make it much more concrete in terms of actual affected industry segments that are no longer present at significant scale in the US. So let me leave it to you, Kevin. It's all yours.

**AUDIENCE:**

Well, that's true, yeah. The, I think, big focus in the paper was the destructive behavior that outsourcing has caused. And you're right. Like you said, it's causing the ability for the US to create now.

And I think following our previous talks on how governments should intervene in these kinds of situations to sort of fix the issue, what role should government play in intervening in company decisions that affect their profits when innovation for the US is the consequence-- the US being able to influence the consequence to any [INAUDIBLE]?

**AUDIENCE:**

Well, one answer is, [INAUDIBLE] I was wondering, does this outsourcing, other than unemployment, does this really harm the US to that extent? Because they argue that there's a reduced industrial commons?

And what if this transfer of industrial commons in other countries-- does it really affect the US



that much? Why can't the US still benefit from industrial commons from overseas other than loss of employment? Do you see what I mean?

**AUDIENCE:** And I think that's an especially relevant point in this innovation wave where a global economy is more relevant than it was in the past. I don't know the answer to that question. [LAUGHS]

**AUDIENCE:** If I had to guess, I'd say that, well, we can benefit from it. But the benefits that we would get would be orders of magnitude less than the benefits of the country that hosts this industrial commons, right?

**AUDIENCE:** Mm-hmm.

**AUDIENCE:** So it would mean having employment benefits. They'd get extra tax revenue. Just, their economy in general-- like they might be able to even undergo an entire innovation wave because of this.

So yeah. It's not so much that we can't benefit, so much that it is that other people are benefiting more, which means that they can get ahead in other technologies. So if you look at long-term, then that puts them ahead in a lot of other fields. And that's just not good for the US interest.

**AUDIENCE:** So but to that point, yeah, it might help in the short-term, but then the long-term what happens is they build up capabilities that we've just never had. Like in business, we talk a lot about compound interest. So a lot of the value will be created in the future.

So the problem is more like 10 years in the future, they can produce things that we never build up the capability. And those are things that it's not like knowing-- it's like actually creating your supply chain in a certain way and creating the system. Silicon Valley took like 80 years to become Silicon Valley because you need a lot of [INAUDIBLE], a lot of mentors, a lot of different expertises.

And so my big worry when I'm reading this is more that we are very short-term-focused in the US. We don't really save. We always assume the future's going to be optimistic. And this is a point from Peter Thiel, Professor, since I know you kind of like him. And like Asian countries tend to be more-- let's say I think, like 30% to [INAUDIBLE] a long-term focus.

So I think that's really a key point with this piece, that we're very short-term-focused. We're

trying to find the big win very quickly.

So that's why our industries are kind of like tech-- technologies that don't matter as much-- Wall Street, finance, which debateably doesn't add that much value. And these other industries take a long time. But you'll get a lot of capabilities that you won't be able to get.

**AUDIENCE:** What was the paper where-- it was Japan that looked hundreds of years into the future and have that anecdote about an advisor or someone. And he said, oh, yeah, this is my plan for the next 100 years. And he was criticized for thinking too short-term.

**WILLIAM** [CHUCKLES]

**BONVILLIAN:**

Right.

**AUDIENCE:** I think it's interesting also-- I understand very strongly the point you're making about how other countries would then benefit when we move our [INAUDIBLE] overseas-- but what's the link between maybe moving those processes overseas and making room for new ideas to be borne?

And if maybe the US takes on more of an innovative and purely like the idea-- like blackboard kind of innovation-- and then ships the idea to another country where they can actually produce them? Does there need to be that separation for us to be able to have the room to innovate? Or can we still innovate and keep all of our stuff here?

**AUDIENCE:** I think we can innovate. I don't know that the US would like moving most of their profits overseas.

**WILLIAM** Let me jump in with a couple of slides that I was going to use later. But they're relevant-- very  
**BONVILLIAN:** relevant to this discussion. So this is the share of employment in services versus manufacturing. So that's the left-hand chart.

So services in the US, 86%, production, 14%. It's actually somewhat lower than that. And then that's the share of earnings in the Standard & Poor 500 coming from manufacturing versus services, right.

So one reason why you manufacture is, that's where the money is, right. It's not in services. So if you develop an economy that's overwhelmingly services, as we have been heading for

for a long time, look at the returns, right.

And then-- I'm really jumping ahead here-- but let's look at the trade balance for high technology goods versus all manufactured products. So the US is running a gigantic trade deficit in all manufactured products.

But now, we're running a major trade deficit in advanced manufacturing technologies. So that goes right to your point, Chloe, right? Let's cede commodity production and make it up on the high end. Except we're not doing that, right. Instead, the whole picture looks bleak.

[LAUGHTER]

Right. This class is designed to scare you to death.

**AUDIENCE:** Yup.

[LAUGHTER]

**AUDIENCE:** [INAUDIBLE] I find that isn't it counter-intuitive for the US to train so much international students, and knowing that most of them will return to their home country and contribute to the industry commons over there?

**AUDIENCE:** Well, see, that's fascinating, because I heard the assumption actually be that the US keeps the international students, and that's why. I mean, we've mentioned it in several classes, right? Yeah, [INAUDIBLE], right?

**AUDIENCE:** They might still do.

**AUDIENCE:** Probably true, but maybe at a lesser rate. Because I think the opportunities available now in the US manufacturing sector, just like outside the US-- for people that come here and do train, it's now a lot more feasible for me to go back, whereas previously I would have had to stay. And so we're seeing sort of a decreasing rate [INAUDIBLE] to stay.

**AUDIENCE:** More desirable to stay, right? It's like the common example we've used in class, I think maybe two or three times, is that with every diploma and cap received in the US, we should staple a visa.

