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**GARY GENSLER:** All right, we're going to turn today to a fun topic of how central banks, right at the heart of the financial system, are thinking about blockchain. And we're going to do this over two classes.

We're fortunate that we have some real expertise in the room, and I'm not talking about myself. But Rob Ali, who ran the digital efforts at the Bank of England, and is now-- and has been for some time-- part of the digital currency initiative over at the Media Lab, is going to come up from time to time and give his perspective. Not only from MIT's Media Lab's perspective, but also from the history of what he's done.

He's authored a number of papers in this area. He works with technologists creating a number of technologies. But I'll let Rob tell you a little bit about what he's doing in central banking.

Simon Johnson's also joined us, who is a former chief economist of the International Monetary Fund. He's told me he doesn't want to be called on, but I will call on Simon to give his perspective at some point in time, from the IMF days. But as you all know, Simon is Sloan faculty, a great teacher, himself, teaches a lot of you in the global markets course and the GLAB course, and things like that.

And Simon and I in the spring teach a public policy and private sector course, which is just one more time for me to plug that that's a good course, too.

So now, let's just talk a little bit about central banking and blockchain. First, what are we going to do? A little bit about our readings and the study questions.

We're going to start with Fiat currency, and go back again to Fiat currency, and how does it fit into central banking. So the first 20% or 30% of today is really just about what is a central bank, and how does it fit into money?

Then, how are central banks thinking about blockchain technology? What are their approaches? And we're going to talk about four different approaches that central banks are taking to blockchain technology.

Then dive into one of those four approaches-- payment systems, and how are they looking at payment systems right now. Dive into probably the most interesting one-- central bank digital currency, and what's called the money flower. You might remember that money flower that was in the BIS report, and so forth.

And then just wrap it up. So that's a little bit of what we're trying to do.

The study questions were really about central banking-- what are they thinking about? How are they thinking about digital reserves, and so forth? Because I have a guest with me, I'm not going to do as much cold calling, because we're going to leave time for Rob to get up here and give some of his thoughts as we go through.

But the key questions were really how are central banks thinking about central bank digital currency? How might they think of the design considerations-- which we're going to dive into in the latter part of the class. Designing retail versus wholesale. Access-- should it be a token or account-based? Interest bearing or not?

And we'll talk a lot Thursday about why Sweden right now is come out with their most recent paper, which was not in assigned reading, because the paper came out about a week ago. But they're saying they're thinking they should make it interest bearing, which I wouldn't have necessarily predicted. But that's where their thinking is as of October of 2018.

And then, what are the challenges? That it might relate back to the commercial banking business, the credit markets, the economy as a whole.

So that's a little bit of the background. And these were the readings. I apologize, because this week is probably a little heavy reading, which meant you all skimmed rather than actually dove in. One of these readings, Broadbent-- Rob did you help write this speech that Broadbent wrote?

**ROBLEH ALI:** No, I confess, this is all Ben's work. And I reviewed a draft that he sent round and made some comments on it, but I can't claim any [INAUDIBLE].

**GARY GENSLER:** Anybody working in the central bank digital currency space really goes back to Broadbent's speech-- I assumed that Rob may have written it or reviewed it. And Garratt, who gave testimony in front of the US Congress on these issues, is often quoted by the Bank of International Settlement and others. So if there were two that you really want to think about--

the economics of money and central bank digital currency, Garratt and Broadbent are picked up a lot.

*The Economist* piece was kind of lively, and walked us all the way back to Adam Smith. Did anybody read *The Economist* piece and remember what he-- anybody remember the Adam-- so James?

**AUDIENCE:** He basically argued everything that's done right and wrong with Fiat currencies, exactly what's happening with Bitcoin.

**GARY GENSLER:** It's exactly what's happening with Bitcoin. In *The Economist* piece, it talks about in the 1770s, when they started to move a bit away from gold money to paper money, and they set up a clearing house in 1773 to deal with the paper that was going amongst and between all the banks. That Adam Smith apparently wrote that it was wagon wheels in the air, and that gold was the highway of money-- but paper money and central clearing of that paper money was the wagon wheels in the air.

So *The Economist* was basically saying, these debates are as old as time. Adam Smith was saying, you can promote an economy with wagon wheels in the air-- money. But maybe that's what's going on now, as well.

So I've already introduced Rob-- research scientist from the Digital Currency Initiative, and before MIT. He helped Broadbent-- he won't say he did, but he helped Broadbent do everything he did at the Bank of England.

And then Simon, who's taking notes feverishly-- did I get your-- did I get this right? Yeah, good picture?

**SIMON JOHNSON:** Not sure about the picture.

**GARY GENSLER:** What's that? Not sure about the picture?

So Fiat currency is anybody going to remind me what Fiat currency is? Brodish? You were slouching in the chair a little bit there.

**AUDIENCE:** So Fiat currency is the currency particularly issued by the central bank of the government of the countries-- which is [INAUDIBLE] something that is normally the norm in the ecosystem to use as a [INAUDIBLE].

**GARY GENSLER:** So it's issued by a central bank, it's the norm in the system. And what are two very important economic features of Fiat currency, that make it so widely accepted in any economy that we've talked about?

**AUDIENCE:** One of the reasons is it's typically used as the means to pay taxes for that [INAUDIBLE].

**GARY GENSLER:** Right, so taxes. And what was the other big one that almost every country you can use it for? Priya, were you looking at me? No? Shawn? What? Yeah, you can use it for debt payments.

So societies come together and say, you can use it for all debts, public and private. You can use it for taxes. It sort of gives it an enormous network effect and an advantage in any economy.

And then what happens is, so many of us in a society then use it as a unit of account, and there's an enormous amount of network effect. Just the raw economics of money is that others will use it, and exchange it, and thus it becomes the medium of exchange, unit account and store of value.

So it's represented by central bank notes. And commercial bank deposits relies on a system of ledgers, which makes it somewhat adaptable, and why blockchain is interesting in this space. And taxes and debts.

So then, I've pieced together a little bit of a slide to think about, where do central banks fit into this? Ultimately, you'll see where I'm going with this.

But commercial banks and central banks both have money. Central bank money are reserves and cash. So it's not simply the cash in our pocket, it's also reserves. And bank deposits actually are a form of money.

So a little diagram-- if the central bank is at the top-- and these are number banks, commercial banks-- reserves are the deposits that commercial banks have with the central bank. When central banking started 200 and 300 years ago, it was the commercial banks wanted something from the government. They wanted some backing, they wanted a lender of last resort, and they would have to open up accounts at the central bank.

But today, when we have unified ledgers, then the central bank issues reserves to the banking system, and those reserves are a form of money.

The next thing is, there's the public down at the bottom-- Bob, Alice, and Charlie. We all have money, and it's called bank deposits. But there's one other piece of this puzzle, if I can get it, it's cash.

So three forms of money-- we can all have cash in our pocket, as I commonly pull out, this here, right. I'm going to watch you, Hugo, I'm going to watch you. No, no, but what is that right there?

**AUDIENCE:** Federal Reserve note?

**GARY GENSLER:** Right. That Federal Reserve note is a representation that at the central bank they're storing some value for me. It's got a serial number. That piece of paper itself is not the store of value, in a sense, even though we accept it. Would you say that's a store of value?

