



MANIAS, PANICS, AND CRASHES: CAN WE LEARN TO AVOID GREAT FINANCIAL MISTAKES

Announcer 12:37

Please welcome the panel on “Manias, Panics, and Crashes: Can We Learn to Avoid Great Financial Mistakes”? moderated by James Mackintosh, senior markets columnist, *The Wall Street Journal*.

James Mackintosh 13:03

Hi. Welcome. I'm James Mackintosh from *The Wall Street Journal*. We've got a great panel ahead. I'm not going to introduce everyone. You know who everyone is. But the title here, in case you're not familiar, Manias, Panics, and Crashes, is a fabulous book by Charles Kindleberger all about the disasters of the past. Frankly, a must-read financial history. And he explores how every bubble ended in disaster. Now, here, of course, we've got the discussion. You've probably been having it in virtually every panel you've been in about whether or not there's a bubble in AI. I think it's safe to say the consensus at this event is that there isn't a bubble in AI, but there's a lot of people who think there is. It's worth going back to Kindleberger's definition. He defined bubbles as ones that popped, which is a bit self-fulfilling. We can't really say that with AI. It certainly hasn't popped, but there's definitely something in the air at the moment. There's a sense of the madness of crowds, and if you don't think that, please, please try and explain why sneaker maker Allbirds' shares went up sevenfold when it decided to pivot to AI. But not everyone, as I say, believes there's a bubble. So I think we'll start. Go over to Cathie Wood. My first question to you, why isn't there a bubble? You know all about bubbles, of course. You became the pinup for the 2021 bubble, I think, for a lot of people. So tell us, why is all this perfectly reasonable?

Catherine Wood 14:46

I'll start by saying I was around for the tech and telecom bubble. I was a fairly recent portfolio manager and also had a background in economics. In 1999, there was not a care in the world. Investors and speculators were throwing capital at anything dot-com or internet. And the Fed was easing. It eased three times and

for three reasons. We had the Russian default, long-term capital, and Y2K, and then finally, the tech and telecom bubble. So the Fed was easing, accommodating all of this, and it ended badly. But it ended badly because the technologies were not ready, and the costs were way too high. And so what we've seen is the seeds that were planted during that time, actually the 20 years that ended in the tech and telecom bubble, they have been germinating. And at the same time, because of the tech and telecom bust in '08, '09, risk aversion has evolved in the marketplace. And yes, you mentioned '20 and '21 for ARK. That was, again, we had massive fiscal and monetary stimulus, and we ended up with, in response to a supply shock and monetary and fiscal stimulus, huge inflation. And it really did gum up the works when it comes to unit growth. So let me just—I'll finish quickly here. But in our work, the technologies that we see evolving, and with our 5 major innovation platforms, 15 different technologies, they are converging. Our work is all about understanding the learning curves, cost declines, cost coming down. When costs come down in a new technology, demand picks up. A supply shock will interrupt that. Our mistake in '21 was not understanding that the supply shock would last for three years and really harm unit growth. So unit growth is key. We have very few of those issues right now. Of course, the Iran war is presenting some questions. Hopefully, that's over quickly. But the seeds planted back then, germinated for 20, 25 years, are ready now. They're flourishing now. The costs are low enough, and the technologies are ready. And so we think we're in a technology revolution. AI is the biggest catalyst, but we've got robotics, energy storage, blockchain technology, and multiomic sequencing. The five major platforms, including AI, they are converging. And the punchline here for us is, this is going to be enough to move the economic needle. We think that real GDP growth is going to accelerate into the 6 percent, 7 percent, 8 percent range sustainably because of productivity growth. And also because of productivity growth, we expect inflation to break down. If you've watched Truflation, it is already breaking down.

James Mackintosh 18:13

Okay. So Sebastian, you've literally just written the book on one of the key guys behind AI. Is this technology ready for deployment?

Sebastian Mallaby 18:26

Look, I think it's an A+ technology and a C- business model, particularly if you're looking at the foundation model builders. Since 2022, when ChatGPT came out, there has been this series of incredible advances, much longer memory in these models, much less hallucination, the ability to do multimodal text, video, pictures, audio, and so forth. Then reasoning models. Now we're talking about agentic models. We've got world models coming down the pike in the next couple of years. So this is a fantastic technology. But if you look at the business model of, say, OpenAI, they've got 900 something million users. About 5 percent of those pay any money. And they finally realized, belatedly, they've got to pivot into a whole different strategy where they cut the video production, they move into enterprise, they subsidize companies through private equity firms to buy their product. So I think there isn't an overall problem with the technology, but I think there is specific pockets of activity where this is not just an experiment with the technology, this is an experiment in capital markets. How deep are global capital markets? Can you raise hundreds of billions of dollars to tide you over from the moment now where you have the C- business model to the moment in the future where you'll eventually have a better business model? And the leaked

internal documents from OpenAI back in January were saying that their expected burn between now and 2030 was \$660 billion. That's an insane amount of money, right? So, that's what I feel about the bubble question. Semiconductors, there's demand all day long, huge shortages. Everybody wants more. They're very highly valued, but I think it's justified. But in some of these other things where you have a commodity product, a generative AI product, where there are five labs in the West and maybe another four or five in China which you could use, it's hard to see the pricing power for now. I'd just make one objection to Cathy's otherwise persuasive presentation, which is costs coming down. Costs coming down? CapEx in AI is off the charts. So I'm not sure about that.