**WILLIAM** Heck, let's staple a green card. To heck with the visa.

**BONVILLIAN:**

[LAUGHTER]

**AUDIENCE:** A green card, sorry. That's what I mean. But yeah, so what does the data actually look like on that bill?

**WILLIAM**

**BONVILLIAN:**

Well, a significant portion of students from abroad do stay here, right. But the numbers are in decline. And more are going back to their home countries. But does that mean-- you all tell me-- that the US ought to close its doors to international students? Right, is that what we should do? Right, is that the right economic strategy? We've got somebody who thinks it is, at the moment.

**AUDIENCE:** You know yesterday he passed another one, right?

**WILLIAM**

Yeah, I know.

**BONVILLIAN:**

[LAUGHTER]

No. No, really-- I'm asking in a serious kind of way. I mean, the US model, historically, was to have these international universities and attract talent from all over the place. Because if you're running an innovation system that feeds talent for the entire world, what an incredible competitive advantage, right? What an incredible competitive opportunity.

But I think the other side of that coin is that it's a value in itself. And yeah, you really asked some terrific questions in your email to me. And this is one of them. What are these Americans doing? Right. What do they think they're doing here?

But I still think it's of overall value to have as much talent here, because that's how knowledge gets sharpened, right. That's how we get sharper and better. And so that would be my argument. But people should feel free to disagree.

**AUDIENCE:** So in a way that-- I feel really uncomfortable when people say, I want to play the devil's advocate. Because I feel like those people are trying to be incendiary.

But I certainly have had peers in the past that would have raised the point of this conversation about whether students who are coming from other countries might be considered spies,

because they would be then understanding knowledge and the innovation or sort of innovation paradigm, and then taking it back to their home countries.

And that also makes me feel uncomfortable, because I feel like trust sort of precludes cooperation. And it precludes the United States' ability to work in a globalized system. So I was hoping that you could talk about that a little as well.

**WILLIAM  
BONVILLIAN:**

In the end, having a world talent base with common education experiences-- that's very powerful for the world in general. I mean, that's a real huge net plus. And we can't assume that all innovation is going to happen in the United States and we can wall ourselves off. It's important for innovation to occur elsewhere.

There's an old story about small towns and lawyers, right. So if there's a small town and there's one lawyer, the lawyer is going to starve. If there's a small town and two lawyers, they're both going to get rich, right. Because their clients will be suing each other constantly, right. In other words, they're going to create more net, right.

And if China is doing brilliant things to bring 300, 400 or more million people into its middle class, that's a great thing for the world. That's a great, overall incredible net plus, to create a massive new middle class.

And if the US can't figure out how to take advantage of that, then shame on us, right. Because it's really important that the world do these things, right. Same story in India. Same story and all kinds of other developing countries that are starting to become emerging economies.

So these things need to happen. And we're not going to be able to wall them off. We just have to figure out-- to develop our own competitive capabilities to be participating. That would be what I would argue. Now, a lot of people see this differently. Matthew?

**AUDIENCE:**

I think another benefit-- even if you didn't care about the Chinese middle class or India's middle class, and if you just cared about the US, you'd still have to recognize that we don't have the comparative advantage in everything such as advanced manufacturing. By having those international students there, like say, a Sloan student who was working in manufacturing in China-- just as much as they're maybe benefiting from the US education and that innovation mindset, they're sharing with their peers their experiences.

**AUDIENCE:**

Yeah. I think that's important. And when we consider the educational model and bringing international people into that, I think it's important to not adopt the perspective that we're the

only ones who have anything to offer.

**WILLIAM** You got it.

**BONVILLIAN:**

**AUDIENCE:** Other people bring other perspectives.

**WILLIAM** Right.

**BONVILLIAN:**

**AUDIENCE:** And that's valuable even just for our benefit, not to mention other countries' benefit, which is good.

**WILLIAM** So, Luyao have we answered your question? Yeah? Are you satisfied with what we've talked  
**BONVILLIAN:** about here?

**AUDIENCE:** [CHUCKLES]

**WILLIAM** You can critique us.

**BONVILLIAN:**

**AUDIENCE:** Well, personally I think it, just for the sake of the world, is benefiting to have an international base of talents. And there are countries that see this as a national strategic move, to attract talents, like Singapore. But because they are such a small country and their only resources-- the human talents-- then I don't know if the US sees this as something of national importance.

**WILLIAM** Right. Your Singapore example is very astute. It's really interesting. Because Singapore, at  
**BONVILLIAN:** least until fairly recently, had a strategy for higher education, in particular graduate education, to get its students out into the world, right-- to send them to the best educational institutions around the world, so that they would learn other countries and how they worked and what ideas could be gained from them-- and that they would be able to set up relationships with those countries. They would be able to have working relationships with the communities that they learned.

And Singapore-- small island nation-- city-state, really-- no real resources. They have to trade to live. So they organize themselves around becoming intermediaries in all kinds of trading activities worldwide, whether it's petroleum and oil and fossil fuels, or it's running the world's most efficient port or running the most efficient cargo transport aircraft operation in the world,

they figured out these intermediary spots.

And then they used their relationship building to be able to build the relationships they needed to play that dramatic intermediary role benefited by their geography. So it's a very interesting example, Luyao, of a country that's adopted kind of a broad look at education and where to get it.

**AUDIENCE:** And to add on to that--

**WILLIAM** Please.

**BONVILLIAN:**

**AUDIENCE:** --with that kind of strategy, there are, of course, social costs. There are like local hatreds of international laborers. And the government takes a responsibility to settle this conflict instead of reducing international talents, because they see this as a strategic move.

And so it is the question, like, when we see maybe there is an outsourcing of manufacturing, there are loss of talents. Or do we just stop doing it? Or should the government take the responsibility to solve the social costs associated with this kind of move, together with globalization?

