Transcript of 2023 Thomas Laubach Research Conference Session #3
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TREVOR REEVE. All right. Welcome back. Well, to round out our conference, we have one more session today focusing on fiscal and monetary policies for the longer run. And I'm very pleased to introduce our session chair, Min Wei, who is a senior associate director here in the Division of Monetary Affairs, and is also a coauthor and a longtime colleague of Thomas. So thank you, Min.

MIN WEI. Thank you, Trevor, and welcome back everyone again. So in this session we'll be looking beyond monetary policy and examining issues related to fiscal and monetary policy for the longer run. We're happy to have Ludwig Straub here to present a paper, "A Goldilocks Theory of Fiscal Deficit." The paper takes into account the effect of government data supply and interest rates, a topic that Thomas also worked on. Ludwig is currently an assistant professor of economics at Harvard University. His research areas are microeconomics and the international economies. Among his topics of interest are the relationship between rising economic inequality and macroeconomic trends as well as the study of fiscal and monetary policy in heterogeneous agent models. The discussant will be Fiorella De Fiore. Fiorella is currently the head of monetary policy and a research fellow at the Center for Economic Policy Research at the Bank for International Settlements. She previously held the position of advisor in the monetary policy research division and in the financial research division at the European Central Bank. Her main research is in the field of monetary and financial economies and the focus is on macro financial linkages and their implications for monetary policy.

LUDWIG STRAUB. Okay. Great. Well, thank you very much for the kind words, Min. And thank you very much for inviting me to participate in this conference honoring Thomas Laubach. I should say at the beginning that when you look at the success of papers like

Laubach and Williams, oftentimes we just, you know, check on Google Scholar how many citations the paper is getting, but behind many of these citations there's actually, you know, research careers and lives that have been affected. And one such career is actually my own when I was a grad student at MIT thinking about thesis topics and I stumbled across their paper about the decline in the natural rate. And so, you know, I started thinking, you know, what could be going on here? And among the reasons that hadn't been explored was the fact that income inequality had increased quite dramatically in the U.S and the in other advanced economies, and that actually ultimately became the start of several papers that I've authored on this issue. So in that sense this is also very much due to the fantastic work that Thomas Laubach and coauthors have done. So the paper I'm going to present today, if I can click to it, perfect, is thinking about how these declines in natural interest rates that we have seen have changed the conduct of fiscal policy and have changed how much fiscal space countries have. And that's how we arrived at this paper. This is joint work with Atif Mian in Princeton and Amir Sufi at the University of Chicago Booth.

So the question we want to ask in this project is very broadly what are the joint dynamics of debt and deficits. And more specifically, if I have higher debt levels, does that represent a positive additional fiscal cost relative to having lower debt levels? Now the standard logic here in the textbooks is very clear. Right? If I increase deficits today, that's going to increase the debt level, and that will require deficits to come down below the original level in the future to sort of pay for the additional deficits. Now what a recent strand of the literature has figured out is that when R is left in G, the interest rate is below the growth rate of the economy. We may actually never have to cut deficits tomorrow to pay for our current increased deficits.

That's kind of the idea for a free lunch that has been proposed, but there so far is no general condition under which a free lunch is in fact possible.

So what we do in this paper is we provide a general framework that allows us to understand the joint dynamics of debt and deficits, and we arrive at four main conclusions. The first conclusion is a general condition for when a free lunch is possible, and in fact we find that that condition is a tighter version of R less than G. It's not R less than G, but it's R less than G minus fi [assumed spelling] where fi is the sensitivity of R minus G to the debt level. And that is, in fact, a constant that none other than Thomas Laubach actually estimated. I'm going to talk about that when we get to it. The second is that we find that actually at the binding zero lower bound, imagine Japan, for example, we actually find that it's possible that low deficits push up debt -- push up debt levels rather than higher deficits. Why? Because we find that low deficits can hurt aggregate demand at the zero lower bound and can hence lead to less inflation at the zero lower bound, maybe even deflation, and that in and of itself has an effect that pushes debt up relative to GDP. Third. We investigated the role of inequality coming from our previous research on the relationship between inequality and R star, and here we find that inequality generally contributes to increased fiscal space. However, when the economy's at the ZLB because inequality reduces aggregate demand at the ZLB, it can actually reduce a fiscal space in that case. And finally, we provide a calibration of our framework to both the Japanese economy and the U.S economy in 2019 before COVID when things were still calm. And we find that actually surprisingly we find that the U.S was barely in the free lunch region. So not that much room for running free lunch policies as advocated by some people in the literature whereas Japan with a much greater level of debt to GDP actually we found that it's squarely in the free lunch

region, that there's actually much more room to run a free lunch kind of policy in Japan. I'll explain why that is when we get there.

I'm going to make these points today with a tractable model that will be based on the idea that government bonds pay convenience yield to investors. There's a bunch of other models that you can use and arrive at very similar conclusions, and we have all of those in the paper. I'm going to skip over the literature, but there's very exciting literature going on these topics right now. So I'm going to start by introducing our framework, and then I'm going to take the framework and analyze it in the absence of a zero lower bound constraint, and I'm going to put the zero lower bound back into the model and see how that changes the conclusions that we arrive at. And then last, but not least, I'm going to quantify the framework for the U.S and the Japanese economies.