**AUDIENCE:** In some ways.

**GARY GENSLER:** In what way is that a store of value?

**AUDIENCE:** I know that it's worth \$20.

**GARY GENSLER:** And why is it worth \$20?

**AUDIENCE:** Because the central bank says so.

**GARY GENSLER:** And see what happens if you hand it to Rob. He'll take it, right? That's how you know it's worth something.

But it's a tokenized means of money. It's a physical token, and the central bank has something stored there.

But you also have bank deposits. And if you go into Starbucks, and you buy something at Starbucks-- James, if you buy something at Starbucks, what are you giving them?

**AUDIENCE:** A piece of paper-- well, a piece of linen.

**GARY GENSLER:** No, but do you actually-- who here--

**AUDIENCE:** A credit card.

**GARY GENSLER:** All right, so when you give a credit card, what are you giving to Starbucks, ultimately?

**AUDIENCE:** A notion that I have some money in my bank account that they can take in exchange for coffee.

**GARY GENSLER:** In exchange for coffee, you're going to-- I hope you give them more than a notion. What will the payment system do? Ross?

**AUDIENCE:** A receivable from the credit card company. They just have a right to get paid from the credit card company. That company checks to make sure they're willing to--

**GARY GENSLER:** And ultimately that receivable will be moved bank deposit to bank deposit. You'll never be handing him my \$20 bill.

[LAUGHTER]

What's that? All right, Rob, that's his fee. Teaching fees are cheap at MIT. But Ross, you want to go through that? So the receivable will be a bank deposit, ultimately.

**AUDIENCE:** Right, and they collect it from the credit card company, who is going to move money from their account to Starbucks's account. Then the credit card company sends you a bill. So there's two separate relationships there.

So when they're checking your card, it's just a credit card company checking its records to see if they're willing to issue the receivable to Starbucks.

**GARY GENSLER:** So what you're really doing is you're spending a form of money called bank deposits. And your bank deposit is going to go down, and what's Starbucks bank deposit going to do?

**AUDIENCE:** Go up.

**GARY GENSLER:** Go up. So three forms of money-- the cash, the deposits, and the reserves, because the central bank is giving some money.

All of this is handled in accounts in a ledger structure. And we talked about it. So the accounts-- there's central bank accounts, and there are bank accounts. It's just accounts are ledgers, I've just changed the words. And it's moved through a system, a payment system that we talked about last week-- and I'm putting to. Real-time gross settlement is that little box up there.

Real-time gross settlement is a system between banks and a central bank. Almost every

country has some form of real-time gross settlement system. Here in the US, we might call it the Fed wire, or ACH. I see Ali-- is ACH real-time gross settlement, or maybe not?

**AUDIENCE:** No, they're not real.

**GARY GENSLER:** Just the Fed wire.

**AUDIENCE:** There's another one, but I forget the name [INAUDIBLE].

**GARY GENSLER:** Chips?

**AUDIENCE:** Chips.

**GARY GENSLER:** Chips-- so in the US, we have chips, and the Fed wire are both real-time gross settlement. That's between banks and the central bank.

And then you have all sorts of systems-- what's in that little box is not as important to read, is basically to move between banks.

So that's central banking and how it fits into money. Rob, how we doing? All right so far? You can come up here anytime.

All right-- what's that?

**ROBLEH ALI:** [INAUDIBLE]

**GARY GENSLER:** All right, we've got some feedback, though.

So I just wanted to hit two things on cash. Cash in the economy is moving up a little bit. The BIS report, for those who read deeply, this is just a chart that comes from your reading. This is cash as a percentage of GDP. You'll see one arrow going down-- Sweden. Sweden only has about 2% of their economy in cash.

The US is going up-- it's about 8%. We have a \$20 trillion economy, we have \$1.6 trillion of those \$20 bills.

So in most countries, it's going up. China-- Japan, by the way, is close to 20% of their GDP in cash. I added this chart, Simon, this was to keep you guessing. Yes?

**AUDIENCE:** Why is Japan so high?

**GARY GENSLER:** Why is what?

**AUDIENCE:** Why is Japan's cash is so high?

**GARY GENSLER:** Who do we have from Japan here? You want to answer this question, Akira?

**AUDIENCE:** Japanese people tend to use actual cash rather than credit card. People use [INAUDIBLE] going to use their credit card, because they're using the account credit card number, and the [INAUDIBLE]-- it's a little bit old people feel uncomfortable to use that number.

**GARY GENSLER:** So a bit of a cultural--

**AUDIENCE:** Cultural, I think, yeah, cultural.

**GARY GENSLER:** And technological. Or more culture?

**AUDIENCE:** So the younger generation is right to use their credit card for [INAUDIBLE], but older people doesn't [INAUDIBLE].

**ROBLEH ALI:** And I think, what's interesting about this slide is, a lot of the other central banks in Sweden is like the canary in the mine-- they see cash usage dropping, and they're thinking about this sort of fundamental question about should the public have access to central bank money at all? And they have it now, in terms of cash, and should we provide a digital version cash is not convenient anymore.

**AUDIENCE:** It's starting on 2007, is this [INAUDIBLE]? Or is it capturing the effect of advanced buying lots of assets in the market?

**GARY GENSLER:** So this question is, is does this reflect because-- we start in 2007 to 2016-- is there something else going on? The quantitative easing of central banks. But what else happened during this period of time? What fundamentally happened during this period, Elan?

**AUDIENCE:** The mortgage crisis.

**GARY GENSLER:** The mortgage crisis, or more broadly, the financial crisis. So there was-- I think, more than quantitative easing, I think that this whole sense-- that Satoshi Nakamoto tapped into, too-- is central institutions are failing. So should there be a run to physical cash? Is this-- it's not gold-- but is this more, in some cases, safe than commercial bank deposits?

Now, my dad, if he would have been-- well, he was alive during this period, but he would've



been taking his money out of the bank and getting gold. Simon, you haven't heard this story, but my dad always had some gold coins and a few diamonds. He inherently did not trust government.

He also carried a gun most days, too.

[LAUGHTER]

He is in a tough business.

But in this period of time, you couldn't easily get the gold. A lot of people went to cash.

How much do you think the US's \$1.6 trillion, or 8% of our economy, is \$20 bills like that, and \$10s? And how much do you think it's \$100 bills? Anybody? It was not in the readings, I'm just kind of curious what do people think here?

**AUDIENCE:** I think \$100 bills are worth 80% of the--

**GARY GENSLER:** So 80% of the \$1.6 trillion. Does anybody have a different thought? That was pretty good.

So here's a chart that I pulled out, through 2017. Of the \$1.6 trillion, it looks like about \$1.3 trillion is \$100 bills.

So what's expanding in the US is not the use of \$20 bills and \$10 bills, it's the use of the \$100s. And I could put up another chart-- over half of those \$100 bills are thought to be held internationally. And they're not even held within the 50 continental-- the 48 continental states, and Alaska and Hawaii. They're not held domestically.

So it's great to be a reserve currency, it's great to be a store of value. Ross?

**AUDIENCE:** I was just going to ask the store of value question. Maybe I misheard you before, when you were passing the \$20, you said, is it a store of value? And I thought you said, no. And if half of that is \$100s overseas, then that's the store of value, that's what people are holding.

**GARY GENSLER:** I don't think there's a real answer to it. I would say this represents a store of value, ultimately, on the central bank's ledger. Because the central bank could, if they wish to, deny use of this. They haven't, they haven't for decades, but I'm saying somebody could say, that's a bad serial number.