**WILLIAM** Have at it, team. What do you think?

**BONVILLIAN:**

**AUDIENCE:** So on the point of education, higher education, that's one of the US's important abilities. So it's a really good thing.

It's dangerous to assume that that's going to be a core strength for a long period of time. So people will learn from us and [INAUDIBLE] There's a couple good universities popping up in other countries that are doing well.

I think the big danger, though, is the point [INAUDIBLE] made previously about why should [INAUDIBLE] create more value? Because ideas don't matter as much as the execution of ideas.

Like, there's a ton of people who came up with social networks. Facebook had 15 social networks beforehand. But it wasn't until one person executed it right.

So the danger is, we could invent something here, and another company in China has-- he's

like, oh, that's a great idea. We can do that. We can do it better. And we can do it cheaper.

And that's the real kind of thing I would worry about, is that capability of being able to execute. And it's something that's hard to understand until you've see it just happen and gone through it. But that's the danger.

**WILLIAM** So Kevin, how about another question-- a closing question on Gary Pisano and Willy Shih.

**BONVILLIAN:**

**AUDIENCE:** Throughout this whole discussion-- this might be beyond the scope of the class-- there's a question that popped into my head. If there stands to be so much mutual benefit from global cooperation, why don't countries prioritize it?

That might be an idealistic view. But if economies now are so interconnected by trade and competition and everything, why don't governments of the world cooperate to sort of prop each other up?

And I'm as cynical as the next person, right. I understand human greed and the desire for money, right-- desire to be the best. But why can't everyone sort of be the best?

**AUDIENCE:** That's a good question.

**AUDIENCE:** Yeah.

**AUDIENCE:** [CHUCKLES]

**AUDIENCE:** So often the people who have to make these decisions, they usually want to put their people first-- like, hey, America first. So that usually means it's America first at the cost of anyone else.

So if you have 196 governments, all of which who are thinking like that, then, well, you kind of end up where we are today. And it's short-term, yes. And I'll try to play a bit of devil's advocate. I know you hate that, Lilly.

[LAUGHTER]

**AUDIENCE:** Yeah, I hate it.

**AUDIENCE:** I love it. Honestly, I love that phrase.



**AUDIENCE:** As an intellectual exercise, I think it's important.

**AUDIENCE:** Yes.

**AUDIENCE:** But if you do it from not a place of trying to find an understanding with other people, then I think it is irresponsible.

**AUDIENCE:** So I see the-- I lost my point.

[LAUGHTER]

**AUDIENCE:** Global corporate [INAUDIBLE]

**AUDIENCE:** Thank you. Yeah, so I see why long-term it would be good to cooperate. But in the short-term, if somebody, say, reneges on a deal when you've already put billions and billions of dollars into it, that could hurt you significantly.

And then they could get away scot-free. And then they could realize, hey, I've damaged this country that-- I don't know-- for whatever reason, I wanted to have less economic benefit than what I'm getting.

So basically, it comes down to mistrust. So like that could happen. Yes, "we are the world." I'd love for it to happen. But I think it's going to take a long time.

**AUDIENCE:** So to point out, we've definitely done the whole reneging thing a billion times.

**AUDIENCE:** Yes.

**AUDIENCE:** Colonialism exists. So--

**AUDIENCE:** [LAUGHS]

**AUDIENCE:** --we've definitely gone to countries and different places around the world, and really just ravished for resources, technological abilities, what have you. And then, I think there's a longstanding history of us kind of doing that and not doing it right, just because it is so advantageous for one party to renege or do it wrong and go in for the wrong reasons in the first place.

And I think that level of trust is sort of hard to build from that history, but also, in the case of [INAUDIBLE] so let's say you build this multi-national cooperation and somebody does sort of

renege on a deal, I can't see really a conflict mediation peace or a medium there that doesn't escalate very quickly, especially when large economic threats are involved-- so maybe war or something.

War is the extreme example, but like tariffs-- there could be large trade implications that now-- whereas previously they would have been isolated to larger countries, but now that it's multi-national, it affects sort of everybody.

**AUDIENCE:**

I'm trying to think of a memoir I was reading recently about a woman named Wangari Maathai in Kenya about her experiences of growing up right as British colonialism was taking off in the 1940s. And she was speaking of the ways in which society had been structured in her village and that different ethnic groups had become, I guess, specialized in certain capacities.

Like, some people were very good at basket weaving. Other people had become very good at agriculture. Other people have become very good at medicine. And each of those communities taught themselves those trades and perpetuated that sort of, I guess, capacity within generations.

And then British colonialism came in. They started exploiting people for agricultural production. And that entire system imploded, and along with it, [INAUDIBLE] culture, the knowledge that they had, the agricultural systems that had taken them thousands of years to formulate, et cetera.

And I think it's precisely what this woman is talking about-- why cooperation is so difficult, which is why I brought up game theory I think two classes ago-- because cooperation and collaboration are so important, but they rest so much on a sort of fundamental trust. And that kind of collaboration always sort of implies a power imbalance that is negated by that sense of trust.

And it's so difficult on a global scale to enact trust and collaboration because there is such a sense of histories and colonialism of power imbalances-- of domination and hegemony. And because we have been, for the past 200 years in the United States, such strong actors in that, we've never had to take this into consideration before.

And I think now, in particular-- I really wish that we had more students in this course who were sort of coming from defense backgrounds. Because I feel like we don't talk enough about the implications of war or the implications of bioterrorism.

But I do think it's certainly important to think about collaboration as our ideal. But as we were talking about last week in the social organization of organizations, how is it that we can sort of have a layered approach, where there is collaboration existing in a system where we feel that we are respecting power dynamics, and also the potential for us to be heard in the short and the long run.

**AUDIENCE:** Yeah, because when I think of collaboration between nations, the first example that comes to me is like World War I-- Axis versus Allies. They were in great collaboration teams. And then that embroiled us into a massive mess because fights between one and each led to fights between all of them. So I think you raise the issue of that occurring.