Catherine Wood 20:39

Yeah. If I can just clarify that. So, the learning curves—our model is focused on Wright's law. Wright's law is a relative of Moore's law. Wright's law is not a function of time like Moore's law is. Wright's law is a function of units. We're back to that again. If you look at technologies, if you look at hardware and software combined in AI, the cost declines per cumulative doubling, in it's a metric of data per unit of a computing power. Those costs are dropping 54 percent for every cumulative doubling in that metric. You've got AI training costs down 75 percent, inference costs down up to 95 percent. In the DNA sequencing space, that space is exploding. The convergence between sequencing technologies and AI is provocative. For every cumulative doubling in the number of whole human genomes sequenced, costs decline by 40 percent. And in the industrial robotics space, and we're at a very low base here now, for every cumulative doubling in the number of industrial robots produced, costs decline by 50 percent. So we've got some massive deflationary undercurrents, undertows, some might say, if you're going to be stuck in the old world. And so that's what I mean by deflationary.

James Mackintosh 22:11

Okay, so Austan, 6 percent GDP growth and AI is leading to deflation.

Austan Goolsbee 22:17

I'll take it. Yeah, I'll take it.

James Mackintosh 22:18

So tell us how—when are you cutting rates?

Catherine Wood 22:21

It's a five-year accelerating—

Austan Goolsbee 22:23

—Look—

Catherine Wood 22:24

—in the next five years—

Austan Goolsbee 22:24

—That's what I want. If we get that, that'd be the best. Maybe the Fed will take credit. But, I wonder—the Kindleberger book about manias, panics, and crashes was really about bubbles. Is there such a thing as a mania that's not a bubble? I think there is, actually, and maybe that's what we're talking about, that people could get really into a thing and it be justified, that it be just as good as what they thought. The mania is they're counting the chickens before they've hatched. Now, that may be the right count. The eggs may hatch. In my world within the Fed, there's a question: What would this do? Let's say it's true. What would it do to the economy? But then the grubbier, well, what would it do to the Fed? What should the interest rate response be now? And the thing that I would-- We brought up the 1990s, and I'd just like to bring that example back to the fore. At the time, we had a productivity boom in the '90s. It started silently. It wasn't like what we're seeing now, where we've seen in the data productivity start accelerating. If you remember, and we have the greatest biographer of Alan Greenspan sitting right here. Alan Greenspan deduced that there must be an increase in productivity, even though it was not yet in the data. He said, "If you look at corporate profits, they're up, but the unemployment rate isn't rising and inflation is low. The only way to square this, there must be productivity growth." And that is when they were loose. That is when they did not raise rates. But by 1999, the data showed there was a huge increase in productivity, and now Greenspan changed his view, and he said, "We've got to be nervous. We've got to start worrying about the fact that everybody's counting the chickens that are coming, and now it's expected." And actually, the Fed raised seven times in less than a year, from '99 to 2000. And there are some people who say that's what engineered the popping of the bubble. Take that battle from now ancient history to the young people today, as they say, "You were alive in the 1900s?" The question of if the productivity growth miracle is happening in an unexpected way, then it will mean lower inflation, and I think it means rates could go down because you have less pressure. But if it's expected, and the more people tell us, "Hey, what is coming down the pipe is 6 percent GDP growth, and we're going to have massive productivity." Just remember, future increases in your income are a wealth effect today. And if what you see is people pulling forward from what they believe is going to be coming, massive investment today in data centers premised on stock market valuations that are super high. Massive consumer spending based on stock market wealth off of AI. Before the productivity has arrived, you can easily overheat the economy in the here and now. And it's not at all obvious that the Fed would need to lower rates in that case. They might need to raise the rates in that case. So if it's as good as advertised, it would be lovely, wonderful, will make us rich. But if that's still to come in the future, I do think we'd need to be a little more circumspect and on the lookout for overindulgence.

Catherine Wood 23:43

Can I just add something to this?

James Mackintosh 26:44

Hang on. Just before you come in, Benedict, you actually spend a lot of time studying the technology. Is it as good as this? Does it live up to the hype?