So what's the framework? So it's a deterministic and dominant economy with the potential for rationing at the zero lower bound. There's three main actors in this model. There's the government that issues government debt, spends, and taxes. There are two kinds of households, spenders and savers where savers are going to have specific preference for holding government bonds. And you can think of this preference as being for convenience benefits that government bonds provide to them. And the third actor is a monetary authority that is basically just trying to implement the natural allocation. The only place where that's going to be infeasible is going to be at the zero lower bound. I'm going to use the following notation throughout so that nobody gets lost here. Capital R is the net nominal interest rate. Capital G will be the net nominal growth rate. And the net nominal growth rate will consist of real productivity growth gamma which will be held constant throughout, and a variable rate of inflation. So whenever I talk about the growth rate changing, that will be entirely due to inflation changing, not because of

underlying productivity growth. Our star here is the natural interest rate that will always close the output gap and will hit the inflation target if followed throughout. Inflation target itself is denoted by pi star, and G star is the nominal trend growth, the nominal growth rate that is obtained when inflation is at its target. I'm going to jump straight to the detrended version of the model. In that version of the model potential output-wise star is going to be a constant which I'll normalize to one. So all quantities that you see floating around in the model, they're all thought -- should be thought of as relative to potential GDP in the economy. And R minus G is simply the detrended interest rate which basically appears once you detrend the model at every place where you're used to seeing a normal interest rate. Okay? Given that Thomas Laubach was a very serious researcher, and liked models, I'm also going to show you exactly how the model works. It's only two slides so bear with me. There's a lot of graphs that illustrate how this model works right after.

Okay? So let me give you the details of the model. There's a household problem that -- a fraction 1 minus mu of savers solve. They maximize discounted stream of utilities over first consumption, a lot of consumption there, and second over holdings of government debt. So B here is government debt relative to potential GDP, and V of B sort of this convenience utility that savers draw from holdings of government debt. And we assume that that V is an increasing and concave function very much in line with the literature that has tried to estimate the curvature of that V function. For example, Annette's work on this issue and Thomas Laubach's work as I'm going to mention later on. The budget constraint of these savers is very standard. We have on the left-hand side consumption and saving. On the right-hand side we have the detrended interest payments that savers obtain. So R minus G times V. We have their share of aggregate income, 1 minus mu times Y. And we have any lump sum taxes they pay to the government. Tau T.

Spenders here are very simple. They're just going to basically eat everything they get. They get a share mu of aggregate income Y, and that's all. That's going to be all spent immediately. Finally, what is YT? We assume that YT is basically a labor endowment that everybody has in any given instant. They sell that to a representative firm. A representative firm just takes one unit of labor, produces one unit of output. And so if we're not at the ZLB basically all of that labor endowment will get sold to a representative firm and aggregate output will be equal to potential equal to one in our normalization. If we have that economies at the ZLB, then there's the potential for rationing because labor demand now falls short of labor supply and so in that case aggregate output Y can be potentially below Y. So the gap between 1 and Y is basically then the output gap in this economy.

Okay? Perfect. Second slide on the model. What about fiscal policy? So in this framework fiscal policy will consist of a triple, consist of government spending X which we'll take to be constant for now. A path of government debt B. And a path of taxes tau that jointly satisfy the standard flow budget constraint of the government. Right? On the left-hand side government spending and interest payments on existing government debt. And on the right-hand side additional issuance of government debt as well as tax revenue. The key object that we will use to think about government policy is the primary deficit Z defined as the difference between government spending and tax revenue. And when we think about varying the primary deficit, under the hood what the model will do is it will change the path of tax revenue [inaudible]. Okay? That's going to be a crucial object in our analysis. The Central Bank here, sorry to say that it's going to be really boring because it's basically always going to set R equals to the natural interest rate, and in doing so will obtain the natural allocation unless said natural interest rate is

below zero in which case it will set the nominal rate of zero. So it's going to be stuck at the ZLB in that case.

Now when the economy's at the ZLB we're going to have a downward nominal wage rigidity that will basically all it will do is it will tell us that wage and price inflation is going to fall short of the inflation target pi star. By how much is it going to fall short? [Inaudible] it's going to be given by a standard Phillips curve slope parameter kappa times the output gap of the economy. So all that is doing is that it's telling us that there's a Phillips curve that becomes active at the ZLB which will tell us how much inflation will fall below its target. Okay. That's it. That's the model. And what I'm going to do now is I'm going to analyze this model without the ZLB constraint meaning it basically turns into an almost real model where R is always equal to R star. Then I'm going to put back the ZLB constraint in and then see how that changes the dynamics of debt and deficit. Okay?

So let's focus first on the case without the ZLB. And I'm going to begin by analyzing steady state equilibrium in this case. So what do I mean by steady state equilibrium? I basically mean a level of government debt that can be sustained forever where debt doesn't change. And for it to be sustainable forever, I'm going to have to pair it with a suitable deficit Z that is chosen so that debt neither goes up nor goes down. Now how do I find that level of the primary deficit? Well, I have to figure out which primary deficit essentially sets that derivative of debt to zero in the government's budget constraint. If I do that, I quickly find that the primary deficit that you can run forever without changing government debt for a given level of government debt, B, is exactly equal to the gap between the growth rate of the economy and the interest rate of the economy multiplied by the level of government debt. Now what are these objects? Now G outside the ZLB is always going to be equal to trend growth precisely because inflation will

always be at its target. So that's easy. G is equal to G star. R, however, is to be determined, and it will move with the level of government debt. And the reason it will move with the level of government debt is simply coming from the other equation. If you write down the other equation for our savers in the economy, it kind of starts out like a standard [inaudible] equation. Right? Consumption growth is equal to the detrended interest rate here, R minus G minus the discount rate. But then there's this additional term which comes from the fact that savers derive utility from holding government bonds and D prime is exactly the margin utility they get when buying an additional unit of government bond. And so if you compute the -- you know, set C dot to zero here to compute the steady state interest rate and solve for R, what you're getting is that R is a function of B precisely because now we have this convenience yield term in our expression for the interest rate. And that essentially captures that when there's more bond issuance by the government the margin utility of holding an additional unit will fall for the saver and so the convenience yield on the margin will fall and R will increase. Okay? So all this model's giving us is an increasing relationship between government bonds on the one hand and R star on the other hand, and that's going to be the crucial outcome of this model that will make it useful and interesting for us to study. Okay? Perfect.

