

# TRAILBLAZERS TALK

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**Ravi Kumar: [00:13]**

Hello, everyone, my name is Ravi Kumar, President at Infosys. Welcome to this next version of Trailblazers. As you know, Trailblazers is a talk series with distinguished guests from the academia, public policy makers, large enterprises, who are making significant impact to the societies and communities we all live in. Today is a special version of Trailblazers and I have a very distinguished guest, one of my favorites, Erik Brynjolfsson, a Professor of Stanford University. He is the Director for the Digital Economy Lab, an expert on AI and productivity, and a best-selling author of several books. The latest two, *The Second Machine Age* and *Race Against the Machine*, are among my favorites. I love his work on productivity paradox, productivity of humans, Economics of Information and Digital Economy.

In the past, he was a professor at MIT Sloan School of Management and the director for the MIT Initiative of Digital Economy. Erik, thank you so much for joining us on this conversation today. A special occasion for us as we launch the Infosys Applied AI joint offering. It is an integrated offer for Large Enterprises.

**Erik Brynjolfsson: [01:41]**

Great to see you, Ravi and it's really a pleasure. It's always fun to talk to you. I'm looking forward to our conversation.

**Ravi Kumar: [01:46]**

Thank you, Erik. So, my first question to you is, at the time of this offering, which I call the Infosys Applied AI, the world is at an inflection point, which I call the second inflection point. The first one is related to consumer AI. [Yes] The second one is right now as enterprises are embracing AI. And there is a push and a pull. The push is predominantly the fact that there is more maturity of AI, there is more data available. There is a view about how to make it more responsible, the regulatory framework, the ethics around it. The pull is in many ways, ironically, the health crisis, which has accelerated digital transformation [Right], the need for a contactless economy, the need for a higher cost imperative and a variety of things coming together and the confluence of digital technologies as well. You know, my point is, there was this inflection point earlier on in technology where you had an exponential curve on per capita GDP, if that's a proxy for value. Do you see that as a big inflection point now as enterprises start to embrace AI? And I love what you said in one of your papers, which is that AI is a GPT. I call it the network effect, as it has a pervasive nature. It spawns more innovation and it improves over time. Tell us a little bit about your views on this specific topic.

**Erik Brynjolfsson: [03:25]**

Well, that's exactly right. AI is a GPT, which is what economists call General Purpose Technologies; these, like the steam engine or electricity are not only powerful in and of themselves, but they catalyze complementary changes throughout the economy, thousands or millions of complementary changes inside each organization. We're still in the very early stages of the transformation that AI is driving. I think it may be bigger than the earlier ones. I mean, in some ways, what's more fundamental than intelligence? We are just beginning to have machine intelligence. And as you pointed out, it's moving from affecting the consumer to transforming the enterprise. So we see occupations changing, we see whole companies changing, we see the whole value chain changing. It requires a lot of innovation on the part of managers to make those complementary changes, because it's not enough to simply slap AI on your existing business processes, because you don't get a lot of value, just as they did when they tried to put electricity in the old way of organizing factories. And that's a process that can take years or even decades to fully play out. But I'm very optimistic about the ultimate effects on productivity, living standards and growth if we make those kinds of changes.

**Ravi Kumar: [04:43]**

So, Erik, thank you so much for the perspective. What's your view on the accuracy of machine learning models? Do you think we've got to that inflection point where it can actually amplify human potential in enterprises?