Benedict Evans 26:58

I remember a professor of mine once said, "History teaches us nothing except that something will happen." And I think it's really obviously useful to think about the late '90s. The challenge there is whether we're in '97 or '99, where, of course, we can't tell. But going into the micro of that, one of the characteristics then was that nothing really worked. It was all really, really exciting, but none of it worked. And it's also, I think, looking at a lot of the challenges with these models to date, it's also interesting to go back and think about the early '90s or the '80s and PCs, when it was an entirely normal experience to look up at your screen after looking away for a second and discover that your PC had just locked. And well, that was the last hour of your work was just gone, and you'd have to go and pull the plug out of the wall, and that was it. And there was a huge amount of work to be done to get to the point that the young people of today do not know what a crash is except in the context of financial markets, but they've never had a PC crash on them. These models look a lot like that now, in that they're amazing and then they're not. And they work really well, and then they don't. And if one thinks about the market structure of the internet in the late '90s, none of those companies worked. And the ones that did don't look like anything like that anymore now.

Most people have probably seen the meme of Jeff Bezos from the '90s looking like a librarian and saying, "I sell books." And then Jeff Bezos today not looking like a librarian and saying, "I sell whatever I want." Generally, an expletive included in that. And so, this was a world when the ISPs were going to be a big deal, and there were going to be portals, and it wasn't clear it was even going to be the web, and it was going to be maybe Yahoo. And Larry and Sergio were at university, and Mark Zuckerberg was in kindergarten. And so all of the companies that actually got the value from this came later. The same thing with mobile a decade later. There was BlackBerry and Nokia and Palm and all of those companies, and that didn't end up being the way that it worked. And so looping back to what Sebastian was saying about capital, it's very unclear why building a very expensive foundation model isn't going to end up being a piece of commodity infrastructure. I started my career as a telecoms analyst in '99 and 2000 when 3G was going to change the world, and it did, but the telcos didn't get any value from that. And it's not just that it took 10 years, it's that even after 10 years, they never got any value from it. And what actually happened was that the industry spent 15 percent to 20 percent of revenue for the last 25 years. They built an enormous amount of infrastructure. The data consumption has gone up by many thousands of times. And the stocks have gone nowhere for 25 years, basically. Some of them have roughly got back to where they were in 2000. Most of them haven't. Because it did take longer, but the important point was once it had happened, it wasn't them. It wasn't Yahoo on the one hand. On the other side, yes, it was telcos were still there, but all the value was built further up stack. And so as I look at people building foundation models today, they'll spend, say, \$700, \$800 billion this year, maybe more next year. We don't know the end state

of this anymore. It's trying to predict where that CapEx is going to end up is rather like trying to predict bandwidth in the late '90s. You know what cells you put in the spreadsheet, but you don't know what the values are going to be. But it looks like there will be, say, three to six companies spending, say, quarter of a trillion to \$2 trillion, that's deliberately a wide range, every year building this stuff and they will have revenue to support that at no margin, and there will be no price discipline.

And some of those companies will have other very highly profitable businesses that mean they don't need to make profit from those models, and some of them won't. And they won't get any value further up the stack. Sam Altman spent time talking about how this was going to be like Windows, but there's no network effect here. You don't have to write your applications for one model versus the other because that's what people use. There's no network effect. There's no winner takes all effect. It's not clear why there would be any value capture. And actually, the more interesting quote from him was that he thinks people will be buying intelligence from us on a meter, like electricity or water. Yeah, do you want me to tell you about the margin structure of the electricity business or the mobile business? So I can entirely imagine that, yes, this will be the new PC. Because clearly this is the new PC, this is the new internet, this is the new mobile. But with the internet, it wasn't those companies. And with mobile, it was those companies, but they didn't get any of the value from it. And that's kind of what I think this looks like.

James Mackintosh 31:47

Okay. Zoe, back in 2006, 2007, there was a vast amount of capital being deployed. You were there watching, President of Morgan Stanley, and worrying about it. Are you worrying about the vast amount of capital being deployed now? And do you think that companies will actually be able to raise these trillions they're talking about, and deploy it?

Zoe Cruz 32:15

So yes, I was worried, but I was very early, to the point where my then-boss used to say, "John Mack, you're too negative. Good leaders are not that negative." So to answer the question of whether this is a bubble, well, in terms of valuations, it is, if you look at the past bubbles. In the '20s, before the great crash, P/E multiples were in the low 30s. It's in the high 30s now. Coming back to the irrational exuberance that Mr. Greenspan talked about in '96. '99, Nasdaq was up 90 percent. So for me, it's less important whether this is a valuation bubble, and much more important the timing thereof. On a scale of 1 to 10, are we in '05 versus '08, the world fell apart? Going back to your original question, when I was running Morgan Stanley so I had a front seat at billions of dollars being put to work. People forget actually that, again, in May of '07, July of '07, Bear Stearns went under. In May '07, equities were making new highs. We in fixed income knew the world had a problem. So for me, it's all about timing and less about valuation. For me, this is a general purpose technology. General purpose technologies transform the world. Steam engine, railroad, the robber barons were born out of those kind of things. A lot of people made a lot of money. You could say the internet was a general purpose - electricity. But people, again, forget electricity—it took 20 to 40 years for many business models to be transformed. So for me, it's all about timing. I think right now I am worried about the valuations. But I'm not going to repeat the same mistake I repeated in '07. I got negative way too early. But I would say for me, it is a very capital-intensive transformation. Right now, the