So I'm going to start drawing a few pictures now and across all these pictures debt will always be on the X axis. And I'm going to start with a picture that just shows R and G. Right? And, as I just argued, without ZLB, G will be just a constant and R will be increasing precisely because with higher levels of government debt the convenience associated with government debt will fall and so the monetary return, R, will have to increase. Now if the overall level of interest rates is sufficiently low, there will be an intersection here where R exactly crosses the growth rate. And so the entire region to the left here is exactly the region where R is less than G. And if I

compute now what the associated steady state meaning indefinitely sustainable level of primary deficit is in this region, well I have to compute, well, the gap between G and R times the level of debt. And if I make that computation, this is what it looks like. I'm going to call this the deficit debt locus. So what does that locus tell me? It's a collection of steady states of the model where if I put you at any point in this diagram you're going to stay there forever. Okay? Notably this implies that in this region here where R is less than G the economy can run a primary deficit forever. It never has to switch to a primary surplus. Okay? Now this is just steady states, and you might be wondering, okay, well what about dynamics? If you're talking about free lunch policies, that's all about dynamics and changing deficits. And that's what I want to talk about next and show you actually that this very framework, this very picture even, is very useful in understanding when a free lunch is available or not.

So there's a very common view out there, and the common view goes about as follows. Imagine you have R less than G and you look at the government budget constraint. Right? That's literally just the standard government budget constraint where Z denotes the primary surplus and prime deficit and B the level of government debt. And so if you have R less than G, it kind of looks like, right, that this is a stable relationship. Right? The coefficient of government debt on the right-hand side is negative. And so if I take this model, just this equation, and I increase primary deficits, the stability of this equation kind of suggests that all that will happen is that government debt will increase somewhat, but then it will converge to a new equilibrium level. And so this suggests that as soon as R is less than G there might be a free lunch that is available according to which I can just increase the deficit by a little bit without causing explosive debt levels in the economy. And what our framework suggested is that conclusion is not correct. Okay? Let me show you how.

Basically, what our framework suggests is that it's really important to have that the interest rate depends on the debt level in this equation. Why? Because if you now want to evaluate stability and hence the availability of a free lunch policy, you can't just look at R minus G. You have to look at the entire derivative of the right-hand side and you have to take into account that when you issue an additional unit of government debt, that will not just, you know, be costless because that additional unit has a very low interest rate. That will also increase the borrowing cost on all the inframarginal units that have already been issued in the past precisely because their interest cost will go up with your additional unit of government debt. Okay? And so if I evaluate that derivative I see that the correct condition for a free lunch policy is in fact not R less than G, but in fact R less than G minus fi where fi is exactly the sensitivity of R minus G. And in this case, in fact, only R because G is constant to the debt level. So that exactly captures that effect on the borrowing costs on inframarginal units of government debt. And I'm going to show you later that these fis once you estimate them in the data are actually sizable and will materially shrink what we think of as the region where a free lunch is possible.

Let me show you how we can think about the free lunch policy, free lunch policies, in our diagram here. So this was the steady state locus. Now imagine I start somewhere over on the left. Right? Somewhere in this increasing part. And I undergo a policy where I start increasing deficit. I can put in these arrows, and they will exactly tell me what happens when I, for example, increase the deficit to go up here. Well, I'm going to increase debt levels more and more and more until at some point I have to come back down to my steady state locus to hold government debt in check and not have it spiral to infinity. And at that point I'm going to have to increase taxes, slash deficits, maybe even run a surplus afterwards. Vice versa if I were to reduce deficits. Right? I would go to left and reduce debt levels. So what does a free lunch policy look like in

percthis diagram? Well, a free lunch policy is one where I start on the left side of this, of this curve, in the increasing part. Right? I increase deficits by some amount, but not too much so that in the long run I'm going to run into a new steady state without having to cut deficits at the end of the day. Right? That's literally a free lunch policy right there. You increase deficits. You keep them high forever. And you don't have debt spiral out to infinity. Now why -- why is this a useful way of thinking about free lunch policies? Well, if you think about it in this way, it's very clear that there's never going to be a free lunch on the decreasing part of the locus. Right? Because if I start over on the right side here, that was on the right side here, and if I were to increase my deficit, there's no way I run into a new steady state to the right of it. And, in fact, I will absolutely have to cut deficits to come back down to a steady state locus. And so what you see here, the right point at which the free lunch region ends is exactly this point up here where R is equal to G minus fi. It is not this point that is often emphasized where R is equal to G. In fact there's absolutely no change in slopes here. Right? So that point has nothing to do with the availability of a free lunch policy. The right point here to look at is exactly R equal to G minus fi.

And this also implies, by the way, that if you think about present value budget constraints, that in this region even if R is less than G here, which has been giving a lot of trouble to people trying to write down a present value budget constraint because you're trying to discount with R minus G and that's a negative object, right, but if you do this over here on the decreasing part of the schedule, it turns out you can actually write down a well-defined present value budget constraint as long as you take the correct marginal rate of borrowing which is R minus G plus fi which takes into account this effect of increasing the borrowing costs on all the inframarginal units. I'm going to skip the rest of the math. It's a little too heavy for an afternoon.

So one question that we started with in this project was, well, if we have this framework for fiscal space, what does it depend on? Right? Can we somehow, you know, rationalize why we seem to be having so much more fiscal space now compared to, you know, 40 to 50 years ago? So here are two ways to think about it. Let's focus first on the right plot here.

So in this plot we're increasing inequality between savers and spenders in the economy. And so if you increase inequality meaning you hand more resources to savers, naturally the demand for government debt will go up. And that will drive down interest rates and will actually make it easier for the government to finance a larger deficit. So the free lunch region in this entire locus expands with greater inequality. So that could be one thing that was going on that helps rationalize why fiscal space seems to be much more ample now than previously. But one thing that this highlights is that there's a potential conflict that this poses between on the one hand trying to leverage that additional fiscal space for deficit finance programs and on the other trying to reduce inequality which kind of reverses some of that resource shift from spenders to savers. Right? Because you kind of -- you can't just, you know, take away resources from savers and then expect them to still keep saving at the same rates in government debt and finance the deficits needed to run a large deficit finance program.