**Erik Brynjolfsson: [04:58]**

Well, there's no question. I mean, hardly a week goes by that I don't read some paper about a machine learning model outperforming a human radiologist or dermatologist in looking at medical images or machines. We all have experience with listening to them and having them understand our speech. It's far from perfect, but we're in this interesting 10-year period where you went from machines not understanding us speaking natural language to routinely having simple conversations. And there are so many other types of problem-solving where machines are beginning to match or exceed human capabilities. But the important thing to understand is that we're very far from artificial general intelligence that has the full breadth of human capabilities. Instead, there are a number of narrow, specific problem-solving categories where machines are quite powerful. We looked at 950 occupations in the U.S. economy, each of them having about 20 to 30 distinct tasks, so that's over 18,000 distinct tasks. And what we found was there was not a single job where machine learning just ran the table and did everything that the humans were doing. But in almost every job, machine learning was able to do some of the tasks. Let me give you one very concrete example. A lot of people talk about radiologists being replaced by machine learning, the medical imaging that I was just referring to. And it's certainly true. The machines can do and recognize medical images quite well now and do diagnosis. But when you look at what a radiologist actually does, there are 27 distinct tasks, according to our analysis that a radiologist does, for instance, coordinating care with other physicians or counselling patients and explaining the plan to them. These are things that you wouldn't want a machine to be doing. You still want to have the human in the loop on those parts, and that's the way it was with most occupations. So what's the takeaway? The takeaway is that machine learning can and will and should affect these occupations, but it's not a simple substitution or automation – take out the human and put in a robot, put in a machine. Instead it's a rethinking of how we do those jobs. Parts of them will be increasingly done by machines augmenting what humans can do. Other parts continue to be done by humans, but in new ways. That takes a lot of creativity. But if it's done right, there's a huge potential for business value and for making consumers and society better off.

**Ravi Kumar: [07:20]**

Thank you, Erik. Thank you so much for that. So, just touching on this specific topic you spoke of, which is about humans in the loop for machine learning to be more contextual, machines to actually amplify humans. What happens to wages? Because there's also this perceived notion that machine learning is going to take away low-wage workers. And what happens to reskilling thereby? And that is something most enterprises are tackling. That is one of the reasons why there's a constraint on scaling AI in enterprises.

**Erik Brynjolfsson: [07:54]**

Well, we still certainly need to reskill. And sometimes I think AI should stand for augmenting intelligence, not Artificial Intelligence, and certainly not automating with humans. There are some tasks where machines are doing better and they're going to replace humans. But if you look at how technology's affected wages, historically, automation or substitution is only one of six different forces. In many cases, they complement humans and make the humans more valuable and therefore drive wages up. They can affect demand, they can affect income, they can affect supply and most fundamentally, they can lead to a reinvention and redesign or reengineering of tasks. And all of those can have very diverse effects on wages. If you look at the broad history of technology, it's

unmistakable that wages have gone up. I mean our ancestors 200 years ago earned a fraction of what most people earn today. So that's been the good news. But there's no economic law that says that everyone is automatically going to get higher wages. It's possible for the benefits to be concentrated to a small group. And one of the things I think we need to do as a society is think about how can we reskill people so that they can benefit broadly from these technologies, and in companies, how can you get your workforce to benefit broadly from these technologies? And that starts with understanding the full, different set of ways that machines augment and affect wages.

**Ravi Kumar: [09:17]**

And Erik, just on the same topic, you've spoken about how in early 1700 there was this huge exponential curve in GDP, per capita GDP, which is kind of a proxy for wages. Do you see that inflection point and is the curve going to be steeper now? And do you also see the digital divide in many ways to be bridged by AI? It could actually create a bigger divide or it could actually bridge, depending on how we implement it?

**Erik Brynjolfsson: [09:51]**

Well, that last comment you made is exactly on point. It's not automatic that we have wages go up broadly and in fact, in the United States and other developed countries, we looked at the OECD countries and in 21 out of 22 of them, we saw a divergence where productivity, while it continues to grow, wages were not keeping up. And that reflects the fact that in many cases, the technologies were replacing low wage workers, leading to a surplus of labor in those categories and lower wages for median income people. It doesn't have to be that way; the same technologies can also be used to create shared prosperity. As I said, that's the way it was for the previous 200 years. But it's going to depend on our choices going forward. I've frankly been a little bit disappointed that the technology hasn't created more of a productivity boost already and hasn't led to more rising wages already. I'm optimistic that it will in the coming 10 years, you know, for two reasons. One is that there's a phenomenon we call the productivity 'J' curve, which is very common with these technologies. Initially, you see a downward hit on productivity and wages. And then later, it takes off in kind of like a 'J', shape. The reason for the initial downward part is it takes a lot of effort to redesign, reengineer companies, you need to reskill workers. And all of that effort, in a way, creates intangible assets, but it doesn't create direct output that consumers can benefit from. And so during that initial period, there's kind of a turn, and seems like things aren't really improving, then later, when you harvest those intangible assets, then you can have the take-off, and the company's profits, the company's revenues, and the consumer value, all start going up. I think we're still in the early part in most companies. But as they go through that transformation, we'll be hitting stride and having the increase. And the more companies like yours, frankly, and many others work to facilitate that transformation, the faster that's going to happen. And when I talk to CEOs around the world, I think they're very conscious of this, and they're compressing that cycle. So we get to the value creation part a lot faster than we did, say, with electricity or the steam engine.