hyperscalers, they've spent hundreds of billions of dollars. It's not your 401k plans. They have hundreds of billions of dollars to spend. 60 percent to 70 percent of this transformation is being built in the US. So if you go to Texas, there are cranes everywhere. There is no recession about to occur in this country anytime soon. So again, going back to the framework, for me, it is something that's changing people's lives as we speak. My company uses AI. We're an asset management company. I have at my fingertips information that I needed 12 Mary Meekers at Morgan Stanley to get, faster, cheaper than Mary Meeker could ever tell me her views of the equity markets. So it's transforming. But I spent over three decades on Wall Street. That subject matter expertise I have, when I ask AI a question, I've downloaded all five of them. For a couple of hundred bucks, you can have the top model. It's amazing. But it gives you unequivocally BS with absolute authority. So you need to actually understand to say, "No, no, no. This is what I'm asking." If you have subject matter expertise that people cannot emulate, that's a moat. This is transformative technology, will make a lot of companies very effective and very rich or richer.

James Mackintosh 36:43

I have to say BS with absolute authority. No one would ever associate that with financial analysts. So that's great. Well. Sebastian.

Sebastian Mallaby 36:53

So I have a funny colleague at the Council on Foreign Relations who's really into experimenting with new models. And one day I had coffee with her, maybe about four or five weeks ago, and she said, "Oh, it's great. The new Claude model, fantastic. It's agentic, it's great. It's already giving me the news feed specific to me every morning." And I'm like, "Yeah, fine. I read The Economist news summary. That's good enough for me." "But I also have other agents and they're doing other things. They summarize my email." I'm like, "Well, I look at my email now and there's already a summary that's kind of generated by some AI in the email system, but whatever." "But I've got this thing and I've got this thing." And then she said, "I had another idea for a fantastic productivity hack, which is going to turbocharge how effective I am. So I said to Claude, 'You're agent, you need to do the following for me.' And Claude responded, 'Kat, are you sure you're not asking me to do yet another agentic task because you're trying to avoid your own work?'" And, I think what this gets to is that the tech can be, on some level, impressive. Like who knew that you could have some piece of software that gave you a tailored news summary? But it can be impressive and yet not useful. Is it something people will pay a lot of money for? And I think this gets to the question of the value capture. It's actually very difficult to go from something which is technically impressive to something which really makes your work more efficient. In coding, we have that, and that's why Anthropic is doing so well, because it's coding. We've had the first kind of coding assistant that was truly great. And there are other specific applications which may be genuinely useful, but then there's a lot of just noise. And to go from where we are today to the point where it's super useful for productivity is going to take time. We don't know how much time. And to Benedict's point, we don't know which kind of company will capture it. There was a SaaS apocalypse a few weeks ago, and the theory, as you know, was, well, these foundation companies are going to produce amazing AI, and nobody will need normal, boring, old enterprise software. Well, maybe if you have enterprise software and it's already embedded at a bunch of corporations and the corporations trust that software provider, maybe the most efficient way for the corporation is to get

access to the AI by asking the enterprise software company to embed Claude into it and be the intermediary that figures out how you deliver AI to that company. So maybe SaaS or some SaaS companies could be in great shape. We don't know. We don't know who's going to capture the value. And so I think it's pretty safe to say there will be specific companies whose value goes up and then they collapse. But then overall, is there a bubble? I don't really think so because I do believe in the tech.

James Mackintosh 39:44

Okay. Sorry, Cathie, I interrupted you earlier.