But most people would say that \$20 piece of linen is a store of value.

**AUDIENCE:** I was going to ask, would you expect the velocity of these to be inversely related? Like with \$20 bills, they probably have a higher velocity than \$100 bills, especially if they're being used to store of value, right?

**GARY GENSLER:** Yes, so the question is, is the velocity of \$20s higher than \$100s? Yes, meaning they turn over faster. And one measurement of it is, is how quickly these currencies, these linens, have to be replaced. And \$1 bills, I think, have an average life about 18 months. They keep coming in and out of the system.

And I'm not entirely sure, but I think \$20s are maybe three, four, five years. In essence, these are all signed by secretaries of the treasuries, and I apologize for those who aren't Americans. But it's hard now to still find Rubin's-- Bob Rubin, or Benson's, which was the early '90s-- signatures on the \$20 bills.

Now, part of that is because the currency design keeps changing. So \$100s aren't used as often. They have turned over since the currency design has changed, because even an illicit activity, you'd prefer a new \$100 to an old \$100. Because a new \$100 is more secure-- it's less able to be counterfeited.

And when I served in the US Department of Treasury, I had to spend a lot of time, because I chaired something called the Interagency Counterfeit Deterrent committee. And I had to meet in these secure rooms, where they locked us in, and you learned about who was counterfeiting the money. Brodish?

**AUDIENCE:** Please go back to the last slide. So what I see here is the vertical shift in most of the economies is smaller, which I'm hypothesizing that the value of consumption in cash are also [INAUDIBLE] dense. So if that is the case, then what is the rationale of increasing the high-value notes in the system?

**GARY GENSLER:** What do central bank issue more cash to meet that demand?

**AUDIENCE:** And why more \$100, as compared to the smaller denominations who have the cash consumption-- seem to be more low value consumptions?

**GARY GENSLER:** So Brodish is asking why-- why, in, essence is this happening? Well, a central bank has a couple of choices-- they can issue paper currency to meet demand. And the demand is really as evidenced through this thing called DAS-- does the public ask for the cash? And that's

what's largely happening.

Or can they put some quota system, or by government Fiat-- like an India, where they said, no, you have to hand in all the old banknotes? And there was an active desire in India to take cash out of the system.

But in the US, we've not had that. We have not had any real large government interest of taking it out of the system. And so what you do have, is you have more and more demand for \$100s, as a-- I'll call store of value, whether it's for illicit activity, or for straight-up appropriate activity. And the central bank is facilitating that.

This entire 8% of our GDP, or \$1.6 trillion of notes, is interest-free borrowing for the US government. So there's seigniorage. Eric?

**AUDIENCE:**

Yeah, I just wanted to make a quick comment regarding the store of value. And going back to what we discussed in the first classes was that, it's actually a social construct, the belief that you're going to solve debts, or pay taxes without the Fiat currency.

And that reminded me of a story, there was this-- this was true-- this was a South American drug lord family, this drug lord was on the verge of being caught. All their assets were being seized by the government. And the story is told by his son, who was actually sitting in the one apartment, surrounded by piles and piles of dollar bills, which they actually couldn't do anything with.

They actually used them to burn and get some heat out of them. And then you go back to think, is it really an intrinsic sort of value? This is going back to the social construct, right? Because their money wasn't good for any merchant in the south-- in that specific South American country.

**GARY GENSLER:**

Right, so it is-- if your point is, it's a social construct, I'm concurring, agreeing. In that case, maybe it was also a little bit of time value of paper money-- he was about to get arrested. There's so much-- so I don't know enough about that circumstance. But for sure.

So let's move a little bit on to central banking. And I choose the US, but it's true around the globe. So there are economic policy goals that central banks have taken on. In the US, it was captured, written into law in the 1970s-- 1977, to be precise-- something called the dual mandate.

Interestingly, the US dual mandate for the central bank has three things, written in law. This is a quote, "promote effectively the goals of maximum employment, comma, stable prices, and moderate long term interest rates." That is what's known as, in the US, is the Federal Reserve's dual mandate. You might say it looks like three mandates.

Simon, do you have any thoughts?

**SIMON JOHNSON:** Well, the central bankers will tell you that stable prices are the best way to moderate interest rates. So that's [INAUDIBLE].

**GARY GENSLER:** And thus, mostly, people call the dual mandate is price stability and maximum employment. And then some central bankers would say, the best way to promote maximum employment is stable prices, depending on how--

You wouldn't say that if you're going for senate confirmation to be a member of the Federal Reserve Board, but am I not right? That some economists--

**AUDIENCE:** If you were up for presidency of the ECP.

**GARY GENSLER:** If you were up for president of the European Central Bank.

**AUDIENCE:** You'd have to say that.

**GARY GENSLER:** Because?

**AUDIENCE:** They only have one mandate.

**GARY GENSLER:** They only have one mandate. So around the globe, central banks might have different mandates, but almost-- I would say, though I haven't studied 180 central banks, all of them would have price stability, or to ensure that there's not much inflation. Because they are in the business of having the public mandate to secure the money. That's the core thing.

Now, what do they do? They manage money. And I think of it as supply and price.

So these are Gensler's way to think about what central banks do, but it's about supply and money.

Supply is physical cash. Do we keep issuing more physical cash? This \$1.6 trillion of cash?

But there's broader things called monetary base. This was not in the reading-- does anybody

want to tell me things like M2 and M3, what-- anybody taking a finance course? Are you studying what monetary base is, or M1, or M2, or M3? There's no reflection on you, it's maybe a reflection on Sloan. I'm just asking. No?

So there's different measurements of money that central bankers will monitor and manage. M1 is usually the hardest core money-- used to just be cash, or cash and demand deposits. In the US system, it's about \$3 and 1/2 to \$4 trillion. So about half of it's the cash.

And then they add-- the Federal Reserve says, demand deposits in a bank are just like cash. And this comes back four and five decades ago, started to say that the hard money, M1 is that.

M2 includes the rest of deposits. So M2, in the US, is somewhere in the order of \$14 trillion. In the US, there's about \$13 trillion-- or 65% of our economy is in deposits the banking system has. Every country that you're from has a different number, I'm just using the US as an example.

So deposits and make up more money than cash. Cash is about 1/2 to \$2 trillion, deposits are \$13 trillion. You add the together, you roughly-- I'm using this term loosely-- M2, which is a wider form of money, is about \$14 trillion here in the US. There's also an M3, and there's other measurements of money.

So the Federal Reserve tries to manage that, and they manage it not only by how much physical cash is printed, but it's also the leverage in the banking system. If you let a banking system be highly leveraged, then you're, in essence, creating more money. If a banking system needs more capital, then it's going to have fewer abilities to expand the economy.

And those are the big tools that a Federal Reserve, or the Bank of England, or any central bank has to basically shape the supply of money. But there's also things they do to shape the price of money. And that's interest rates.

The price of money is like I'm lending Rob money, he's giving it back to me in a year-- what's the price of money? And it's that.

So two big tools-- supply of money and price of money. If you ever want to be a governor of your central bank, you're in the Fiat money business.

Rob, any thoughts? Did I--

**ROBLEH ALI:** Yeah, I that's about right. And obviously, that's when modern central banking came in, mid '70s, when the Bretton Woods came to an end. So this is [INAUDIBLE] floating exchange rates, and all the rest of it.