**AUDIENCE:** Well, actually to counter that-- the difference between now and World War I is currently, as we saw in the last week's readings are our economies are just so linked, we can't have that again. Because then, the entire world could just completely collapse.

And honestly, you probably can't even have the war, because you need the gunpowder produced, I don't know, in one country. You'd need the bullet casing produced in another country, the stock for a rifle built in a third country. Everything is so interconnected, as was pointed out, that, well, we can't even mobilize very well.

**AUDIENCE:** But what if [INAUDIBLE]

**AUDIENCE:** If you're just using rifles and sticks.

[LAUGHTER]

**AUDIENCE:** I don't care. OK, yeah. Everyone gets sticks.

**WILLIAM** I'm going to put us back into manufacturing and out of war.

**BONVILLIAN:**

**AUDIENCE:** I mean, look at the opposing view, though. There's a lot of value in conflict. Like, in management, we do this a lot, where it's like you will put out something to make it seem like you're doing bad when you're actually doing OK so that people will get to work. I think a good example was, like in Silicon Valley, somebody made out a white paper about like, oh, this is the distribution of diversity.

And a lot of the times, it's very illogical. But it's actually the person you don't expect, because they want people to focus on that topic. So I think there's a lot of value from creating that conflict.

So I think on the macro, I think we are in a relative peace. Because is there ever going to be a time with no conflict at all? Right, it's too utopian. So what you do is, it's macro-utopian. But you create these minor issues that really don't matter [INAUDIBLE]

**WILLIAM** Maybe. Kevin, why don't you give us a closing thought on this piece.

**BONVILLIAN:**

**AUDIENCE:** Well, to counter all the points, it's hard to tell-- especially in the long, long term-- which is more sustainable-- our historical behaviors or whatever future model we come up with. But maybe the next big innovation wave for the US is a global one and not just one leaning to the country.

**WILLIAM** Interesting. All right. We'll now dive into Jonas Nahm and Ed Steinfeld, both of whom worked in  
**BONVILLIAN:** MIT. So Jonas is now teaching at Johns Hopkins SAIS. And he's from Germany, fluent Mandarin, spent lots and lots of time in China. So he knows both German and Chinese economics and manufacturing systems, in particular.

Ed Steinfeld has gone on to head the Watson Institute at Brown from MIT political science department. Both are terrific scholars of the kind of manufacturing advances that China has been able to put together.

So this dramatic thing happens. China moves from 5.7% of global manufacturing output in 2000 to almost 20% in 2011, passing the US in output. I mean, that is startling, right. Those numbers jump off the page. How did that happen? Right.

So what happened here? So the operating assumption in the US has been that China had lower production costs due to lower wage costs and lower cost parts. That was the operating assumption. And then there's been an assumption in the US that manufacturing naturally migrates to low-cost producers and that the knowledge required for manufacturing processes is comparatively trivial.

And Nahm and Steinfeld argue, neither of those is true. The assumption that production knowledge flowed via multinationals from outside into China-- it's a much more complicated story than that. The assumption that the IT revolution enables severing of manufacturing from

R&D-- from production and design-- and turns out to be a more complicated story.

And none of these explanations explain that dramatic rise in China's production capability and output. Instead, they argue that China has developed some remarkable new process innovation and manufacturing innovation. And that needs to be understood and respected as a major innovation advance.

So China has tended, they argue, to specialize in rapid scale-up and cost reduction, in combination. And they join really remarkable skills in simultaneous management of the tempo of production and production volume and controlling cost, and that that's a very powerful set of skills and capabilities, and that these kinds of factors are much better explanations for that remarkable rise than simply a wage differential.

So they argue that this has enabled China to expand even in industries that are highly automated or not on governmental priority lists. And low costs and government support are just not sufficient to explain China's remarkable accomplishments in manufacturing.

So let's get more into a little detail here. China's developing production processes in areas that were previously thought fully mature and impervious to additional cost reductions or technological improvement. China's taken on various sectors and shown that, in fact, you can bring innovation to these in process and in cost.

So the key has been accumulation of firm-specific expertise that has enabled what they call "extensive, multidirectional, inter-firm learning." In other words, they're able to get a community of producers to operate together in a unified kind of way that's kind of unthinkable in the much more fragmented, decentralized US system-- to build a level of cooperation, particularly in a regional basis, that is able to scale up production very quickly in ways that are pretty unprecedented.

So elements of China's new production model, they argue, include backward design capability-- in other words, taking an existing product and rethinking it, right, so that you can create lower cost production systems for those components, and therefore be able to sell it into a lower cost, lower wage Chinese economy, right, in a creative kind of way here.

Yes, there's been a partnership of foreign design and Chinese manufacturing. But that has been multidirectional, they argue. Both sides have been informing each other. And technology absorption and collaborative development across networked production firms has been

remarkable. That's part of this ability to do rapid scale-up.

So these are all new elements that we haven't seen in production systems, that China's been able, they argue, to put together in unique ways. So an explanation of Chinese manufacturing as just a wage advantage completely understates, they argue, what, in fact, China has accomplished here. It's a remarkable story.

So we have to kind of keep this in mind as we confront these global competitive issues in the class today. It's not a simple story of a wage advantage. It's a much more complex and interesting and innovation-based story.

**AUDIENCE:** When we're putting into detail about why China was so successful, why it could do things in such a short time span, but my question and the question some people have as well was, what next, in terms of trade relationships between-- economic relationships between the US-- the United States, especially in this political climate? Are they a force to be reckoned with? Are we going to learn from them?

**AUDIENCE:** So actually part of my thinking that maybe they had such a rapid growth because, if you think about it, they have a lot of people, I think a lot of resources.