Catherine Wood 39:45

Sure, sure. No, no problem. I think one of the things that's happening today is that everyone's talking about a bubble and is fearful there is a bubble. As a portfolio manager, I feel very comfortable in that environment. It was in the late '90s, and you're right, the Fed had started tightening, but they were still scared of Y2K, and so they were not aggressive. There was not a care in the world at that time. I was really uncomfortable with that. I have to defend, since we own OpenAI, Anthropic, and xAI, as it was absorbed by SpaceX. So we're looking at the models. Of course, we are. And it started out, many people said, "Well, this is free. Only 5 percent." But what we're seeing internally, and we're not a coding shop—Claude Code and Claude Cowork, now Codex and Codex Goal, which is this week's release, is far surpassing Claude Work. And so, it's very interesting. Started out \$20 a month. This is for use inside Ark. Then to \$200. Everyone's running out of tokens. Our chief futurist is willing to pay \$2,000 a month. Why? Because he doesn't want to train an assistant. He has an assistant, and the assistant is training itself. So it is no surprise that Anthropic's ARR went from \$9 billion in December to \$30 billion. Think about that. ARR, annualized recurring revenue, from \$9 billion December to \$30 billion in April. And there are rumors out there that the latest read is \$44 billion. And developers are not loyal. You're right about that. There's no loyalty. They're going to go to where the best performance is. And now it's Codex, something called Goal, that can reason for 20 hours. So for companies that harness this technology and run with it, it's very valuable. And they're going to, from a competitive point of view, pull away very quickly. And so I think there's a sense of urgency. C-suite, not only C-suite, though. It is also from the bottom up, people saying, "Oh my gosh, am I going to lose my job? I better learn what this is all about so that I can compete." So that's how I would answer that question. And you're right. We don't know if they're the ultimate winners. But I do find it interesting that unlike the late '90s, where, again, companies like Amazon would say, "We are going to lose so much more money now," and the market went straight up on that. In the public markets, that's not happening. It's happening a little bit more in the private markets, the venture market. So it is a very different environment, and the changes are incredible. One last thing. We're not just talking about productivity here. We're talking about embodied AI, like autonomous transportation, which is the biggest revenue-generating opportunity during the next 5 to 10 years, robotaxis, trucks, drones, and so forth. And we're talking about maybe the most profound application of AI, which is health care, embodied AI. Collapsing the cost and time to research and discover new drugs, diagnosing diseases in their earliest stages or even before as the body's setting up, and ultimately—not ultimately, this is already happening, curing disease. We are seeing cures for sickle cell disease and beta thalassemia. Many of the things

happening in health care today would not be happening if we didn't have sequencing technologies. We have 35-40 trillion cells in our bodies, and now we have single-cell sequencing. That's a huge AI project.

James Mackintosh 44:09

Austan, you wanted to come in, but before you make your point, I just wanted to ask you, does the Fed have a chief futurist?

Austan Goolsbee 44:15

I don't know. Am I the chief futurist?

Sebastian Mallaby 44:18

Yeah, absolutely you are.

Austan Goolsbee 44:20

No, I don't think we have. The Fed will always be—especially in the payment, we run much of the payment system of the United States—the financial plumbing. There is a sense in which the Fed is always going to be a little bit the fuddy-duddy of finance because moving fast and breaking things is not compatible with \$6 trillion a day of payments. Oh, whoops, sorry. Fed Wire didn't go today. We will have a financial crisis. So there is a sense in which we want to be a little slower adopting and make sure that it's safe. I'm interested in this, let's call it the maximalist description of what AI can do. Is it based on the technology that exists already, or is it based on an extrapolation of the improvement that we have seen in the last three years out into the future? And the reason why that matters, as I think about it, is part of that improvement has come from algorithms and let's call it the theory of AI improving. Part of it has come from massive capital investment in computing power, massive increases in the size of the data sets that it can be trained on. And the more of it that comes from that, the more there will be diminishing returns that kick in relatively soon. And so I'm a little uncomfortable, and let's just be careful figuring out. Take autonomous driving. Fifteen years ago, it was a widespread prediction that autonomous driving would be so ubiquitous that every professional driver in the United States would be out of a job within five years. And you'll remember, and people were like, "Oh my god, that's the most common occupation in the United States. If it happens that quickly, we're going to be in for a world of pain." It didn't happen that quickly because for what the improvements were, they were extrapolating that it would continue improving at that rate, and it didn't. It hit diminishing returns. So I wonder when I see these massive data center expenses, how much of the improvement that we've seen so far is going to reach the limits of growth, and that at least ought to be in our calculation of what's the probability that it takes over health care, it takes over—

Catherine Wood 47:11

—Can I just add, James?

James Mackintosh 47:13

My favorite example of this is on your codex, that it has to be instructed not to talk about goblins all the time. And I just love the idea that the cutting-edge AI models left to themselves would just talk about Dungeons & Dragons stuff. So it sort of is a little bit, maybe it's not quite there yet, but anyway.

Catherine Wood 47:32

Can I—since I realize I'm—

James Mackintosh 47:34

—Just quickly, because I want to go to—

Catherine Wood 47:35

Oh, yes. I actually think that with AI in the transportation space, it's going to be winner take most, and that is how the market is sorting itself out. There were many, many competitors, as you say, 10, 15 years ago. And innovation does happen slowly, slowly, and then all at once. We are at the all-at-once stage, and vertically integrated models like Tesla's, we believe, will win over Waymo because there'll be much lower cost structures. I think what you're saying, if we weren't witnessing what Tesla and Palantir and Tempus in the AI health care front are doing, I wouldn't be able to say winner will take all, but that is, I believe, what's going to happen here.

James Mackintosh 48:28

Okay. Zoe.