On the left here I'm feeding in what was already called today the prototypical you know demand shock in Keynesian models, the discount rate shock. I'm increasing the discount rate here to make a people more impatient and want to spend more, and it turns out that that which we think of as kind of a good shock actually tightens the budget of the government, tightens fiscal space, reduces the locus here over on [inaudible] great. So this was all fiscal space without the ZLB. Now let me add the ZLB and see what happens in this case. And the reason we wanted

to do this is we wanted to think of one particular country that had seen a lot of time at the ZLB which is Japan. Okay?

So imagine now we're in a world where the natural rate is negative. So in this case the economy will be at a zero lower bound, and the nom, actual nominal rate, will be stuck at zero. It can fall as much as the natural rate falls. In this case we're going to have that there is a positive output gap. Y will fall below potential, below 1. And then we have a system of equations that we need to solve for what now in this case inflation and output are. I'm going to spare you the details, but I'm going to give you the highlights. So what will happen in this case is that now the interest rate will be constant at zero, but instead the growth rate, the nominal growth rate, will now vary with the level of government debt. How so? The reason will be that with lower levels of government debt, R star, the natural interest rate, will fall more below zero than before. And that will make the ZLB so to speak more binding. And so you see in this expression that that pushes down the nominal growth rate because it pushes down inflation further below its target. Okay? So then which is constant of the two and which varies with government bonds exactly flips at the ZLB. So if I show you the plot that I showed you before, again now with a ZLB region, you see exactly what's going on. Right? We already know outside the ZLB the nominal rate depends on the debt level as, you know, lower and lower debt levels increase the convenience benefit. But once we hit zero here the nominal rate will get stuck at zero and we go -- as we go to the left, we go further and further into the ZLB region. And as we go further into this region, the nominal growth rate will start falling because inflation will start falling more and more short of its target. And so this gap between G and R which is important for how much of a deficit I can run -- if you remember this formula for the deficit was exactly dependent on the gap between G and R, that kind of shrinks again as we go to the left.

And so if I plot what fiscal space looks like here, I plot what kind of deficit you can run. In this world you see that suddenly at the ZLB there's less of a deficit that you can run precisely because that gap between G and R now narrows as we go, as we go to the left. Having said that, at a binding ZLB we always are in this case in the free lunch region meaning we're to the left of this peak so you can see by increasing deficits here you could make your way out of that ZLB. Now there's one thing that can happen in this model, and that is actually super interesting, and I wish I had enough time to give you all the details. Let me just show you the plot and then try to give you an intuition of what's going on. So one thing that can happen here. If inflation is sufficiently responsive at the ZLB, it falls sufficiently at the ZLB, we can have a backward bending locus for the ZLB. Okay? So what is going on here? And, in fact, this is what we're going to find is true for Japan. So let me explain what's going on here.

Imagine you are at this point right here at the ZLB. You're not quite in the ZLB region yet. Okay? And in that region imagine you reduce deficits. That will certainly reduce [inaudible] but whenever inflation is below target, it gets sort of harder for government, you know -- it gets harder for government debt to sort of fall naturally as the economy grows because now nominal GDP growth will slow down because inflation falls below target. So there's a natural force here that actually acts towards increasing government debt precisely because inflation starts to slow down, starts to fall below target. And if that effect is sufficiently large, and if government debt is sufficiently large, that can actually overwhelm the direct effect from cutting deficits on government debt and you actually get this backward bending locus here. Okay? Vice versa. If you're already in the ZLB region and you were to enact expansionary fiscal policy where you increase deficits, right, you'd think that that increases debt levels, but if it also increases inflation, that will counteract the increase in debt coming from higher deficits. And again if that increase in

inflation is sufficiently strong and multiplied by a sufficiently large level of debt, you can actually get that on -- in total you go to the left towards reduced debt levels. Great. So in my last few -- do I still have some? 10 minutes. Okay. Ample enough time here. So in my last 10 minutes I want to quantify this framework for the U.S economy and for the Japanese economy.

So the key determinant of this locus is coming from the shape of this convenience yield that crucially depends on the marginal convenience utility V prime of B here. And here we go with the literature in our main analysis, but we provide a robustness in our paper and assume that that is a linear function of government debt where fi is exactly that sensitivity of R minus G to the debt level. Now what is fi here? And this is where Annette's work comes in and this is also where Thomas Laubach's work comes in because he, among other people, have estimated -- has estimated that kind of a fi parameter in the data. We provide an extensive survey in the paper and we find that fi broadly speaking is in a range from between around 1.2 percent and 2.2 percent. And we pick the midpoint as our main baseline, baseline parameter choice, but we provide robustness also in the plots that I'm going to show you. So we're going to use 1.7 percent for fi. What does that mean? Let me put some intuition to this. This means that if I increase government debt by 1 percent that R minus G goes up by 1.7 basis points. So if you take the recent increase in government debt that we had in the U.S, let's say 10 percent, then that would mean that according to these estimates R minus G goes up by 17 basis points. Okay? So that's going to be our benchmark case. You already see that this kind of a fi, that's in the same order of magnitude as the gap between G and R that we typically get from [inaudible] work. So this is not just a minuscule correction. This is going to be a big tightening of the, you know, R less than G constraint that's going to come in by just accounting for that fi. We're going to calibrate the remaining parameters of our models to the pre-COVID steady states in Japan and the U.S. I say

that because before COVID it looked like they were pretty much at a steady state, and then obviously COVID upset that and we can discuss what the effects of the COVID shock were on our diagram and on our analysis in the Q and A later.