**Ravi Kumar: [12:03]**

And do you believe in that 'J' curve, we are at a point now where we have hit the bottom and we are going to move up?

**Erik Brynjolfsson: [12:14]**

Yes, my prediction is we'll see higher productivity in the coming years, and faster productivity growth. You know, it varies across company, across technology. In some areas, we're already beginning to harvest some of the benefits and others where we are still in the early stages. You know, there's not just one big 'J' curve for the whole world or for every company. There's many overlapping 'J' curves. But I think that the evidence is increasingly suggesting that we're beginning to harvest them, but there have been literally hundreds of billions of dollars invested, just creating the

skills. I mean, we look closely, for instance, at self-driving cars, over a 100 billion dollars invested in different technologies and skills to do that, and as far as I know, not a single chauffeur has been replaced, not a single taxi driver, but I think they will be and there will be truck drivers and others that are affected and will start harvesting that. But that's still mostly in the future. When it happens, then there'll be hundreds of billions of dollars value created.

**Ravi Kumar: [13:13]**

And, Erik is this also a point where you believe that the spawning of downstream innovation is yet to happen, and therefore that will create an additional productivity catalyst? And the second bit I was wondering is, based on the learning we have had so far on consumer AI, is there a way to avoid the 'J' curve because businesses are almost measuring themselves on a quarterly and a yearly basis?

**Erik Brynjolfsson: [13:40]**

Yes. Well, you know, it varies. And just to give you a little bit of optimism, I mean, we've also looked at other industries, for instance, we looked at machine translation, and eBay implemented a new machine translation system. And there, it happened very quickly, it was literally a matter of weeks before you started seeing a big revenue boost, about a 12% boost in revenue, and increased transactions from the better machine translation systems. So there are some types, some places, they're relatively rare, we just sort of plug in and relatively have the transformation. The more common situation is that you need to rethink your business processes and your value chain. And as I said, that can take years to really do correctly or at least months. Most applications are in that second category. And, you know, we're beginning to see it in some different places. It's hard. You know what, I've been doing some work with some of the medical areas and your doctors tend to resist it, hospitals tend to resist it. Even when there are demonstrable benefits, people feel uncomfortable doing big changes in the way they meet with patients or the way that they diagnose things, but it'll come, it'll come over time.

**Ravi Kumar: [14:49]**

I had one other question which comes up with most CXOs of large enterprises. The responsible AI which is needed to de-risk, in fact, de-risking AI is almost a category of constraints starting from responsible AI, to how to deal with regulation, how to actually deal with reskilling. How do we scale AI based on converting every user from a consumer to a creator of AI? You might write software but the distinction of consumers of software were different to the creators. How do you blur that line? What's your view on all of this?