Zoe Cruz 48:29

So you can be in heated agreement that this is a great technology, it's going to change things, it's going to be very effective on a number of things. And as I said, to me, some of the best technology, we've spent a billion dollars a year at Morgan Stanley in '07, real money. Some of it was the effectiveness is of spending very little money in technology, but have the best technology minds sitting next to the trader or the wealth manager, the broker, and map out what is the process they're going through and use technology to

make it better. This is happening. A lot of companies are doing the same thing. We can be in heated agreement. I don't think there is enough talk about risk management, because right now the markets are making—and again, I'm an enthusiast of this technology. The markets are making, around the world, a very big assumption that capital will continue to be available and cost thereof will continue to stay low. That's a very big assumption. So when you look at, in the past, the way these things kind of became bubbles that burst is the Fed tightened, some of it to fight inflation. You don't need to get into religious discussion whether too early or too soon. So for me, right now, even if the Fed keeps interest rates low, the curve is already upward sloping. And I think what I watch is if the curve starts saying in this environment, sovereign governments, not just the US government, the Germans are printing money, for God's sake. The Chinese are printing money. Everyone is printing money. So the debt to GDP around the world is going up. These hyperscalers are going to come to the public markets to borrow more. So I think what we all should look at, you're taking a risk in investing in this amazing technology. You don't make any money unless you take risk, but you need to get paid for the risk you're taking. So to me, the right question to ask, are we getting paid enough for the risks we're taking? And I would say in the private credit world, I don't want to create enemies—debatable. So that's how I would actually—what I try to proselytize people is there's no point to argue the unarguable. This is going to change, and it is changing the world. But if you run out of money, and I remember again, the '08 fiasco. What saved—I took billions of risk of the firm's balance sheet back then—is I went to California, and this guy said, "Zoe—" This is, remember, the housing - is it a housing bubble, is it not? And he said, "... go back to New York and stress test your assumptions of this company." I can tell you, he was a mortgage expert. Your recovery rates are going to be a lot lower than your models predict, and your actual default rates are going to be a lot higher than your models predict. When did the world change? When we went from mark to model to mark to market. It didn't matter that it was an amazing evolution of digitizing, if you will, and privatizing housing. CDO squared said that we didn't risk manage enough our balance sheets. So that, I think, there is not enough being talked about.

James Mackintosh 52:11

Okay. Benedict.

Benedict Evans 52:13

Yeah. There's just an observation on the two previous comments. There's a difference between a good technology and a good company, and there's a difference between a good company and the right price, and indeed the right price right now. The question of Tesla and autonomy is partly religious and partly comedy. We've had autonomy next year for 15 years. We'll have it for another 15 years. We'll find out. But there's no predictive value, certainly in anything that Elon says. But really, we can't really predict when that's going to happen. And there's a more general point here, which is, I think, the fundamental way that the generative AI is different from every other platform shift or certainly every other bubble, is that we don't have a good sense of how this works. That is to say, we didn't know what the next iPhone was going to be, but we knew it wouldn't have a one-year battery life and a neural implant. We didn't know which Internet companies were going to work, but we knew that telcos weren't going to give everybody in the world fiber broadband next week, and we knew how Moore's law worked, and we knew how many PCs there were. We don't really know why LLMs work so well. We also don't know how human intelligence

works either. So, we can't draw a chart and say, well, ChatGPT-4 was here and 5.5 is here, and chimpanzees are there, and people are there, and in 17 and a half months, it will get to octopuses. And we don't know how we can model all of that. So, we might look at our phones this afternoon and see a notification that there's a DeepSeek paper which turns out to be misunderstood, which is what happened a year ago. Or we might get a paper that says someone's worked out how to get the same results for one percent of the cost, which is great for everybody except investors in data centers. Or it may be that over the next three years, the whole thing kind of slows down the way autonomy did, and the models that we have now are kind of what we get, and we don't continue to get these step changes in capability.

And the problem is we don't know. So everybody making statements about this, whether it's Demis or Yann LeCun or whoever, is ultimately just kind of vibes forecasting. They're saying what they feel the technology might do because we don't have a theoretical way to say what it will do. And for better or worse, that's just kind of a conceptual difference from the other technology shifts that we had. That comes back to your point about investment in data centers. The fundamental difference here, of course, from the investment in fiber is that the investment in fiber was ahead of demand, and this is all massively behind demand right now. So right now, this stuff is all sold out well in advance. Right now, they can't meet demand. Even if the technology doesn't improve at all, you could probably fill twice as much data center with the models that we have today.

But then you have that question of how much does the efficiency keep improving? So right now we've got an explosion in demand, an explosion in usage driven by agentic and more people, which pushes the demand up. We have inference efficiency doubling every couple of months, which pushes the demand down. You can't get enough kit to build more data centers, so everything kind of gets pushed out. There may be new approaches, and then you're training the next model every six to nine months. So how long are you chasing the frontier? How long do the models keep getting better? At what point does the improvement in efficiency catch up with the increase in demand? Which is kind of what happened with telcos as I mentioned earlier, that telcos dealt with exponential growth in demand for 30 years, and they managed that by keeping prices more or less steady and spending 15 percent or 20 percent of their revenue on CapEx every year. And the result was they kind of maintained equilibrium for 30 years. We don't have equilibrium in LLMs. We don't have equilibrium for the price, for the demand, for the CapEx. We don't know where that equilibrium will be. But we also don't know how the change in the technology will affect that. So it may be that we have stuff that's absolutely amazing and has great ROI, and everyone really does spend \$10,000, \$20,000, \$50,000, \$100,000 per employee on this stuff, which is what people in the Valley have started to talk about, like, "What's your expense per employee on tokens?" It may also be that the price collapses, the model stops getting better, the efficiency takes over, and this stuff just gets cheap and free and becomes a commodity and gets rolled into your \$10 a month plan and doesn't get much better. So we kind of don't know what those curves are going to look like.