**AUDIENCE:** Untapped potential.

**AUDIENCE:** Yeah, they just haven't tapped their potential until relatively recently. The fact that they were able to do it so quickly is pretty remarkable. But beyond that, the fact that they are where they are now should not be that surprising. Yeah, I feel like they have the expertise to do it. And the internet's made information pretty easy to get. So I don't know, maybe like all manufacturing [INAUDIBLE] you can't easily get, but.

**AUDIENCE:** Yeah, I do think, kind of in line with this paper, there's this presumption that if we weren't buying manufactured goods from China, we could just make them in the US. But that's pretty clearly not true, especially as emphasized by a lot of these reading. Like, we simply can't make them any more.

So I see that there can be a lot of talk about not purchasing as many goods from China. But if we want to maintain our lifestyles, have Kindles, have these other devices, I don't see a realistic way in the short-term for us to not have some dependence on China. Like, long-term we could change our systems and try to gain back some of that footing. But I think a lot of it is just talk right now.

**AUDIENCE:** And digging into why China has the advantage here, I think it's two things-- mostly because work and kind of their life has been very integrated. For example, at factories, like semiconductor factories, you live in dorms. And you go to work. And there's not that much separation between your work and your actual life. So there's very much an expectation that you are very devoted and dedicated to your work.

And also, I think in China it's less stigmatized to go into like kind of manufacturing and work on these really innovation-driven from manufacturing, kind of in a reverse process. And so that means a lot of the academics there aren't afraid to go into these fields, which is important because, especially in a field like semiconductors, you need a lot of technical expertise even though it might just be manufacturing.

If you want to make those improvements-- make them faster, smaller, et cetera-- you have to be able to have that background to innovate further. And I think that's why a lot of these firms have been having success, taking that extra step beyond just learning from the innovations posed by other countries.

And this might be a little bit controversial, but I think the government structure in China also has had a big role in why they're able to make that happen so quickly, because they're able to come up with an idea and turn it around really quickly because it's very integrated and more unilateral, as opposed to our structure here. So if they have a construction project, like they want to make a bridge happen, it'll happen in a year. In the US, it would probably take like three years.

**AUDIENCE:** At least.

**AUDIENCE:** Or yeah, if that. And it might not even happen.

**AUDIENCE:** Well, that's true. The directed focus of a government definitely has some advantages. Like, if you want something done, it gets done. But on the other hand, there are disadvantages too. Like, any disagreement, and it might end up being a bridge that points upward for no reason. So then it's not actually useful, even if, oh, yeah, we got it done really quickly and really under-budget, it doesn't actually solve the problem as well as it could, whatever the problem might be.

**AUDIENCE:** Yeah.

**WILLIAM** Kevin, why don't we lead you back into this. How are you reacting to these comments?

**BONVILLIAN:**

**AUDIENCE:** So not only with the discussion with this paper, but with other papers we've been discussing short versus long-term in terms of what direction the nation might head in, in terms of innovation. Speaking of short-term now, what do people feel the US's reaction would be?  
[LAUGHS]

**AUDIENCE:** [INAUDIBLE]

**AUDIENCE:** [INAUDIBLE]

**AUDIENCE:** Yeah. Can we fast-forward maybe like one slide, two slides? Yeah, one more please. Mm-hmm.

[LAUGHTER]

There we go.

**WILLIAM** It's OK.

**BONVILLIAN:**

**AUDIENCE:** Yeah. So I think there is an opportunity here in this second point with this partnership of foreign [INAUDIBLE]-- rather than kind of walling ourselves off in the short-term, if we can kind of just accept that they have this-- I don't even want to say like a built-in advantage-- but they've actually constructed a system that we've just learned is super effective.

And so rather than kind of copying the Chinese model, which will take structurally a lot more time and might even be impossible because we're so fragmented, or kind of walling ourselves off, I think it just might be important to just capture on this partnership of foreign design and Chinese manufacturing, and facilitate that multidirectional learning.

So hopefully some of the trends will come back. But at the end of the day, I think if I sprout a mustache and glasses and a tie, will I say this is OK?

[LAUGHTER]

But you're going to have to just look towards what's the next innovation wave so that we can kind of capitalize on those. And I hope that those that don't all go to China. Because I think



we've kind of already lost the ball on what they've done with backward design and these network production firms because of structure and how they do things.

**WILLIAM BONVILLIAN:** We'll come back to that, Rasheed, when we talk about these advanced manufacturing partnerships.

**AUDIENCE:** I agree only in small part with you on that, because I think we need to be really careful in the short-term. Because we do maintain the capability of-- so for example, in this paper, [INAUDIBLE] solar cells. We can do that in the United States.

Problem is, in China, the Chinese government is dumping subsidies. So yeah, that's marginally legal or even illegal. But how long is it going to take us to work that out in an international court? So we need very much forge ahead with-- or protect what we can still do here.

I agree with you, we need to understand that there are some things that China does better-- maybe even adopt some of their practices. But we need to protect what we can still do, I think. Because we don't want to lose the entire solar market. And then they take their subsidies away, and we could have competed. You know what I mean?

**AUDIENCE:** Two questions-- or two things I wanted to bring up. One, I didn't realize-- is it illegal to subsidize your own industry?

**AUDIENCE:** In a lot of trade agreements there are rules about what you can do.

**AUDIENCE:** Yeah.

**WILLIAM BONVILLIAN:** There are anti-dumping rules. In other words, can you dump on a foreign market a good that's produced and sold at less than its cost to produce. Right. So that's where you begin to run into issues.

**AUDIENCE:** Because then internationally, they're ruining the ability of other countries to produce. And then when they take those subsidies away, they're no longer cheaper or better.

**AUDIENCE:** They're just the only options.

**AUDIENCE:** They're just the only [INAUDIBLE]

**WILLIAM BONVILLIAN:** Right. But remember, too, Lilly, that China is selling its solar capability into its own market because of its own staggering demand for power resources. So this is not entirely an attempt

to capture world solar markets. This is serving a pretty strong need in its own power development areas.