**Erik Brynjolfsson: [15:32]**

Well, you know, I mentioned that AI is having effects all throughout the organization, and we focused on some of the business process changes. But there are, frankly, also changes in some of the ways we think about privacy, ethics, bias, the whole social side of things, you know, those have to be reinvented. Most countries are rethinking some of the privacy laws, you know, Europe, United States, China, India, are all taking different approaches to that. And I think one of the big revolutions that is underrated right now is the focus on consumer privacy. But going forward, I think employee privacy may be an even bigger issue as you monitor the workplace with the potential for big increases in productivity, but also it can be intrusive. So there are some changes there. On bias, that's one that I think, you know, a lot of people didn't think about that much, you know, 5 or 10 years ago, but now it's front and center. I really don't think I've been to a conference yet where that topic didn't come up. And I'm not surprised it came up in our conversation. Machines can amplify existing biases, and they can perpetuate stereotypes. Of course, machine learning, most of the systems, they're based on existing data. So, if your existing hiring process or parole process or a loan approval process is based on biased data, the machine learning system is going to amplify and perpetuate that. There is the potential for reducing the bias tremendously. And I'm optimistic that

ultimately the machine systems will be less biased than we humans are in making these decisions. And it'll be a fairer system. But it won't happen automatically, it's something we're going to have to be very conscious of. And we also have to be realistic, you know, there's some mathematical proofs that, sadly, it's impossible to eliminate all bias. If you have some type one error, or let's call them some false positives, and some false negatives, you know, in different sample groups, no system can equate the levels of false positives or false negatives across all the different groups, it just mathematically can't be done. And that means you're always going to have some level of disparity. What the machine learning systems will do, is force you to be explicit about what your values are, what kinds of trade-offs you want to make. And it's a hard question, we have to confront these facts that we're going to have to make some choices about how we want to minimize bias, what we want to focus on first. I think it's a healthy conversation. It's one that needs to be made more and more, and any responsible CEO, or ML expert, or anybody working in an organization needs to consider not just the performance of the systems, but also how it's affecting different groups.

**Ravi Kumar: [18:14]**

Thank you so much, Erik. I am just going to squeeze in one last follow up question on this. You know, one of the other challenges most CXOs in enterprises talk about is getting curated data to mature and learn AI models. That is going to be a huge issue. But I've also seen some recent research, which talks about no requirement of data to actually mature AI models in a very different way. Do you see that as a possibility because that can actually reduce bias as well?

**Erik Brynjolfsson: [18:40]**

That's right. I mean, there are systems where there's a number of different things that people are working on. One of the difficulties of existing systems is they tend to require very, very large data sets. Thousands or millions of examples of photographs. And of course, humans do much better. You know, if you show a picture of an elephant to a three year old child, you know, they can recognize future elephants just with one example. Or they can even, in some cases, do what we call zero shot learning, or less than one shot learning, where you can show them a mythical creature, describe a mythical creature, and they could recognize it. Machines currently are very far from that. But there's some exciting research work on being able to learn from much fewer examples, I would say still relatively on the cutting edge. And for most companies, the supervised learning systems that use very large data sets are the more reliable sort of industrial strength systems. But over time, I think we can have systems that require much smaller data sets. And that will, as you say, not only make them more efficient, but also potentially reduce bias.

**Ravi Kumar: [19:44]**

Terrific! That was such a wonderful conversation. I could go on for hours and hours but I know we all have limited time. Thank you again for this wonderful conversation, great insights, as always. Every time I speak to you, Erik, I go back learning so much. I'm sure the audience is going to love this chat session with you. And I'm looking forward to working with you more. This is such a fascinating topic. Every large enterprise across the world is grappling with these issues. And if we have a pathway to solve some of this, I think we could scale AI into enterprises, and productivity is going to be on an exponential curve thereafter.

**Erik Brynjolfsson: [20:26]**

Absolutely, Ravi. I mean, it's such a pleasure talking to you. I learn a lot from you, as well. And I'm really impressed, what you and your team are doing at Infosys. I mean, the real challenge is taking these exciting technologies, and implementing and changing organizations. And I'm so glad you're working on those problems and making the world a better place.

**Ravi Kumar: [20:43]**

Thank you so much, Erik. And all the very best on your new stint at the Stanford University, directing the Digital Economy Lab. I'm sure you are going to make a huge impact there.

**Erik Brynjolfsson: [20:53]**

Thank you. I'm loving it and after the pandemic, I hope you'll come out and visit us.

**Ravi Kumar: [20:57]**

Absolutely, I will be happy to do that. Thank you so much.