Catherine Wood 56:22

Can I just since I actually do think about the risk side of this here. I think what may happen to interrupt maybe the momentum, and this is something we're watching, is that now that everybody understands agentic AI, I think that the idea of who's really controlling this. Are you a real human being? I think that the resurgence of the human being in the decision-making process could possibly, not interrupt, but slow things down as we get into proof of humanhood. And if any of you know of Eightco, Orbs, and so forth. I

think it's going to become very important because who controls the purse strings at the end of the day? This is more on the consumer side, of course. It is a consumer. So, we are on the lookout for a change in momentum because you're absolutely right, Benedict. I think certainly when it comes to chips, we saw AMD reporting last night, but we learned something else. Guess what? Agentic AI means the ratio of CPUs to GPUs is going to increase from one to four today to one to one if Lisa Su is right. So it's like we're back to the future. We're seeing Intel. We're seeing names like, well, Dell, of course, Flex, which used to be Flextronics, so Cisco. It's all hands on deck for this hardware build-out side of it, hardware and software. But there will be a moment where people will say, "Wait a minute. I need to figure this agentic thing out a little bit better in terms of the economics."

James Mackintosh 58:15

Austan, we've got an interesting couple of interesting—well, quite a lot, but a couple of readers, sorry, audience—our audience wants to know, could we end up here in a sort of new feudalism where there's an elite that uses the AI and everyone else loses their jobs? And if so, what on earth should we do about it?

Austan Goolsbee 58:41

Directionally, yes, but let's not overemphasize what it is. That's the, let's call it the K shape. Does it have income inequality implications? Can technological changes have inequality implications? For sure, they can. If you look over the centuries, depending how fast they come in, they can affect different groups differentially. If the AI were as powerful as what we're describing in its most expansive form, and a bunch of people said, "I don't want to touch it. I want to have nothing to do with it." That could show up in wages. But the idea that there will be 10 owners of the AI and everyone else will be destitute, but for their universal basic income, to me, that seems a little overplayed.

James Mackintosh 59:37

Okay. That's good to hear, I have to say. There's a lot of interest here, but one of the big questions when we're trying to, for those of you who do believe there's a bubble, or even for Cathie, if we're watching for turning momentum, what is it that you look for as the indicator? Are we in '97 or are we in late '99? When do we know it's time to get out? I don't know who wants to take that, but maybe Zoe, since you raised this.

Zoe Cruz 01:00:18

Yeah. I would say, again, you want to have liquidity. So before you act, you need to have enough liquidity. So whatever investments right now that we're making in this space is you're being asked to lock up your money for 10 years, and you have people managing that money decide who the winners and losers are going to be. So as a portfolio allocator, I would say—if I have enough liquidity, I would look at—and can I

get out? And I would want to hit that bid. As I said earlier-The debt in terms of debt to GDP of sovereign nations has never, and I use the word never very, very judiciously, has never been higher. And so if that demand for capital keeps on going up, what they've done in the past is they print money. They even have active balance sheet management, where you issue as a government on the one hand, and you buy back the bonds with the other hand, and you can keep artificially cost of capital low. To me, the fact that 30-year interest rates broke 5 percent, I don't know where it is now, maybe it's down below again. That's something I watch for. I don't think the Fed is going to tighten dramatically, whether they tighten 25 basis points or ease 25 basis points, it doesn't matter. What I look at is what is the yield curve going to do? And if we have a Liz Truss in the UK, that kind of moment where UK gilts, this is basically government paper, one of the top nations in the world. UK gilts basically got annihilated in the space of weeks. I look at that, and if that happens here, I would hit the bid.