So this is what it looks like. On the left here we have the U.S. You see in solid our main baseline assumption coming from the fi of 1.7 percent. These dotted lines here are the two alternative cases for fi. And you see that according to this calibration the U.S economy is in the free lunch region. It's to the left of the peak. It has R just below G minus fi. But it's really not far away from the peak itself, and so -- so there's not that much space to run an increased deficit forever. There's not that much space for a fiscal -- for a free lunch fiscal policy here. Compare that to Japan here. Japan has despite having huge government debt it has very low interest rates and very low inflation. And this kind of makes the model, one, an extreme amount of saving pressures coming from savers in the model. And so we find that despite the high level of government debt, we are in this backward bending part of the deficit debt locus. And so this implies for Japan according to our model that if we were to increase deficits not only is debt not going to spiral out to infinity, it's in fact going to over the long term actually fall precisely because that additional stimulus when deficits are increased would add to inflation and that would, all is equal, bring down government debt rather than increase it. Vice versa if you tried to be a fiscal hawk in this framework, at least, and you tried to raise taxes on people you would have the exact opposite effect from, you know, the typical intuition. Great. With that, I'm actually basically done already. I'm not going to take the remaining five minutes to just talk about these four bullets here, but let me just summarize the main insights that we got from this -- from this research.

So we started with this standard textbook logic according to which if you run higher deficits forever, you're going to get explosive debt trajectories unless at some point you cut the deficit well below the original level. You've kind of got to pay for the original deficit. So we find that actually when R is less than G minus fi, not when R is less than G, the debt is not -- the debt doesn't even have to be explosive. It could well be that increased deficits forever have a debt level that converges to some well defined new steady state debt level. We find that when the ZLB is binding, increasing deficits may not even increase debt levels at all in the short run. In fact, debt levels might decrease. And finally we found that inequality increases fiscal space outside the ZLB. And what I haven't told you, but we show in the paper in great detail, is that actually tightens fiscal space at the ZLB precisely because it's going to reduce aggregate demand because more resources are now in the hands of savers rather than spenders. Great. Thank you very much.

[Applause]

FIORELLA DE FIORE. So thank you so much for inviting me to this conference in honor of Thomas. It's a great pleasure to be here. I got to know Thomas not only for his outstanding academic contributions, but also because he used to travel to [inaudible] to attend the BIS meetings of monetary policy. And he played also a very important role in helping the BIS initiate the discussions with -- among central banks on monetary policy frameworks. He brought his clear thinking and his passion for monetary policy into those discussions, and he was a real driver of those meetings. And he also always was kind and humble which really made it a pleasure to have him around. So I'm very glad to discuss this paper because also among other things it builds on the estimates of R star that Thomas provided quite some years ago.

So the paper asks two main questions. The first is whether deficits are always needed to be offset by future surpluses or if there are cases when there is a free lunch available for the government. And second if there is a free lunch then it asks whether this requires R to be less than G. And the main answers are that a free lunch requires R to be less than G minus fi or if fi is the [inaudible] of the convenience yields that the government debt provides, and its more restrictive condition that G minus [inaudible]. And also it shows that the free lunch can arise also to the zero lower bound, but there the relationship between deficits and debt can be [inaudible].

So in my discussion I will first try to summarize the domain mechanism at play in the model and provide some comments, but then since this is an academic conference that is also in honor of Thomas, I will try to step back from the model and highlight what I think are the main challenges for central banks in the current circumstances coming from the interaction between monetary and fiscal policy.

So [inaudible] Ludwig did a great job in describing all the details of the model. I won't be able to do that, but just there are four key ingredients of the model that help to understand the mechanics. The first is a Phillips curve that is characterized by the slow parameter kappa. Second is a standard other conditions that also reflect the benefits, the convenience benefits, that bonds, government bonds, bring to savers. The third is a definition of the semi elasticity of the convenience yields that measure the increase in R minus G that comes from an additional issuance of a government bond. And the last important ingredient is the government flow budget constraint, and this is important because it already highlights two channels through which deficits affect the debt evolution. The first is a direct channel. It just says that if you have one more unit of set of the deficit, that will tend to increase the debt. But there is also an indirect

effect to the extent that an additional unit of deficit helps increase G minus R. This indirect effect could be large enough to compensate the direct effect and it could lead to a reduction in debt.

So the first thing that the paper does is to analyze the conditions for a free lunch away from the zero lower bound. And the question is for each level of debt, what is the maximum deficit that is consistent with the debt that is not increasing? And so you can analyze that in steady state in a situation where monetary policy can perfectly implement the natural allocation. So this is a case where R will be equal to R star and inflation will be at target. Output will be at potential. And the nominal growth will be constant at -- following the inflation rate which is at target. And then you can use the [inaudible] equation of savers and set consumption to a constant as it would be in steady state to realize that any movement in government debt will now affect the natural rate of interest because all the rest in this condition are exogenous terms. And you can do the same with the flow government budget constraint. You set debt to a constant and check what locus for the deficit is consistent with that constant level of debt. And so combining these conditions, Ludwig, you know, told us how to get to this figure which shows that the locus of deficits consistent with stable debt is M shaped, and the -- it peaks at the level of debt that is equal to this B star, and this B star arises where R is equal to G minus fi. So any level of debt below this B star will be in a region where R is less than G minus fi and so this will be a region where free lunch is possible. You can increase the deficit and still that would be consistent with the stable -- perhaps larger, but stable level of debt. Why is that? What is the intuition is that imagine you need to issue one additional unit of bonds. Debt will provide a cash flow to the government to the extent that R is less than G. So the government will gain G minus R. But at the same time it will have to pay all the outstanding stock of debt, the interest on the outstanding stock of debt, and this interest will increase by fi, this elasticity. So you will have to compare the

gain which is G minus R to the increase in what the government will have to pay on their standing stock of debt which is fi. And only when the benefits exceed the costs will be in the region of free lunch, and that's at the left of B star.

The second thing that the paper does is to characterize the free lunch in the zero lower bound. Here the natural rate of interests are negative. The policy rate cannot fall in stock at zero. So it remains constant. And here output is below potential. Inflation is below target. And nominal growth will also be below the level, exogenous level, G star that would pervade the way from the zero lower bound. And so if you then -- if you then substitute the output gap in the condition for the nominal growth rate, the G, you can see that there is a complex relationship between the level of debt and growth in the economy at the zero lower bound, and this relationship will depend critically on the slope of the Phillips curve.