And there's some good books about this-- there was a-- there's a recent book came out, a history of the eurozone, like monetary union in Europe is about 40 years old, give or take the different [INAUDIBLE]. [INAUDIBLE], his name was, a guy at the IMF, I think, worked on the Greek crisis, and he wrote a very good book about, right, the history of monetary union in the European Union, and how that worked. And this goes for a long-- like end of-- taking place at the end of Bretton Woods to, I think, the Greek crisis.

**GARY GENSLER:** One weekend in 1971, if I've got my year correct, early 1970s, Richard Nixon took to Camp David-- which is the presidential retreat in western Maryland. The leaders that he needed to get together in one weekend-- the head of the Federal Reserve, the undersecretary for monetary affairs at the Treasury Department, who happened to be Paul Volcker at the time. But he got together four or five people in one weekend, and took the US off the end of the gold standard.

We kind of went off the gold standard in the 1930s, but after World War II, there was an international consensus, Bretton Woods, and there was still that central banks to central banks could exchange money for gold. So we were still in somewhat a gold standard. And Rob might have a different point of view-- a good friend of mine, Jeff Gordon, is writing a book about that weekend, he was dean of the business school at Yale.

But the French had asked for some of their gold back. And they got it back. But then the British started to make noise, Bank of England, started make noise that they wanted some of their gold back. And Richard Nixon had a challenge. So he decided he'd just take us off the gold standard.

There's a lot of historians' debate whether the Bank of England forced it or not.

Simon?

**SIMON JOHNSON:** It wasn't their gold, it was our gold-- they wanted to exchange their dollars for our gold. That's what Nixon didn't want--

**GARY GENSLER:** I see, I see. So Professor Johnson is saying, it was actually--

**SIMON JOHNSON:** US gold.

**GARY GENSLER:** Wait, it was the US gold, or the UK's gold?

**SIMON JOHNSON:** They had dollar balances that they accumulated, which was all fair and good. And under Bretton Woods, you could convert your dollar balances into gold, until Richard Nixon said you couldn't.

**GARY GENSLER:** Right. And so the question was, whose gold was it? And under Richard Nixon's view-- and I think Simon is agreeing, it was-- I didn't know, because you're a dual citizen, aren't you? I just didn't know when you said our gold, whose gold?

**SIMON JOHNSON:** It was in my American accent.

**GARY GENSLER:** So your British accent was throwing me off.

[LAUGHTER]

OK, so Richard Nixon would agree with Professor Johnson that it was our gold. And the British to this day would say, well, we didn't really ask for it back, They were making some noises about this.

I don't know if that's-- that might even be.

So what do they do? What does the central banks actually do? They oversee the fractional banking system, providing those reserves. But also regulating the banking system. I mean, if you're sitting on top of all of this back here, you might want to regulate the whole system. And that's why around the globe, by and large, central banks regulate the banking system-- not always, and sometimes, like in the United Kingdom, they gave it up to another agency and then pulled it back. Hugo?

**AUDIENCE:** Yeah, I just have a question. So I understand how central banks introduce new money into the system. But what would be the mechanism of trying to decrease the supply of cash? Would it be an increase in the-- or not allowing the commercial banks to use much leverage? Or how would they bring money back and get rid of it?

**GARY GENSLER:** So you can apply-- a very good question-- Hugo is saying, how can you change the amount of money? And I'm going to use all digital forms of money, not just physical cash. But off digital

forms, the way you can effect it is say that any one bank needs more capital, or more reserves-- so you're lowering the multiplier effect in fractional banking.

If you need 5% capital, that means you can have \$20 of balance sheet for every dollar of capital. If all of a sudden you say, no, you need 10%, then you would be shrinking the banking system in half, for instance.

So there is a number of tools, but one of the direct tools is reserve requirements and capital requirements. It's not the only tool.

**AUDIENCE:** So it would be a mandate to the commercial banks? You wouldn't necessarily directly interact with the retail?

**GARY GENSLER:** Correct, the Federal Reserve manages monetary supply in numerous ways, but some of the direct ways-- and it's why they also regulate the fractional banking system. They have that direct need.

But they also need, very importantly, the third bullet point, to promote a safe and efficient payment system. In some countries, many of the countries represented here, written right in the legislative act that sets up a central bank, says they must promote a safe and efficient payment system.

And if it's not written into legislation, it's at the heart of every central bank.

They are also the lender of last resort. When banks fail, they come in and support them. Our central bank was set up in 1913. In 1907, we had a crisis. Banks were failing all around.

Does anyone know the history of that crisis? Who actually was the lender of last resort in the US economy in 1907? And it was not the US government.

**AUDIENCE:** JP Morgan.

**GARY GENSLER:** JP Morgan. And not JP Morgan the bank, JP Morgan the man. I mean, he had a bank, he had a library, he had a lot of other things going on for sure. You could say, he was the Bill Gates or Warren Buffett of his time. But in sense, he had more influence than a Warren Buffett or Bill Gates in 1907.

We had had a-- in fact, that picture in the upper right corner, is the First Bank of the US in Philadelphia, set up in 1791. It was set up with a 20-year charter. Hamilton and Jefferson had



a huge fight. The Congress passed the law to set up the First Bank of the US.

And Jefferson recommends-- Jefferson with Secretary of State-- recommends to President Washington, veto it. Hamilton's wrong. Washington gave Hamilton one week to write him a report. It's a really well-written report-- I've not read it in a number of years, but I went back and read it when I was at Treasury.

One week later, Washington signed the bill. Jefferson never forgave Hamilton for that, and many other things. But it was a compromise that only lasted 20 years. In 1811, we no longer had a central bank.

So we had a love-hate in the US with this central authority in central banking.

**AUDIENCE:**

There's [INAUDIBLE] and crypto anarchists say that because Fiat currency isn't backed by the gold standard, and because of fractional reserve banking, that the Fiat accounts is worthless-- I guess, what would your response-- or the bankers in the room-- what would your response to that be?

**ROBLEH ALI:**

Well, I think-- I mean, money is-- it comes back to money as a social construct thing, right? Anything can be money if you want it to, almost anything. So if you've got a big enough group of people who think something's money, then it has-- that it's valuable, then that's true-- the US dollar, and a Bitcoin.

But I guess the question is how do you generate trust in the system? And I guess the US government generates it through having a nation state, an army, and a treasury, and everything else. Whereas Bitcoin has this network of miners, and this code that people put their faith in. So it's just generally-- it's the trust in a different way.

But to say, money is only worthless if everybody thinks it's worthless, or like a significant group of people. So the Zimbabwean dollar is worthless, right? But Fiat money as a general concept being worthless, I mean, now you've choice. You can choose Bitcoin, or any other crypto currency, if you want to, depending on your preferences.

But I think it's difficult to maintain it's worthless when lots of people use it all the time, can exchange it for goods and services.

**GARY GENSLER:**

And I think also, Fiat currency has had a lot of challenges and crises. Usually related to either poor fiscal policy-- that the nation, the government state is overspending its taxing ability,

because taxes are revenue, and then the spending. Often related to wars, but not always. Or to the monetary policy-- in essence, a lot of printing of money.

In the old days, it was physical printing of money. In the new days, it's digital. It's the overseeing of the banking sector.

And some of the biggest banking crises have led to significant, in essence, expansion of the monetary base. Maybe it was lending against real estate in a housing bubble in Ireland, or other countries, and so forth. But we're not unique in the US to have housing bubbles.