**AUDIENCE:** Just a [INAUDIBLE] point-- from the Chinese market preference perspective, there's this mysterious preference for foreign goods, especially US-made products over our made-in-China goods. So I do see the US still has this advantage. For example, if there's two medicines for you to choose-- there is one made in China, and there is one three times more expensive but it's made in the US-- people who can afford it, will just buy it, like without any reason.

**WILLIAM** That's fascinating.

**BONVILLIAN:**

**AUDIENCE:** Is it?

**AUDIENCE:** My counterpoint is, it's that way for now. But there's a thing called the "innovator's dilemma," which is a common strategy in business. What you do, is you make the product that isn't that great, but it's cheaper. And then what happens is you do that specifically so your competitors don't attack you.

It's the equivalent of, say you're at a dinner table and there's a person who eats a lot. Right, he eats like 10 plates. And there's somebody who eats like one little appetizer. You don't mind that eating the appetizer. So they focus on industries or markets that the big player can't attack. And they slowly grow their advantage.

There's a strategy that was used by Japanese companies with cars. They made the cheap car that companies in the US wouldn't focus on until they could make cars that were much, much better. But it's a common strategy.

**WILLIAM** OK. So a closing thought, Kevin, on this great debate you've kicked off here?

**BONVILLIAN:**

[LAUGHTER]

**AUDIENCE:** Well, these next four years are going to be interesting.

**WILLIAM** Yeah, OK.

**BONVILLIAN:**

[LAUGHTER]

It's going to be very interesting.

**AUDIENCE:** Oh, sorry. I didn't [INAUDIBLE] my second thought.

**WILLIAM** Feel free.

**BONVILLIAN:**

**AUDIENCE:** Yeah, that happens. So I was thinking back to the point that Chris had pointed out, that there are differences between our government and the Chinese government.

I think one of the differences that comes in-- I'm not certain about China's government. I don't know-- are there term limits? Are there limits built into these governmental permissions that, say, force them to be re-elected every so often?

**AUDIENCE:** I think probably, but it's longer, right.

**AUDIENCE:** It is every four years.

**AUDIENCE:** Oh, it's also four?

**AUDIENCE:** Really?

**AUDIENCE:** Yeah.

**AUDIENCE:** OK.

**AUDIENCE:** [INAUDIBLE] their policies [INAUDIBLE]?

**AUDIENCE:** Yeah, I don't know much about it at all.

**AUDIENCE:** Yeah, me neither.

**AUDIENCE:** [INAUDIBLE]

**AUDIENCE:** It's not really elected.

[LAUGHTER]

[INTERPOSING VOICES]

**AUDIENCE:** OK, OK.

**AUDIENCE:** It's like [INAUDIBLE]

**AUDIENCE:** So it's a dictatorship.

[INTERPOSING VOICES]

**AUDIENCE:** OK.

**WILLIAM** All right.

**BONVILLIAN:**

**AUDIENCE:** Then that--

**WILLIAM** Go ahead.

**BONVILLIAN:**

**AUDIENCE:** --yeah-- my point to that would be that, well, then the governmental officials can think a lot more long-term. Because the way that our current electoral system is made, at least representatives have to think like two years in advance.

And that's basically the most they can think of. They need to produce results within that very short time period. Senators, they have six years. A president, if he's lucky, he gets eight.

So there's just a different emphasis on what the governments are able to do and what they're incentivized to do. So with that, if we were to try to adopt that kind of a structure, we'd have to make some radical changes to the Constitution and a lot of stuff.

**WILLIAM** Yeah. It's hard for democracies to think longer term.

**BONVILLIAN:**

**AUDIENCE:** Yeah.

**WILLIAM** All right. So we're going to dive into Suzanne Berger's work on the "Production in the

**BONVILLIAN:** Innovation Economy" study. So we talked last class about her work on distributed production.

And she led this big study at MIT, the "PIE" study-- "Production in the Innovation Economy." Pulled together a whole faculty group from a variety of fields and ended up with this in-depth,

two-volume study of what had been happening in US production.

And I think there's some very important stories here. I had you read the kind of preliminary report. The depth in the two volumes is really quite powerful. So if you want to read further in this area, this is a great place to start.

So Suzanne wrote the kind of cover, overall view, drawing on chapters that particular faculty members and researchers pulled together in different segments. And then she did that kind of overview piece.

The overview piece is one of the most powerful books, in my view, that's been written about US manufacturing. So well worth thinking about. You're just getting a kind of early snapshot, frankly, from the preliminary report I had you read.

But I want to try and pull out, frankly, blending the preliminary report with my knowledge of the underlying report some stories that I think help us understand what's been going on in US manufacturing. And she tells a series of these in her book.

One story is that manufacturing turns out not to be agriculture. And I'll explain what in heaven's name I'm talking about in a minute. Secondly, that our manufacturing firms are increasingly, as she puts it, "home alone," that small, mid-sized, and startup firms are having a lot of trouble scaling up their production in the US.

A fourth story is about if you want to keep strong innovation, you need to think about the link between innovation and production, which this book argues is profound-- that there's a real link between innovation and production. There's deep workforce training education issues. There's important lessons from Germany. And then there's some very interesting jobs stories here, too.

So let me try and tell these quickly. First, manufacturing is not agriculture. For a long time, the economists thought that manufacturing was agriculture. In other words, in 1900, half the population-- not quite-- but half the population was farming. And now less than 2% of the population is farming. And we're producing much, much more, right. So it's a story of staggering productivity gains and advances.

But the MIT report takes that argument apart. So economists were saying, oh, this is just productivity gains. We're just much more efficient in production. So what if you lost one third of your manufacturing jobs between 2000 and 2010? No problem. Productivity gains, right.