And this will lead to this locus for the sustainable level of deficit, and if you -- if the Phillips curve is very flat, then you will be on this part of the [inaudible]. You will be at this part here, and that's because the -- an increasing deficit will help sustain aggregate demand at the zero lower bound, and therefore inflation. But the effect on inflation will not be very large. And so the reduction of real debt will not really prevail over the direct increasing debt coming from an increase in deficit. And so you will be in a free lunch region, but still an increasing deficit will also lead to an increase in debt. Now instead if the slope of the Phillips curve is steep, is high, then you are on this branch of the curve and here the effect of increasing deficit on growth and therefore on inflation is so large that then the higher inflation can help reduce the real value of debt and so the indirect effect of an increase in deficits on the debt will prevail over the direct effect. You can have an increasing deficit will actually lead to a decline in debt.

So the third thing that the paper does is to assess empirically or quantitatively the space that is available in the U.S and Japan. So the paper calibrates the model and then in addition also runs [inaudible] regression to estimate the level of the semi elasticity fi and they come up with this point estimate, 1.7, and then they do robustness. But what is important is that then they make an assumption of -- about a linearity of the function B prime. This convenience benefit function such that the semi elasticity is constant. So the same for any level of debt. And under this simplifying assumption they can obtain very simple expressions that allow to compute the maximum level of debt B star in the deficit [inaudible] star depending on the initial conditions and trend growth. And so then you can -- they computed this maximum level of sustainable deficit being 2 percent for the U.S and an even much larger level of sustainable deficit for Japan despite the level of debt being much larger, and the reason for the difference is the fact that Japan is much closer to the zero lower bound. So R minus G is larger. So that's for the model. And now let me provide a few comments before I move.

So the first comment is that the focus of the paper is on steady states within the region of R minus G. And the nearby transition dynamics. Now we know from previously literature that R minus G fluctuates quite remarkably and also can change sign. And that's what you can see in the left panel of this figure where I plot out [inaudible] for 17 advanced economies since the 1950s And of course at the same time variability you can observe it also in R minus G plus fi except that the fi really shifted the locus a bit upwards. And so it makes your [inaudible] negative values or the free lunch region less frequent historically. But the point here that I would like to raise is what role is there for time variation in these boundaries of the region and for the assessment of the region of -- for the space for a free lunch.

The second comment is about the exogeneity of fi. So I took the same data that the paper uses and I did the same regression of R minus G on the log of government debt to GDP, but you know distinguishing countries with above or below median debt to GDP. And the regression results show clearly that there are significant differences across different specifications in the estimate of fi for countries with high and low debt to GDP [inaudible] with -- and the coefficients are much higher for countries with below median levels. And so this suggests that the homogeneity of fi could call for different -- a need for a different specification of the prime function with implications for the quantification of the region of free lunch.

And the last point I would like to make is that the assessment, the quantitative assessment, of this region of free lunch seems to me to entail quite a difficult judgment and may suggest a bit of caution in exploiting these free lunch regions by increasing deficits. And one example here was just trying to think, okay, now we are not pre-COVID. We're after COVID. So what has changed and how does that affect the maximal level of sustainable deficit? So here I have reported values for the U.S that [inaudible] in December 2022 right after the December 2019. And then I was a bit in trouble. What do I do with those? So B0 is the initial debt to GDP that's higher. Fine. So we can have a conservative scenario where you assume that B0 is permanently higher, but you keep the same assumption about R minus G. And that would not change much the level of maximum sustainable deficit which is 2 percent. But if you think that the current level or high level of interest rate will still not go back to a pre-COVID level and G minus R will be lower, say 1 percent instead of 2 percent, then the maximum deficit would be only around 1.1 percent. So let me move to the last part of my discussion which is trying to think a bit instead what are the current challenges for central banks arising from the interaction between monetary and fiscal policy. Clearly the current high levels of public debts and deficits

and the weakening [inaudible] are also providing some challenges for fiscal space, but they're also providing difficulties for -- not difficulties, but they're challenging also central banks in the sense that they -- the high level of deficits and debt can work at cross purposes with tightening of monetary policy and may also delay the achievement of this inflation.

And the second challenge I see is that high debt levels and spiking interest rates may lead to [inaudible] and bring the economies closer to regions of financial instability, something that [inaudible] told us before, during the [inaudible]. So I would like to expand a bit on this last point, the possible risk for financial stability. And I think that doing that with a simple three period model that I've been working on with [inaudible] and [inaudible] recently it's a very simple framework. It is not a quantitative one, but just one to highlight channels. And this is a standard model in many respects, but what matters here is that there are banks that have a certain amount of net worth. They hold private debt capital and nominal public debt, BG, and they face an occasional binding leverage constraint. And then there is a government that chooses the fiscal surplus, and the Central Bank that sets the nominal interest rate.

There are three periods in this model, a very simple model. If G equals 0, this is the time of decisions. And decisions are based on the probability that a certain bad financial shock can occur at the equal one. And the time zero policy decision [inaudible] the central banks that the nominal interest rate, and the government sets the discretionary fiscal surplus. A T equal one is that there is a negative financial shock that occurs with a certain probability P. And whether the leverage constraint binds or not will depend on the decisions taken at time zero. So it will depend on the level of capital, K0, and the government debt, BJ0, and a net worth N0. And time two there is a return to the steady state. And so our exercise is to try to see what are the combinations of nominal interest rate and fiscal surplus that make the leverage constraint bind at

T equal 1 if a negative financial shock occurs. And for us the constraint becoming binding at T equals 1 coincides with the financial instability region. So this is what the model delivers.