And that can undermine the social consensus about Fiat money. Take China in the late 1940s, where every few minutes you had to worry about, did you have enough suitcases of physical cash to pay for your restaurant bill, if you were at a restaurant, and so forth. And any country that's in the midst of hyper-inflation, you usually then-- the social construct falls away.

But it's rare that it hasn't been replaced by another Fiat currency-- maybe with a stronger military, or a stronger central bank. But after some crisis. Occasionally, it's replaced by another country's Fiat currency, and there's a number of Latin American countries that have said, well this isn't working. We're going to go to the US dollar. And just be darn-- we're not going to trust our sovereign, we're to trust somebody else.

And remember, I've said this once, I think, in this class, the history-- and Simon, bail me out, and Rob, bail me out-- but the history of the Bank of England was that the King of England was at war with the King of France, and needed to borrow some money and couldn't borrow it readily. I think it's like 1 and 1/2 million pounds.

And some noble lord said, well, this is how we'll give you the money-- if we set up a board-- it was initially, the Bank of England was in essence a contract between the sovereign and the noble lords that said, we have to check. And then the war went on, I don't remember, you guys probably won and beat the French. But it was in the midst of a war that--

**SIMON JOHNSON:** Always.

**GARY GENSLER:** All right, you're recorded, by the way, video. Rob?

**ROBLEH ALI:** Yeah, the Bank of England was set up to finance a war with France.

**GARY GENSLER:** Yeah, was to help finance a war with France.

**ROBLEH ALI:** And what's interesting-- because the English Civil War was actually in the mid-17th century, so shortly after that. So that's after the powers of the king had been significantly reduced, and became effectively a kind of constitutional monarchy. So the Bank of England was sort of set up around that time.

**GARY GENSLER:** Same spirit of checking the sovereign. So let's move on a little bit, just so we can get to what central banks are doing. But in essence, what central banks do is they oversee the banking system. I mean, back to they promote the economy through stable prices, and in some countries, also this concept of a dual mandate. They manage the Fiat currency-- money-- through supply and pricing. Oversee the banking system. And basically, are the bankers to the government.

When the government's really in trouble, think back to the 1690s when some noble lords were funding the king-- it still happens that central banks do sometimes fund governments.

So the US Federal Reserve balance sheet-- I'm not going to spend time on it. It will be in the slides in Canvas.

So let's talk about where central banks approaches to blockchain and crypto.

Some-- I would say a majority-- are monitoring and studying. The US Federal Reserve would be this way, the European Central Bank. Rob has a better feel, because he talks to central banks all the time. But monitor and study is the dominant place.

Restrict-- restrict its use. I'd say that the People's Bank of China is more towards this. They're kind of a mixture between monitor and study, because one of the readings was actually from a senior policy person at the People's Bank of China, and he's written some remarkable pieces. Every few months, there's a piece in like CNN, or CCN, which is a crypto newsletter, or *Coin Telegraph*, that this one individual from the Central Bank of China is writing these pieces.

Now, I don't know a lot about the Central Bank of China-- he always puts at the bottom, these are my personal views. But I have a suspicion he would not be allowed to write these things if it weren't something bubbling underneath.

But you can restrict the use of crypto. And some countries, like China, and elsewhere are doing that.

There's payment system experimentation, which we're going to chat about. And then there's

this thing called central bank digital currency initiatives. And Rob and I know the answer to this, but I'm curious to the group. Central bank digital currency, having read all that you've read for today, does it rely on blockchain technology?

Show of hands, yes or no? So yes, it relies on-- my hand won't matter. Does it rely on blockchain technology? Central bank digital currency?

I don't see a single hand. How about no? How many people think no? Oh, you did your readings well. Did you read it-- thank you. She's-- Simon, I'm-- you know.

So central bank digital currency is inspired by this whole crypto finance movement, but it does not necessarily depend upon blockchain technology. But I think it's central to this course, and central to a study of blockchain technology and money, because it's absolutely inspired by this whole movement. Though, the first person that wrote about it was Tobin in the 1980s, if I'm right. Right?

**ROBLEH ALI:** [INAUDIBLE]

**GARY GENSLER:** Yeah, 1987 or something, I think. Tobin wrote about basically giving the public a direct tokenized means beyond paper money-- a digital means of an account.

But most people would say, central bank digital currency relies on blockchain technology, and you've made me proud that you said no.

Let's talk about the pain points. This was last Thursday's lecture, but there's some payment system pain points. I added one or two because of your feedback, but cost, delayed settlement, chargebacks, fraud, privacy, financial inclusion, and the like. And for Rob and Simon, this was last Thursday's discussion.

So some of what the public sector is doing is non-blockchain initiatives-- entirely non-blockchain initiatives. The European Union, the US, others, are doing things about faster payment. Basically trying to move the payment system to 24 hours a day, seven days a week, not locked up on the weekend, where you can actually move. And that merchants can do it as well as banks.

So whether it's the target instant payment system, or what's known as TIPS in Europe, or faster payment task force, which has led to a faster payment mechanism-- I think, I'm guessing Priya's husband's working on that, right? Does he--

**AUDIENCE:** He was.

**GARY GENSLER:** He was working on the task force? Shrimp joined us last Thursday, and he talked about-- he's at MasterCard.

So a lot's going on. I just note-- I put just two other countries. India's immediate payment service is really government sponsored, government pressed. I think one of the gentlemen that works on it, Simon, you have speaking at MIT'S campus in a few weeks. Arvent worked on it.

And in the UK, where they're saying-- not only are we updating our real time gross settlement system, but there's a government mandate that banks have to open up their bank accounts to what's called open API. A lot is going on, non-blockchain related, related to payments, making it faster and more access.

But in the midst of that, here is a little bit of what's happening in the blockchain space. And with the help of the South African white paper on this, I break it into three phases. So I thank South Africa's central bank.

First is phase one. Three countries wrote papers-- Canada, Brazil, and Singapore. Canada and Singapore even called them something-- it's called Project Jasper in Canada, and Project Ubin in Singapore. And they did some experimentation, all based on a Ethereum network-- could you do a better payment system based on Ethereum?

So an open-source, blockchain, permissionless system. And they tested out a new real-time gross settlement system. And generally, the way they do this is they get a group of banks in their country-- and if you were to read each of their detailed reports, there's some similarities and some differences-- but by and large, get a group of banks in your country, use the platform, try to do a talking through, and see if it will work. Elene?

**AUDIENCE:** So they built a permissionless system?

**GARY GENSLER:** They were trying to see if they could use the Ethereum network to build a better payment solution.

**AUDIENCE:** Or are you saying they developed a smart contract undercutting Etherium? Or did they deploy their own Etherium permissionless network? Which one did they do?

**ROBLEH ALI:** I think it was, they just claimed Ethereum and deployed it. Like internet-- it wasn't ever outside the [INAUDIBLE].

**AUDIENCE:** They were doing mining?

**ROBLEH ALI:** I don't know how they did it, in terms of mechanism.

**GARY GENSLER:** Now, what you'll see-- because I want to quickly go to phase two. Phase two, none of them used Ethereum. Phase two, two more initiatives happened-- Japan and Europe together. And when I say Japan and Europe, I mean the central banks. And all of these are central bank focused.

Japan and Europe added, and South Africa. And all five initiatives-- all have been published already-- were happening in those various states in mid to late '17. And into '18, were all on permission. They were looking at Corda, Hyperledger Fabric, and Quorum-- Quorum is the closed loop system that JP Morgan.