But then the story turns out to be much more complicated. We thought that manufacturing output was holding firm. But it turns out that it wasn't, right. So we thought we were producing the same with less labor. But it wasn't the case.

In fact, in 15 of 19 industrial sectors, we had output decline. And our official statistics overestimated output because we adopted a view of computing and IT technologies that assumed the components, for definitional reasons, were because the United States. But they weren't, right. That's the Willy Shih, Gary Pisano story, right. So we were completely inflating our numbers. And output wasn't what we thought it was.

So if output, which is obviously half the story of productivity, is not what you thought it was, then the productivity numbers were considerably lower than mainstream economics had been telling us. It's not that there weren't productivity gains in that period. There were. But they weren't what we thought they were. So instead, the job loss numbers really tells us the sector is hollowing out, not getting more productive.

So a second story-- what Suzanne calls the "home alone" story. So she tells a story that, for the last several decades, we've been thinning out in the US our manufacturing sector. We used to have firms and supply chains that had to be very vertically integrated.

This is the story we told last week about LEGOs and model airplanes, right. We hit on a financial model. And Martin, you had been pointing some of this out. We hit on a financial model that emphasized quarterly returns, which led us to want to reduce interim risk, which led us in the financial sector to focus on getting firms to nurture their core competency, not do a lot of other stuff.

So therefore, they should go what's called "asset light." Strip the firm of assets that are not part of its core competency. Right. So we began to thin out what had been these very vertically integrated groups of firms. So the companies in the system are now much more "home alone."

Story number 3 is related. This is the scale-up problem. So the US is home to a large percentage of the world's multinationals. They're global. They can get production efficiencies by producing in lower-cost countries. And they need to be in global markets. They don't have an option here. They need to be worldwide.

Generally speaking, they're OK. They're producing more abroad than they did in the past. But

there's two much more vulnerable sectors. So one of those sectors are what we could call, and what the book calls, "Main Street firms." So these are the small and mid-sized firms.

So there are between 250,000 and 300,000-- let's call the 250,000 of these small and mid-sized firms that employ less than 500 people. That is most of the manufacturing sector, that's a majority of US production.

They have trouble getting scale-up funding. They are thinly capitalized. They have to be risk averse to survive. They don't do what we would consider R&D, although they can be very innovative in modifying products and changing processes. But they don't do what we would consider innovation-based research.

So they're kind of outside of the US innovation system. And there are a lot of them. It's a big part of this. For them to innovate, they have to have access to ideas, which they don't necessarily have, and a thinned-out ecosystem. And they've got to have the financing to scale up.

Part of the Production in the Innovation Economy study was led by John Reed, who was head of the MIT Executive Committee and former chairman of Citicorp-- a brilliant, famous banker, who created a lot of the amazing Citicorp model. John Reed was part of these deliberations.

And he said, yes, we ended local banking in the United States. That was the historic era where your neighborhood banker would know, in your city or town, who the quality producers were and know who to lend to.

That's gone. We substituted really national and then international financing models. And we replaced that face-to-face, kind of relationship-based banking to a very significant extent.

The Main Street firms were dramatically affected by their ability to get scale-up money out of their banking system. Right, it really hit them. And there isn't really a substitute for them.

And then meanwhile-- and we'll talk about this more later in class-- the other manufacturing community is entrepreneurial startups that want to make something-- that want to make a hard technology. Unfortunately, the venture capital system has walked from this territory.

So venture capital at this point in the US funds predominantly software, secondarily biotech, then a series of service sectors like media entertainment business services. They're not funding firms that want to make something, that have hard technologies.

So the implications of this are really quite powerful. That's part of the reason why Rafael Reif put The Engine together down the street, because a lot of MIT-developed hard technology was just not getting out. We had to have a different way to stand them up.

But this is where the next generation of manufacturing will come from. This is what the next generation of manufactured goods will come from. And we're not doing it. Right. Big-time societal implications here.

So there's a big scale-up problem for these two, right. How are you going to scale up innovative production and innovative technologies? We're in trouble to the extent we rely on them. We rely on them a lot.

This is just a chart that shows who does the R&D. So large companies do R&D. Small companies don't. Right. So the small companies are just not part of the innovation system.

Story 4-- the relationship between innovation and production. So what's wrong with scaling up abroad? The issue is that for most products-- not all products-- and it looks like there's a lot of exceptions in the IT area-- but for most products, you need your innovation pretty closely related, particularly to your initial production stage.

In other words, there's a lot of interchange as you design for production. You take your idea, and you design it for production. Right. That's a very creative process. Lots of engineering. You often have to rethink your basic science.

So if you're shifting your production capability abroad-- and this is the most important conclusion of the PIE study-- you're starting to affect your innovation capability. So the US has thought that its competitive advantage, really since the end of World War II, is in a strong innovation system. But if it's shifting production-- particularly initial production-- it's losing that interaction between initial production and its innovation capability.

So a fifth story is, how do you begin to wrestle with these issues? They looked hard at workforce. So there's lots of workforce studies out. And they consist of CEOs saying, we don't have enough skilled workers.

And the MIT approach, led by Paul Osterman, a faculty member at Sloan, said, look, let's not ask the CEOs, right. The CEOs may be saying there's a tremendous shortage of \$10,000 Cadillacs, right. That may be what they're, in effect, saying. In other words, what they're



prepared to pay for skills is not an appropriate compensation for the skills. It doesn't match markets.

So let's actually ask the human resources departments. And let's not ask them, are you short of skilled workers? Let's ask them, how long did it take you to hire for positions that have come up in your firm?

And what they found was that 75% of the firms studied-- and they reached way over 1,000-- I think was several thousand-- they were able to hire within one month. Now, that's logical. Because, after all, we just laid off almost 6 million production workers, right. And they've been largely shunted into the lower end service sectors. Maybe they would want to come back. So presumably, there's a surplus of capability out there.