Sebastian Mallaby 01:02:38

One thing maybe in a discussion about bubbles, and whether we have one right now that we should keep a hold on is that, a large part of the activity in AI is going on in private companies. And, so you don't get to the point about liquidity. These are private investment rounds where nobody can short the asset. You can't be a short seller in private markets. And to the contrary, in fact, when you act in private markets, lots of people are desperate to get into the round. They want access. So you can't even speak short. You can't denounce the value very easily of some new investment round in OpenAI if you're part of the Silicon Valley ecosystem and you want to remain on good terms with all your buddies who may refer you to future deals that you do want to be part of. So, I wrote a whole book about the history of Silicon Valley through the eyes of venture capitalists, and this is one of the big features. You always get bubbles in private tech assets, partly because at the early stage, there's no data to go on, right? There's no price earnings ratio because there's no earnings yet. And so it's all a story-driven thing, and that's susceptible to booms and busts. But also because when you get into growth companies in the later stage, nobody can be short, nobody can criticize it. You've all got to be part of the club. And, so what I would look for is that when you have these very high valuations, take the most recent round for OpenAI, 850 billion or whatever the valuation is. And then you look in the secondaries because there's some market for that. And the secondaries are telling you that the nominal paper valuation is above the secondary action, and that's a sign. If you look in the public markets and you see that companies that have a lot of contracts with OpenAI are falling and OpenAI is being revalued up, which was happening in the last three or four months on a big scale, that's a sign. So I think one thing to just remember is that private markets have this characteristic. The second thing is circular deals. If we go back to 1990s and the bust in the early 2000s, one of the things was that you had certain kind of core players in the internet ecosystem that went down. And then it turned out that a lot of other companies in the system were selling product to the core. And so then everybody went down together. And there are a lot of these circular deals now emerging between the builders of the foundation models, the suppliers of the compute clusters, the suppliers of other services, and I think also that's something to watch quite carefully, and I'm a bit worried about that.

James Mackintosh 01:05:10

Okay. And yeah, Cathie, so what's the point at which you would sell? And then also on these IPOs that are coming, are you a buyer? It's notable, SpaceX, for example, the—

Catherine Wood 01:05:20

—Yes. This year is going to be very interesting because of the SpaceX IPO. We know OpenAI and Anthropic are leading. And it may be the midterm elections fear about a change in the regime down the way. So I think the supply is going to be enormous. Index providers, especially because the S&P and others are going to let SpaceX in much sooner than they would otherwise. Everyone's geared up. But in order to absorb the supply, what are they going to do? The index providers will be selling the rest of these indices. So I think your point about the private versus the public market, we've seen over the last few years, many companies go public and go straight down. So the public is becoming a little skeptical of, I'm not saying of these in particular, but of many private companies that are going public. When do we sell? I can tell you I sell all the time. I do. We take profits all the time and redeploy right now, certainly over the last four years, the multi-omic space. The idea that health care and AI are converging in a provocative way. We've been buying into that. That has just been dead as a doornail. And I would say, if we were in a real bubble, that group, you get AI attached to anything, and it is happening in there now. This is not when, it is happening now, and yet it has just been devastated as a group because the convergence between health care and technology is really hard for research departments that are siloed by sector or industry or sub-industry. Tech analysts don't like health care, health care analysts don't like tech, different chemistry. So highly inefficiently priced. In a bubble, that would not be true because we're not dreaming about personalized health care right now. It is happening now, unlike in the late '90s.

James Mackintosh 01:07:33

And buyer or seller of SpaceX?

Catherine Wood 01:07:36

Pardon?

James Mackintosh 01:07:37

Buyer or seller of SpaceX at IPO at 100 times sale?

Catherine Wood 01:07:40

Well, we own it. We have a venture fund. It's roughly 850 million. It's our largest position. We've been in for many rounds. Orbital data centers, we're doing the modeling work on that, are going to dwarf Starlink,

and SpaceX is 10 years ahead of anyone else in space technology. So you would buy more at IPO, not sell what you've got? So the model we have out there, and you can see it if you want, it's on GitHub and on our website, ark-invest.com. In that model, pre-orbital data centers, we had a valuation target of \$2.5 trillion in 2030. Now they're saying this may be a 1.75 to two. So if they had not announced orbital data centers and if we were not modeling them, this could increase the revenue base of SpaceX, 20 to 30-fold if you go into the out years.

James Mackintosh 01:08:47

So that would be the biggest company in the world by a very large margin.

Catherine Wood 01:08:51

Yes.

Benedict Evans 01:08:51

I remember when I was a baby analyst in the dot-com bubble, and we were looking at companies that would say, "Well, we're going to be this, but then we'll be that, and then we'll be that, and then we'll be that, and that's what you should value us on." And we called them multi-stage rockets.

Catherine Wood 01:09:04

Well, it—

Benedict Evans 01:09:04

—And that's the sum of the parts of Tesla and SpaceX. It's not this, it's not the next thing or the next thing or the thing after. It's that other thing that doesn't exist yet that maybe it will happen. But of course, Elon Musk—

Catherine Wood 01:09:15

—And I'm glad there's that kind of skepticism. I think that's good. Believe me, we have a brainstorm with outside visitors, and we're hearing a lot of pushback on this, and I understand it, but we're doing the modeling. We're doing very serious research, using Wright's law, trying to figure out how big could this data center opportunity be.

James Mackintosh 01:09:41

Well, on that note, we've drifted some way from manias, panics, and crashes, but there's certainly a bit of a—I would say a lot of disagreement here about valuing these things. I just want to say thank you very much to the panel, and I hope everyone's enjoyed it.

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