We talked about Hyperledger, Fabric, and Corda. So I think, Elene, this kind of starts to answer your question. That they then said, well, no, it's not going to work on a permissionless. Every one of them in phase one said, we don't think this is going to work on a permissionless system. Let's then go into a phase two experimentation.

We're now in kind of phase three, or a third wave. We haven't heard from Brazil recently-- don't know whether that project is basically stopped. But these are big countries and big central banks, that are interested is-- can there be a payment system solution?

So I'm just going to talk about Singapore for a minute, and give you a flavor for outside of the readings, but a little bit of what the Singapore project is. But it captures all of these by just talking about this project.

This is from their papers. But they really see that we're in a multi-phase project. And they are willing to publicly say, we're going to go further than where we are right now. We want to get to the place where we have domestic delivery versus payment, and in the future payment versus payment systems, money versus money. Delivery versus payment, DVP, is basically a security versus money.

So if you see the words DVP, it's in the securities business where you move a security and a payment simultaneously, and there's no credit risk. I will not give Rob the security unless he

gives me the cash, or vice versa.

Ask me one day about when-- before we had DVP, what the markets were like.

So Singapore is willing to publicly announce-- we're going to take this as far as we can go, all the way to a cross-border settlement of payments and securities against each other, D versus P versus P, is what they call it. The D you can think of as securities.

Will they succeed? Do they need to stay on a blockchain? I can't predict that. But they're willing to say, we're going to give this a try.

Where are they right now in phase two? Well, they tested Corda, Hyperledger Fabric, and Quorum. And they have a full 60-page report they published a month or two ago about how did each of them work to do basically payment versus payment, cash, large cash movements. But here are the six criteria they tested, and they say they passed every one of them.

Now, I read the full report, and I have to say, it struck me that they probably did pass it. But I'm not enough of an expert, and this stuff gets very granular, and the question still is, could you just use an Oracle database to do the same thing? And it's a fair question.

But they tested it basically, can you digitize the payments? Can you decentralize the processing? Can you do the queuing-- the queuing of payments. And a lot of cross-entity payments, you have to net the payments. I'm going to pay Rob, Rob is going to pay Hugo, Hugo is going to pay me-- well, that doesn't make sense. You net it all, and it's a queuing factor in all these real-time gross payments. Elene?

**AUDIENCE:** So what is decentralized processing mean here? So this was in what country?

**GARY GENSLER:** Singapore.

**AUDIENCE:** Singapore? So there's a central bank in Singapore, it's clearly very centralized. What is the central [INAUDIBLE]?

**GARY GENSLER:** It's up to them. And what they write about, they think that you could lower the single point of failure risk by not having the central bank. They actively-- this is a central bank writing the paper saying, we could have more resilience in the system if the database is distributed amongst-- in this case, they had 11 banks participating. And the 11 banks have separate nodes.

Now, it's still a permissioned system. You might say, and somehow the central bank has a notary node, maybe. But it's amongst the 11 banks. And that there would be more resilience to this system than having it centralized.

**AUDIENCE:** And the central bank still does monetary policy?

**GARY GENSLER:** Central bank still does monetary policy. Rob, what do you want to add to this? Because Rob swims this lane, I don't.

**ROBLEH ALI:** Yeah, I mean, I think it's one of the big challenges, right. Because the question of how much the central bank consciously limits its own power, I think is important. Because if you have a system where-- because I think there is an instinct of certainly some central banks, they want to maintain control of the system. Like, well, OK, but we want to have a special node for the central bank, we can do all this, that, and the other.

And my argument is, you actually want to limit the power of the central bank as far as you possibly can, because it-- to the extent that the central bank has special powers over the system, that creates a weakness in the system. Because if that node is then taken over, then whoever can go change the system-- has effectively all the power of the central bank. Which takes away the benefits of decentralization.

To my mind, the point of decentralization is increasing the cost of the attack, by saying, well, to attack the system, you have to attack 50% of the nodes, or whatever. But if you have this one special node that could do everything, then you only have to attack one node. And it defeats the object.

So I think when you're speaking to central banks, you have to persuade them of the need to have a system that they-- like almost setting up and let it go, rather than have to continuously interfere with, and have to have these special powers in it.

**GARY GENSLER:** What's interesting with so many countries, there's going to be a wide variety. And I really do think that many of the central banks are in that monitor and study slipstream, and a couple are in let's restrict the use slipstream. And even China that says, we're restricting the use, is still studying the heck out of this.

But some countries like Singapore and Canada are in the forefront saying, let's figure out-- maybe this technology will make the payment system, and thus the system of Fiat money more resilient. It's still unknown, but they're really trying to test the edge. Yes?



**AUDIENCE:** So perhaps this is just a peculiar observation, but I feel like the very institutions that Satoshi and Bitcoin were trying to disintermediate, are the ones that are taking inspiration from this, and then trying to advance their own technology. And it feels-- is it a competitive threat? What's the disconnect? How are they thinking about using this for something that was basically built to disintermediate them [INAUDIBLE]?

**GARY GENSLER:** Remind me your first name?

**AUDIENCE:** Zahn.

**GARY GENSLER:** Zahn-- so Zahn is asking about Bitcoin, and wasn't Satoshi Nakamoto's innovation about doing something not just decentralized, but not trusting-- trustless sort of system. But every technology evolution, whether it's in electronics and telecommunications, or elsewhere, startups, if they have something good, incumbents will look at that technology and see what to adopt for themselves.

Partly because they're threatened by the startups. And in this case, I really do think central banks have felt a little bit of heat on their neck, a little bit of heat like, we've got to think about our payment solutions and our money solutions, and maybe there's something from blockchain technology. But regardless of whether it's the heat on the neck or opportunity, incumbents will always look at technology, and see.

And that's why the paper that you've read sometimes, the Geneva Report, that Simon and three of our colleagues and I co-authored this past summer, we called blockchain technology a catalyst for change. And we were agnostic, partly because there were five of us co-authoring it, but we felt that that captured our five points of view. That it might be a catalyst for change for incumbents, it might be a catalyst for change to inspire central bank digital currencies, which frankly, don't have to be on a blockchain at all.

Or it might be some startup that does really a unique thing, and I mean unique beyond crypto kitties. You know, something more than that. Aviva-- I know you, Aviva.

**AUDIENCE:** So I was just curious, are there details about the timeline for this, in the sense--

**GARY GENSLER:** Wait, say that again?

**AUDIENCE:** Are there details about the timing for like how long it takes to process a payment by the central

bank, like all the way to settlement, vis a vis Fiat currency?

**GARY GENSLER:** So the timeline for the-- so not the study, not this timeline, but you're saying a timeline for--

**AUDIENCE:** No, for that specific project, and this extract here that they defined. Have they also--

**GARY GENSLER:** I'd have to look back-- it's a good question. I don't think Singapore has said they're going to finish this by 2019, but I don't know whether they said a date like 2021, or '22. But it's a multi-year project.

**AUDIENCE:** [INAUDIBLE] for a specific transaction to process it all the way to settlement, how long it takes?

**GARY GENSLER:** Oh, the test case in Singapore and Canada, within seconds-- but I don't know if it was like nanoseconds. No, it's very quick.

**AUDIENCE:** I have another question for the three of you, actually. How is the central bank thinking about reporting for these transactions? Or is it a later-stage problem to worry about?