You -- the white region is the region of financial stability meaning that even if the negative financial shock occurs, the leverage constraint will remain [inaudible] in period T equal one. But the blue regions are the financial instability ones where the constraint will turn binding. Now the -- at the left of this vertical black line you have regions of the economy when the public debt dominates. So [inaudible] larger than the private debt. And indeed these are the regions where the primary surplus is negative. And on the right of the line instead you have regions of financial instability that arise where private debt dominated. So there is a larger [inaudible]. So and the -- so I mentioned that you are at a steady state which is this tiny little point here. And you now start increasing. You are in a region where public debt is large on this side. And you start increasing interest rate. So this from steady state. And this can bring you to financial stability regions because increasing interest rates can increase the debt to service ratio. It reduces the asset price and therefore the value of net worth, and it also depresses real activity and inflation therefore increasing the real value of the debt. And instead if you are in the region where private debt dominates, the risk comes when you're reducing an interest rate because that's what -- increasing the demand for capital or for private debt -- and also supports real economy and the demand for credit. Now of course these regions move with the characteristics of the economy, but let me make my point with this figure here. This shows the regions that we saw before of financial instability, but it also shows the region of microeconomic stability. So here is the steady state. It's within a region of macroeconomic stability meaning that the inflation output gaps are closed or close to zero. And this is the region between these red lines.

Now we mentioned that there is a negative demand shock that shifts this region of macroeconomic stability to the left. Now how can policy react? Of course you can just react with monetary policy. You decrease the interest rate and you move. And you stabilize the economy. Or you can do it with fiscal policy. You [inaudible] deficits and bring back the economy to macroeconomic stability. But doing these unilateral moves and policies can also bring you closer to the regions of financial instability. And so measures that combine monetary and fiscal action can achieve the same macroeconomic stability, but reduce the probability of financial instability across the world. So that's my last slide. In conclusions, monetary and fiscal policies can contribute to macroeconomic stability and therefore to the fulfillment of the mandate of central banks, but the feedback between interest rates and debt can also be a risk for financial stability tomorrow and macroeconomic stability then the day after. And so keeping the economy within this financial stability region is an important task for central banks, but can also constrain their use of policy tools. Thank you.

MIN WEI. Thank you, Fiorella.

[Applause]

LUDWIG STRAUB. Great. First of all, thank you very much, Fiorella, for working your way through a very dense paper. All the points you made are very well taken. I just wanted to say two things on two of the points you mentioned. The time variation RG and fi is something that we've been thinking about as well. What would you do if you were in a stochastic world where all of these three objects move around? What's the right condition in that case? So we have a section where we exactly study that, where we allow for aggregate risk in the model and we actually show that basically as long as the environment is stationary, right, which is big if -- but if it is, then you really only need to average R, G, and fi. And then the same condition just

averaged still tells you whether you can run a free lunch policy or not. But that requires stationarity, and there are some shocks like COVID for sure that do not look like they happen all the time. And so there obviously you have to, you know, maybe resort to other kinds of analyses where you draw up different scenarios maybe, where you, you know, analyze, you know, a good scenario or a bad scenario like Fiorella did in one of her slides to see where we are in the deficit debt diagram.

The non-linearity in the convenience yield I think is super interesting. We haven't really done very much on that at all so it was great to see that Fiorella thought that was important and actually cut the data the way we hadn't done it yet. I think you want to be careful when you do this by basically distinguishing cross-country comparisons versus within country comparisons. Like I can well see that for, you know, endogenous reasons the countries that have more fiscal space and lower fis load up more on debt like advanced economies whereas economies that maybe have a convenience yield that's much more sensitive to the debt level do not load up on debt as much so it's a bit difficult then to cut by debt itself. So we talked over lunch also whether there's a way to do this within country where you can sort of see how a country's debt goes up and see whether their fi goes up or goes down. So which way the non-linearity goes. Great. That's all I have to say. Thank you very much for the discussion again. Thank you.

LUDWIG STRAUB. Stephanie.

STEPHANIE SCHMITT-GROHÉ. So very nice paper. Just to understand it, suppose I forget about the ZLB. I'm not interested in that. I just think about an endowment economy, and I make your B money. Are you showing me the Seigniorage Laffer curve?

LUDWIG STRAUB. No. Great question. If I have the clicker, this is a fantastic question. So let me go -- let me take just this diagram. So when you have B being just real

money balances in a Sidrauski style model, then actually the -- over here if you were to increase deficits, it actually operates exactly in reverse. You would jump to the left. You would not find that there's no free lunch here. Why? What's going on there? Basically what happens in the Sidrauski model is if you increase deficits that makes in some sense debt less attractive. And so the price -- or money less attractive. And so the price level will jump up and that will reduce real money balances. So you will move to the left. And so you can't use that model to analyze free lunch policies the way we do it here. So that -- and the reason is -- the reason is price flexibility. Right? If you -- but you -- so for you what you were -- my understanding was that you want to put real money balances in the utility function. Correct?

STEPHANIE SCHMITT-GROHÉ. Correct, but their -- You told me that Y is equal to 1 unless I'm at the zero lower bound. I can go to the [inaudible] economy.

LUDWIG STRAUB. Appendix C. But basically what's going on is just let me just reiterate. What's going on in that model is that the level of debt -- first the level of debt corresponds to real money balances. That's an object that will jump around. Right? Because the price level will jump around in that model.

STEPHANIE SCHMITT-GROHÉ. But why is that price [inaudible] for the steady state? That usually never matters.

LUDWIG STRAUB. No, but this is not about the -- the free lunch is about transitions. Right?

STEPHANIE SCHMITT-GROHÉ. All right.

LUDWIG STRAUB. The free lunch is about transitions. I can't just use steady states.

STEPHANIE SCHMITT-GROHÉ. But before we go even to free lunch, because I'm going to also have a question about the word free lunch, so I think this looks to me like the

Seigniorage Laffer curve when you looked at the steady state because then, you know, the normal rate of return on money is zero. Inflation is positive. So the real rate zero minus pi is -- you know, I can make the growth rate zero. So it's an exact match. So then we usually think about when we are talking about a free lunch, what is your measure? I mean people hate it here when you increase debt. I don't see how, you know, with money in the [inaudible] like you have it, why are people happy? Unless of course you're going to go to the zero lower bound. But you're minimizing welfare or not. I mean

LUDWIG STRAUB. No.