But the most interesting part of what they found was that for 25% of the firms, they weren't able to hire in a month. It was taking them a lot longer. And interestingly, these tended to be the smaller, more innovative, technology-focused firms. And they were having a much harder time, actually, because they needed a higher skill raft of workers. They are having a lot of trouble hiring in a reasonable time frame.

So Paul Osterman would summarize saying, there's not an immediate emergency here on workforce skills. But we're going to have trouble ahead. And the signal is the 25% of more innovative firms that are having more trouble getting the skill sets that they needed. And look, we've got a big demographics problem. So the manufacturing workforce is an aging workforce. And it's going to need replacing.

Sixth story-- and there's only one more to go after this-- what can we learn from Germany? So the US has been sitting around for at least a decade-- more like 20 years-- thinking, oh, we have to lose manufacturing jobs, because we're high wage and high cost. So we have to lose these jobs.

Somebody never sent that memo to Germany. They failed to get that word, right. Because Germany is much higher wage and higher cost than the United States. Their wages and benefits are 66% higher for their manufacturing workers than for US manufacturing workers. And they are running staggering trade surpluses with everybody, including a major trade surplus with Germany-- I mean with China, excuse me.

What are they doing? They're supposed to lose this sector, right, according to our thinking. But

they didn't. So the US has about 8% of its workforce in production jobs. Germany, 20%. What are they doing? Right.

This is an important set of lessons here. How has Germany organized its manufacturing sector so that it's able to run an extremely successful manufacturing sector that continues to bring major returns back to its economy, even though it's very high wage and high cost? What are they doing? Right.

So there may be important lessons for us to learn. And the PIE study, in fact, went through a number of these. They found that, unlike the US, which was thinning out its ecosystem for its manufacturers, that its small and mid-sized manufacturers, in particular, were more "home alone," Germany was doing the opposite-- a much more connected, collaborative system, right-- in part through a Fraunhofer network system that, starting at the end of World War II and partially, by the way, paid for by the Marshall Plan by the US, brought large and small and mid-sized firms. In Germany, the small and mid-sized firms are called Mittelstand. And it's a famous German capability, these very talented small and mid-sized firms.

They were able to bring them together in collaborations around new innovations in production. And they would work together, assisted by German engineering academics in the process. They have 60 of these Fraunhofer institutes, really manufacturing institutes, spread all over the country.

So they have a way of avoiding the "home alone" problem. If anything, they're ever enriching the collaboration between their firms and the trade-off of ideas.

They have a whole system for collaborative R&D that's shared between the small and mid-sized firms and the larger firms. Through that system, they have the most famous workforce training system in the world, through a remarkable apprenticeship system that consistently produces incredibly highly skilled workers.

And the apprenticeships will last for three or four years, right. Really in-depth training. We have nothing like that. We have highly decentralized labor markets in the United States. We have nothing close to this.

So they have a whole shared training system for their workforce. And they've developed ways through these collaborative mechanisms to rapidly scale up their production.

So Germany's workforce in manufacturing is 80% unionized. We're not remotely close to that.

It's a different system. It's hard for the US to do an apprenticeship system here. It doesn't quite match the way we organize things. But there are some ideas that we could learn from.

And the seventh and last story is about jobs. The manufacturing sector affects our services sector. And Suzanne Berger and the team tell an interesting story here, that the 21st century firm, right, is going to increasingly tie a complex hard product to a service and link them, and offer customers solutions-- not a good or a service, but a solution to a problem.

So your Apple iPhone, in many ways, is a combined service delivery hardware technology, right. There's lots of service delivery through that Apple iPhone, right. Things are going to be more like that in the future.

Now, personal services tend to be face-to-face. And they're hard to scale up quickly, right. It's their kind of one-to-one relationship building. And that process takes a long time.

Whereas if you're producing a manufactured good, you can produce one product on day 1. On day 12, you can produce a million products, right. You can scale very quickly-- much faster than through a personal service operation, right. So one advantage of manufacturing is that it tends to scale up the gains in your economy much more quickly.

Part of the reason why it took so long to recover from the 2007, 2008 recession is that we had so damaged our manufacturing sector that the normal scale-up coming out of a recession just wasn't happening. It was taking forever.

But if you're able to combine a tradable good, right, that can scale with a service, then the service starts to become tradable as well, right-- and can scale. So that's a whole new capability in services that we haven't really spent a lot of time thinking about.

But it's very interesting, since 86% of our workforce is in services. Maybe we ought to work on this territory. But a prerequisite is having the tradable goods that you can tie to a service, right. Yet another reason why, in the next generation of firms, manufacturing capability is going to be important.

You saw this chart before. This shows you where societal returns come from, right. Predominantly from production, not from services.

So let me just summarize. Here's the stories that Suzanne and the PIE study taught us. Manufacturing is not agriculture. This sector was hollowing out. It wasn't enjoying productivity

advances to the extent we thought possible.

Our manufacturing firms are increasingly "home alone." Their ecosystems of support are thinned out. There's less of what Pisano and Shih called a "commons" available to support them. There's a real scale-up problem for small, mid-sized firms, and for startup firms, for somewhat different reasons.

There's important linkage between innovation and production. These are very related and tied to each other. And if you lose one, it'll affect the other.

There's interesting lessons about workforce, that we've got a problem ahead in up-scaling our workforce. It's not an emergency now, but we probably have a problem ahead.

Very important lessons from Germany on the societal benefits of a strong production sector. And then, in this jobs area, if you're able to tie tradable goods to services, then the services themselves become tradable and scalable, as well. And then, there's an underlying question about how our manufacturing sector, therefore, affects our services sector.

So let's come back and do some questions about this. And then we'll dive into the next round of readings. And Steph will lead us in those.