**GARY GENSLER:** Well, the reporting, as I have read these reports-- and then I want to move on to central bank digital currencies, which we're going to be largely talking about Thursday, but I want to set it up because Rob won't be with us Thursday. Reporting is-- this is a ledger, this creates a database, this permissioned blockchains amongst 11 banks in Singapore. And it's just a test, it's just a test-- is basically a form of a ledger.

So I don't think they've built out any customer user interface and reporting that way. But the transaction ledgers were kept, similar to bank ledgers, as I understood it. But they didn't build out a user interface.

Unless Rob, you know any otherwise. No.

So let's talk a little bit about the next and the toughest-- central bank digital currencies, that may or may not be based on blockchain technology. But they're absolutely inspired by blockchain technology.

So central banks currently issue digital reserves. We saw that earlier. It's digital money already. And then physical tokens-- I keep my eye on this physical token here, right? So that's the form of money. Commercial banks, then, issue bank deposits.

In the US, that's about \$13 trillion to the public in bank deposits, and there's only \$1.7 trillion of this. So bank deposits are the biggest form of money, and it's all digital.

Essentially, bank deposits are intermediated central bank digital currency. Those are my words, but it's digital currency bank deposits, it's just not directly with the central bank. It's intermediated in between-- if you go back to that flow chart that I had earlier.

So the private sector is also experimenting with stable value tokens. We're going to talk about that Thursday, there's some readings, so I'm not going to dive in now. So there's a little bit of competition. So it's like Zahn's earlier question-- the private sector, Circle, and Tether, and others are having these stable value tokens. So there's a little bit of competition coming that way.

So the strategic question for the central banks is, should we allow direct access to digital reserves? We have this intermediated central bank digital reserve called bank deposits, but should we have something direct to us? Like cash is a direct relationship between the central bank and the holder. That's really the strategic question, when you-- I believe when you move away from the technology, you don't know have to know about hash functions or anything. That's the strategic question.

Why do I think there's some opportunities? And we're going to dive more into this Thursday, but I want Rob to see if he wants to speak about this and tell us.

I think this is a real question-- and Sweden has highlighted it-- they want a continued involvement in the means of payment. Sweden is already down to about 2% of GDP, or 1/2% of GDP is their kronas-- the physical kronas-- the US is still at 8% or 9%.

But they're saying nobody is accepting physical kronas anymore in Sweden and Norway, and so forth. Pretty soon, most retailers will not take them. So they're saying, maybe the government needs to have a continued direct relationship.

Could it promote competition in the banking system? Because otherwise, if you don't have it, then the banks are controlling the payment system, and the means of payment. Promoting financial inclusion-- not everybody will have a bank account. Well, maybe they could have some digital form of central bank money instead of a bank account.

The pain points-- and I would say for some countries, some countries are clearly looking at central bank digital currencies to avoid US sanctions. Venezuela and Iran both have projects

for central bank digital currency. Sorry, question?

And so here, of course, blockchain technology could be relevant. For these six reasons, or five reasons, you didn't need blockchain technology. But I'm going to say, blockchain technology could be relevant-- Fiat currencies on a ledger, verification and networking costs are critical to the economics of money. So I wouldn't count blockchain technology out of this, because blockchain technology can lower verification and networking costs.

But I think we're too early to know whether blockchain technology will be at the center of central bank digital currency. But it could have an effect.

So the challenges. And again, we'll dive more of these Thursday. Rob, you want to say anything about these challenges?

**ROBLEH ALI:** Yeah, I mean, I think Ben's speech was good on--

**GARY GENSLER:** Ben Broadbent's speech.

**ROBLEH ALI:** Yeah, Ben Broadbent's speech is good on that one. Because I think the fundamental one is this-- how do you fund a productive enterprise in the real economy? Right, that's the real--

**GARY GENSLER:** How do you--

**ROBLEH ALI:** How do you fund productive enterprise in the real economy? And at the moment, certainly in the UK and Europe, and I guess to a lesser extent in the US, but it's largely true for the US, as well, is that you are very much reliant on bank lending. And if you do something which essentially drains deposits from banks, are you like fundamentally changing the nature of the system? And how are you going to create a system which allows people to fund mortgages, or fund businesses, or whatever it is?

And I think that's the big challenge. So I think that's like the central question, which I think is the bullet three, effects on credit allocation in the economy, is the thing that I think weighs on central bankers the most.

**GARY GENSLER:** So basically, if you disintermediate the banks, and the banks are not collecting-- again, using US numbers-- \$13 trillion of deposits, but only \$12 trillion of deposits, or maybe \$6 trillion of deposits, what are we doing to credit allocation? Because for three to five centuries, or certainly since the Industrial Revolution, banks form an important feature in our economy to

promote the extension of credit.

And we had this six or eight lectures ago, this graph that in the US, debt to our economy is about 3.8, or 380% of our economy in debt it's not all bank debt, but bank debt is a big piece of that. Can you move credit allocation away from the banking system?

Well, the answer has got to be in some level, yes, but what are the pros and cons of doing that? It's not whether you can, it's whether it's a better system, a better economy, better growth with or without it. Shawn?

**AUDIENCE:** I was just curious, can you use different interest rates to represent different level of risk? And then use a differentiation and interest point as a way to fund the corporates, so they can get the loan faster, or they can get the [INAUDIBLE]?

**GARY GENSLER:** So the question is, could you use interest rates to try to do it? Which leads us to design considerations. Which is basically, I listed that the last one. You could have a central bank digital currency that had zero interest rate-- interestingly, we'll talk more Thursday-- Sweden said no.

They think they'd put an interest rate on it. But you could go no interest rate. And I'd like to hear your thoughts Thursday, well, why did Sweden come out there? And what does that make sense?

You could put limits or caps on it, and say, these are only low dollar accounts. You can only have X 100 euro, or X 100 krona, or Y number of dollars. And it's really just small transactional accounts, equivalent to \$20 bills, not \$100 or 500 euro notes. So you can put limits or caps, or no interest rates, and so forth.

Do you make it widely accessible, and so forth?

So there's all these design considerations, which I'm guessing Rob, you've talked to a bunch of central banks. Where do they come out on these issues, as you see it, in 2018?

**ROBLEH ALI:** You've got a lot of different opinions on it. I think the limits and caps thing is a hard thing to practically implement. That was always the sort of skepticism around that-- it's like if you have these accounts, and you say, well, we're going to only have one per person, we're going to cap it at a certain amount of money. What practically happens in a wrong-- is the government really going to say, well, no, you can't put any more-- Like there'll be a lot of political pressure

in any crisis, so I think caps are really seen as viable.

And then, I think the interest bearing thing is interesting. I mean, the only reason cash doesn't bear interest is because it's technologically difficult to make a paper bear interest. So I think with digital currency, they might as well give yourself the option. Say, yeah, well, we can set the interest rate to zero if you want to, but why limit yourself to say, well, we won't charge interest?

Because it's again-- it's like that's a limitation that comes from the technology of physical banknotes, and there's no real need to import it into the digital world, when you could achieve the same effect by just setting the rate at zero if you want to.

**GARY GENSLER:** And one of the reasons that some countries are exploring this option, is they think it'll be easier to do monetary policy, because you're going to have negative interest rates. Physical cash makes it hard for-- oh, nobody like that, huh? No, the two Elenes, you don't like negative interest rates?