STEPHANIE SCHMITT-GROHÉ. No. How come?

LUDWIG STRAUB. So many questions.

STEPHANIE SCHMITT-GROHÉ. Is it steady state? In this steady state it's impossible that –

LUDWIG STRAUB. Let me take the questions one by one if I may. Okay? First is in our model now, not the Sidrauski model. Is running a free lunch a Pareto improvement? Absolutely yes. Okay? Why? Because the government gets more resources. Right? And you increase debt. And people like to have the availability to save in more debt. Right? It enters the utility. Now you could say, "Oh, that seems like a chicken model." But I can write down the exact same -- you know, I get very similar shape if I say have a view of the economy where there's idiosyncratic risk and people need that to [inaudible]. So people -- no. No. Z -- government spending, it will be 1 equals C plus X. I'm not touching government spending. I'm just changing the path of taxes here. So it's really I'm holding basically the way to think about it, Stephanie, is consumption here along this line is the same, but they get more debt to save in which they like. So it is a Pareto improvement. Okay? The same way that in the Sidrauski model

now to move to the second question it is that as long as margin utility is positive over real money balances, they appreciate having more real money balances. Right? And that's kind of the same logic here.

On the Sidrauski model let me give -- give me one more attempt and then if that fails, I will explain it to you one on one afterwards not to hold up the show too much. But basically -- and we've literally done this analysis because we were wondering about that same question. Basically, what happens in the Sidrauski model is that the analog of what I call debt here is real money balances. That object will jump around. Okay? The reason it will jump around is because the price level will jump around. And whenever the government would like to finance a larger deficit, it will be that the price level will jump up. Right? Kind of makes money less attractive, in some sense. And what this gets reflected in in this diagram, I agree the steady state locus is the same in the Sidrauski model, but the dynamics are totally different. If I were to increase deficits in the Sidrauski model, I will jump to the left because the denominator in real money balances, the price level, will go up. Right? That does not happen in our model because here debt is a state variable. Right? It does not jump around. You can increase it if you want by increasing deficits or reduce it by reducing deficits, but it works the other way around. I hope that was somewhat more clear, but I'm very happy to go into all the details after the Q and A.

MIN WEI. Great. Thank you. I have two minutes if anyone wants to ask a final question. If not, then -- yes.

AUDIENCE MEMBER. Thank you. I was hoping someone else would ask this, but since you only have a minute left, let me ask this. It's the question is about balance sheet policies. So when we're discussing fiscal monetary interactions and given the experience we have seen in the last, what, 15 years now, I would have expected a significant role for the effect of Central

Bank balance sheet policies on the cost of financing of government debt and then interact that with the very nice analysis that you're presenting here. So as I look at the -- at the chair of the panel, for example, I mean [inaudible] wonderful work demonstrating how quantitatively significant the reduction in the term premium is from quantitative easing. And if nothing else is happening, that actually significantly improves the fiscal space of governments at the ZLB. I was wondering if you could offer some insights about how we should think about this. It would be an extension clearly to what you have and how you think about integrating the whole thing.

LUDWIG STRAUB. Great. Thanks very much for this question. We -- this is one of the extensions that we had in the paper a while ago, and then to fit it into a format you can actually submit it we had to cut that extension, but I'm happy that we were not the only ones who were interested in this question. So yeah. Very much in the spirit of what you said. What we found in that extension is two things. The first one was that close to the ZLB or in the ZLB region this really helped because it obviously got short rates, the natural short rate, R star at the short end, to go up. And so potentially you can use that to escape the ZLB region. It also more generally exactly as you said -- it more generally helped bring down financing costs for the government and so expanded fiscal space in sort of more on the left side here where interest rates are low. Surprisingly what we found is that as aggregate debt levels increase, that -- we found that in at least the framework that we had written that captures the extension that we've written that captures this that convenience benefits of short-term debt phase out more quickly as aggregate debt increases. And we actually found that having a lot of short-term liabilities if you include Central Bank, that's probably one legacy of a [inaudible] actually leads to reduced fiscal space over in this right region here rather than increased fiscal space. So that's one of the conclusions that we found from this extension. Great. Thank you.

[Applause]

MN WEI. I'll return the floor to Trevor to offer some concluding remarks.

TREVOR REEVE. Thank you, Min, Ludwig, and Fiorella. That was great bringing our inaugural Thomas Laubach conference to a conclusion, a very interesting and spirited conclusion. So thank you. I want to -- I just have a couple remarks to close us out for the day. I want to offer a special thanks to our speakers, President John Williams, Chair Jay Powell, and Ben Bernanke, all of our session chairs, presenters, and discussants. And of course, thanks to all of you for attending today whether in person or online. You really have been the key to making this a success. I would like once again to thank my amazing team in monetary affairs and our terrific partners here at the Board of Governors for making this event happen. I especially want to acknowledge in the back corner here Nelly Ramdass, Nicole Haroon, Robin Ross, and Oladoyin Ajifowoke for their tremendous drive and dedication to turning this idea into this conference. It has been absolutely astounding. So thank you for that. And I also want to thank David López-Salido and Annette Vissing-Jørgensen who were instrumental in putting together today's program. And most of all I want to thank Thomas. As we have heard repeatedly throughout the day, he inspired so many of us and in so many ways from his innovative research, his insatiable curiosity, his dedication to public service, his passion for monetary policy, and his endless empathy and kindness. Thank you all for helping us pay such a fitting tribute to Thomas' legacy. I know he would have loved to have been here. With that, I wish you all well. Safe travels. Be well. And I look forward to seeing you at the next Thomas Laubach research conference. Thank you.

[Applause]