In the last few presentations, we have already heard a lot about debt, COVID and output stability. Of course, this is a relevant and hop topic and in peoples mind essentially all day.

I like to focus on the sustainability of debt during this period and in the next few minutes I like to illustrate some of the work I have been doing over the past weeks. My name is Luuk Oudshoorn and I am enrolled in the Quantitative Economics track. The research I did in the past weeks focussed both on existing literature and on an analysis of historic data. Due to the limited amount of time available today, I found it most interesting to focus on the analysis part and not too much on the literature review part.

**Slide 2**

On a daily basis, we get to head about the effects of the pandemic on the economy. At the same frequency, we hear about the ways in which the government tries to support businesses to survive this period. Back in March 2020, what would become one of the largest post-war crises, the government announced to spent up to 90 billion euros on financial support during the pandemic. The newest estimate of the government subsidy is around 75 billion euro in direct subsidies and the total costs of the pandemic for the government are estimated to be up to 150 billion euros already.

This number is of course only going to increase with the pandemic taking longer to come over. With a GDP of about 800 billion, 90 billion does not seem that extreme. However, it is more than twice the amount of all annual expenses on education, culture and science. And, compared to the annual government budget of about 350 billion, we are talking about large sums of money.

**Slide 3**

These government expenses are related to different fiscal stimuli. The most well-known examples are job retention schemes, where one should think of the government taking over salary payments from businesses, liquidity support, either via direct loans or government guarantees in bank loans. Also, cash transfers to businesses, for example in the catering industry. Lastly, expenses are still to come to rebuilt the economy stronger and better and regain strength after the pandemic. These are part of the NextGeneration EU fund, which will help rebuilding the EU after the pandemic. s

**Slide 4**

Essentially no one doubts whether these financial support measures are truly necessary. However, with decreasing tax revenues and strongly increasing costs, there is little room for the government to finance these expenses from existing resources. Instead, it will greatly drive up the government deficit, which was over 10% in 2020. This deficit is filled by the issuance of debt. The central question in this work is whether this debt is a good or a bad thing. Many academic work is written about it and there are many conclusions obtained.

The plot on the left here shows the average debt-to-GDP ratio for respectively advanced and emerging economies. We see that the level has steadily increased since somewhere in the second half of last century. It increased even harder after the Great Financial Crises and is now again rising steadily. Is this debt sustainable?

**Slide 5**

We read about debt sustainability in newspapers and discussions in talk shows quite frequently. There is an apparent trade-off between financing the government expenses and thereby stabilizing the economy and increasing debt and thereby potentially damaging the economy. This trade-off also includes the relation between debt issuance and economic growth. What do higher debt levels do to economic growth? And how does a strong economic growth change debt levels?

The most important driver of the debt-to-GDP ratio is the difference between economic growth and interest paid on the debt. In the plot here on the left, we have plotted four theoretical paths of debt-to-GDP, all starting at the 2020 level for the Netherlands. We used the long term GDP predictions and considered a few interest rate scenarios. Obviously if the growth rate of the economy is larger than the interest rate paid on the debt, relative debt levels will decrease. A dangerous situation is the opposite, if the interest rate paid on debt is larger than the economic growth. In such a situation, the relative debt will increase and this will be an exponential increase. Such a situation is obviously unstable. But, what does history well us? These situations are only unstable if there are no debt repayments, and if the rate paid on the debt is floating.

**Slide 6**

I will now look at historical fiscal and monetary data to estimate some models describing the dynamic interplay between debt and economic growth.

**Slide 7**

Key parameters in such a description are obviously the debt and GDP growth and interest rate. But furthermore, we also require government deficits and inflation. We study these models using both Vector Auto Regressive models (**click**) and Vector Error Correction models. I will spare you with the details. Such a model is able to capture the relation between the different macroeconomic variables. Here, for example, without bothering too much about them, I show one of the models relating economic growth, inflation, interest rates and debt to one another.

It is much more interesting to look at what happens in these models than to spent too much time on their mathematical description. What I did is the following. I estimated these models on 40 years of annual and quarterly data. In the estimation of the model, I removed 2020, such that the model is not biased to the pandemic.

**Slide 8**

Next, in the fitted models, I added the (estimated) values for these economic parameters and simulated the next 8 years using the model. Here I show the results for the government deficit, government debt and economic growth. Of course, these models do not take into account the relationship of the economy with the pandemic. For example, if vaccines go well, this will lead to a quicker economic recovery and vice versa. Still, there is a clear message form the model. If the historical relationships describing economic growth, debt and the other parameters are still valid in the future, we can expect something like is shown in these figures. The grey shaded regions indicate 95% confidence intervals. The models agree that we will have a positive government deficit before 2024 and that debt will increase to about 80% of GDP but will lower afterwards. The economy will recover already sooner and show positive growth in 2022.

In this model we also estimated the dynamic behaviour of the interest rate using historic data on long term sovereign Dutch bonds. There is however still the risk of an increasing interest rate.

**Slide 9**

We therefore considered the effects of both savings and interest rate in somewhat more detail. The low interest rate regime is the current 0%, the high interest rate is 5% per annum. We considered both government being very strict after covid, trying to save money and a loose fiscal policy. We find a striking result. From the data, debt becomes rapidly unstable in a high interest rate regime with little government savings. It is not expected that there will be tight policy after COVID and this regime is thus very dangerous. Here we used that g=0, so r=r-g.

**Slide 10**

We should thus look at what can be concluded about both the sign and amplitude of g-r. Looking at the past, we find that this macroeconomic quantity showed really large up and down swings, but it has been stabilizing recently. Since the GFC, it is positive, which is positive for the debt sustainability. Still, the plot also shows us that we cannot discard situations in which the interest rate is indeed higher than the economic growth, as these have occurred very frequent in history.

On this slide we show two more things: the impulse response functions of the economic growth on the debt level and of interest rate on debt. Both have on their horizontal axes quarters, so in total three years. The models suggest that a 1% increase of GDP growth will lead to a 1.5 % drop in debt. This is a good thing for the debt sustainability, as especially in recession times, the economy will grow again in future. But also, a 1% increase in interest rate will lead to an increase of debt rather soon.

**Slide 11**

Something that I am still working on and that is very interesting for future research, it the probability density of r-g values. This would allow policymakers to attribute probabilities to the different scenarios. For example, the work by Lian et al tried to do a similar thing. The plot here on the left is from their work and shows the probability density function of r-g values conditional on the debt level of the economy. Lower levels of debt clearly have their r-g distribution centred around negative r-g values, whereas higher debt levels have their distribution centred around zero r-g. such an approach would be very helpful in the debt sustainability analysis.

**Slide 12**

Overall I can summarize the main points of this work as follows. I presented a very concise overview of some of the models I used, aiming to model the economy in times after the pandemic. Literature shows that the fiscal support used by the government now worked in the future and is thus expected to be beneficial again now. But these expenses can only be financed via debt. We tried to analyse whether this debt is sustainable. Key parameter here is the difference between economic growth and interest rate. This is not expected to change soon, but it is also very hard to be sure. Given the results of this concise study, it is more likely that financing the government expenses with debt is a good thing than that it will lead to unsustainable levels of debt in the future.