But for a while, we effectively had negative interest rates. Certainly for corporate deposits. But if everything was digital, and there was no physical cash, central banks say we could actually go and have no lower bound, no zero bound to interest rates.

**ROBLEH ALI:** I guess you, in a way, you don't necessarily need that. Because if you can just create more money and pump it into the economy, it has the same effect, right?

**GARY GENSLER:** Right, so what Rob is saying is you could affect that by supply of money, rather than the pricing of money. And so there's both.

One of the most interesting to me is the second bullet point-- is a token or account based. And the two merge together, in a sense. This piece of paper is a token. Nobody's keeping an account that when I hand this to Rob-- here, you can take it, Rob. That's your fee, remember. So that's a token based bit of money, that's what is called token based.

Token based money is more anonymous, and you can keep it more anonymous. Account base is when you're actually keeping the ownership somewhere on a registry. Even though that \$20 bill is registered somewhere, it has a serial number, it's a token based bit of money.

The Swedes, interestingly, say they'd have to change the law-- their own central bank laws-- for one of these two. And now I can't remember. But they have-- if it's token base, it would

come under their e-money laws, and I think they don't need to change the law to do that. But in Sweden, they would have to change their central bank laws to do e-deposits, because they would literally be opening up their central bank to something other than commercial banks.

That's it-- they have to go to their legislative body and parliament to actually do an account based, and not a token based, if I recall. So there's some also legal reasons why you might need to do one or the other, but one would have more anonymity than the other.

**ROBLEH ALI:** I think it's worth noting, on these token versus account models, it's not well-defined what people mean when they say taken and accounts. So different central banks will say this, and mean different things.

And also people who work on Bitcoin will think about-- so when I see tokens, I think about particular structure and transactions, which Bitcoin has. And when I think about accounts, I think of structure of transactions that Ethereum has. And that's how I distinguish between those two things.

But I think having spoken to different central bankers, they think about it differently, because e-money is like-- you could think about it as-- I mean to me, that's an account based system. But some bankers think about it-- some central bankers think about that as token based. So it's worth noting that the definitions are very fluid in this area.

**GARY GENSLER:** So we're going to save this for Thursday. I'm not going to go through this-- it was in one of the readings. Garratt, who testified in Congress, was so popular with this, then the Bank of International Settlement picked up this thing called the money flower. But I'm going to save this, I want to kick this to Thursday.

But it's basically the four things-- widely accessible, is it digital, is its central bank, is it token based? And depending upon where these intersect, you can take any form of money. You could say, well, it's not central bank issued, its token based, private digital tokens, is down on the right hand corner is one little piece of it. It's just a way to take these four important features.

And we already have central bank digital money, which is in the middle of all this, it's called reserves. But we're going to hold this for Thursday-- but this crazy little money flower, central bankers who are in this world, they've been using this, because this Professor Garratt came up with it. I mean, I've seen this in other papers.

**ROBLEH ALI:** It's very important.

**GARY GENSLER:** They love it, you know. I don't know. Money and flowers together, there you go.

But Rob, I don't know if you want to come up and help close it, but these are the ones we're going to talk about on Thursday. And since Rob won't be here on Thursday, I'm kind of curious if he has a point of view on any of these-- and you can see them here, as well.

**ROBLEH ALI:** The UK one is actually being stopped. So I read something recently that the UK government-- I assume at the prompting of the Bank of England, although their fingerprints are not directly on it, I can imagine that they were behind it.

I think Uruguay is an interesting one. I recently went to a presentation by Uruguay central bank, and what's interesting about that project is that it was actually live and out there in the hands of people, paying for things in shops. And I think that's what distinguishes it from a lot of the other projects.

So for example, the ones that Gary's talked about earlier in, say, Singapore and Canada, are really just in-house creative concepts, whereas the Uruguay project was something that actually has worked, and they've taken an early form. The Swedish one, again, is fairly early stage. The e-krona is not out there yet, they're just starting to explore it.

The Tunisia one was interesting-- I've spoken to one of the guys working on that. And again, that's interesting because it's a live project. It's continuing-- unlike the Uruguayan project, it's a continuing project. So it'll be interesting to see how it plays out there.

And I think the reason being is a lot of the thing that puts off central banks from actually doing it, is they don't know what effect it would have on the banking system, or whatever. And I think you will start to see-- when you start to see people actually trying it, and deploying a central bank digital currency in the real economy, then you will have a real pilot, or a real world example, that you can then research and say, well, actually the effect was this.

Because at the moment, a lot of the debate around central bank digital currency, what would be the effect be on the banking system? This is conjecture, you can build a model. But it's very difficult.

But I think once you start to see countries actually issue them, then you get the evidence in. And then I think you'll see a cascade effect. It will be very quickly, then, the technology is



proven out, and then more and more countries will issue them.

And also because of the funding effect, Gary talked earlier about the cash-- like US dollars, physical cash, is effectively \$1.6 trillion of interest-free borrowing by the US government. And if, say, the US government issued digital dollars, then arguably you could retire half the national debt and replace it with money.

So there are these big fiscal implications. And the Body of the Commonwealth paper, which my colleagues at [INAUDIBLE] wrote, I think, two years ago, sort of addresses that fiscal element. And I think that will be a big attraction to politicians looking to spend money.

**GARY GENSLER:** And before we close, Simon, because you're rarely with us, but from your perspective, either from your chief economist days at the IMF, or just because you-- Simon hosts the Tuesday night blockchain seminar dinners, by the way, too, for three years. So Simon is way ahead-- one might say he was kind of a blockchain Bitcoin maximalist three years ago. I think you've moved more to the middle-- you can self-declare where you are.

And Simon, Johnson, and Nehan, Narula, and Michael, Casey, and I, are going to be standing up a blockchain lab course in the spring. So Simon? Your question is, what do you think about all this, and maybe for both of you in the last minute, when are we going to see a true central bank test this out?

I mean, there's nine of them on this page that are kind of feeling it out.

**SIMON JOHNSON:** I don't think there's any technical problem here at all. I think Rob has clearly put this out on a long time ago. I think the issue comes down to what Rob said, what does it do to credit? Who really wants to find out the hard way? And what does it do-- what happens in a crisis when everyone-- you know, let's say you're not paying interest on a digital central bank currency, and you can get interest on your bank account, but there's a crisis.

And you say, well, I don't want to have this-- be holding the liability of a private bank anymore, I want to be holding the liability of the central bank. Doesn't everyone run to the central bank? And what does that do to credit? And how you're going to figure this out, without actually running something like on [INAUDIBLE].

**GARY GENSLER:** And two predictions-- how many years before our country actually-- because 180 countries, nine of them are already bubbling around. Two of these-- Ecuador stopped, Uruguay maybe

stopped, and the UK Royal Mint might have been stopped by its own government. But when do you think we're going to see a country actually have a direct digital account to their reserves? For the retail public?

**ROBLEH ALI:** It could be a couple of years. I mean, Tunisia is the closest to-- up on that list-- but a couple of years. For the first one, yeah.

I mean, we're early [INAUDIBLE] years, within two years, at least, possibly.

**GARY GENSLER:** So back together on Thursday. We're going to dig back into these nine, and talk a little bit more about the money flow and the readings, which I think, as I always do, I list them. Some of those are more fun, and they're shorter readings, as well.

So I will see you all on Thursday at 2:30 to 4:00, and I thank you once again.

[APPLAUSE]