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Fiscal sustainability during the COVID-19 pandemic

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Non-technical summary

Research Question

The "Great Lockdown" implemented in response to the COVID-19 pandemic has led to a severe world-wide economic crisis in 2020. Consequently, in euro area countries sovereign debt-to-GDP ratios are on the rise and reductions in expected fiscal surpluses raise sustainability concerns amongst investors. Fiscal space is the difference between the "fiscal limit" and the sovereign debt stock relative to GDP. The fiscal limit is the maximum level of debt that is sustainable, i.e. the value of all expected fiscal surpluses when tax revenues are maximized. Against this background, a key macroeconomic question is by how much the COVID-19 pandemic reduces fiscal space in euro area countries and whether the European sovereign debt crisis could resurface.

Contribution

This paper provides fiscal limit estimates for the five largest euro area countries and the euro area. The main contribution is to show by how much fiscal space shrinks in different COVID-19 pandemic scenarios. The scenario is a combination of a negative supply-side effect and an expansionary government spending response. Both shocks contribute to a downward shift in the fiscal limit. I calibrate the country-specific fiscal responses according to the fiscal stimulus packages announced up to the end of March 2020. I assume that productivity declines at a scale consistent with model-implied forecast revisions for real GDP growth in 2020 between early April and late February.

Results

Before the pandemic, fiscal space is very heterogeneous across countries, but seems to be reassuringly large. A robust finding across all countries is that in the pandemic scenario fiscal space reduces on average by 58.4 percent of national GDP. In a worst-case scenario, total fiscal space is only 28.6 percent for Italy and 65.9 percent of national GDP for Germany. Overall, the estimates point to an elevated risk of a sovereign debt crisis.

Nichttechnische Zusammenfassung

Fragestellung

Zur Eindämmung der COVID-19 Pandemie wurde in vielen Ländern eine Massenquarantäne angeordnet. Als Folge wurde das soziale und wirtschaftliche Leben weitgehend heruntergefahren und löste eine Wirtschaftskrise aus. Die in den Euroländern steigenden Schuldenquoten und eine Verringerung der erwarteten fiskalischen Überschüsse haben bei Investoren Bedenken über den fiskalischen Handlungsspielraum hervorgerufen. Der fiskalische Handlungsspielraum ist die Differenz zwischen dem "fiskalisches Limit" und dem Schuldenstand relativ zum Bruttoinlandsprodukt (BIP). Das fiskalische Limit ist das maximal nachhaltige Schuldenniveau, welches dem Wert aller erwarteten fiskalischen Überschüsse beim höchstmöglichen Steueraufkommen entspricht. Vor diesem Hintergrund ist eine makroökonomische Kernfrage, inwieweit die COVID-19 Pandemie den fiskalischen Handlungsspielraum der Euroländer reduziert hat und ein erneutes Aufflammen der Schuldenkrise in der Eurozone entfachen könnte.

Beitrag

Dieser Beitrag liefert Schätzungen für den fiskalischen Handlungsspielraum der fünf größten Euroländer und der Eurozone. Der Hauptbeitrag besteht darin zu zeigen, wie stark der fiskalische Spielraum in verschiedenen COVID-19 Szenarien eingebrochen ist. Das Basisszenario besteht aus einem adversen Angebotsschock und einer Staatsausgabenerhöhung, welche beide das fiskalische Limit reduzieren. Ich verwende für die Modellberechnungen die länderspezifischen fiskalischen Rettungsmaßnahmen, die bis Ende März 2020 beschlossen wurden. Zudem unterstelle ich einen länderspezifischen Produktivitätsrückgang, welcher im Modell einen BIP-Einbruch für das laufende Jahr erzielt, der den BIP-Prognoserevisionen für 2020 während des Ausbruchs der Pandemie entspricht.

Ergebnisse

Vor dem Ausbruch der Pandemie ist der fiskalische Spielraum der Euroländer sehr unterschiedlich, erscheint aber zunächst im Wesentlichen ausreichend groß. Ein robustes Resultat für alle Länder ist, dass im COVID-19 Basisszenario der fiskalische Spielraum im Durchschnitt um 58.4 Prozent des BIPs einbricht. In einem Negativszenario verbleibt der fiskalische Spielraum für Italien bei nur 28.6 Prozent des BIPs und für Deutschland bei 65.9 Prozent des BIPs. Insgesamt deuten die Schätzungen auf ein steigendes Risiko für ein erneutes Ausbrechen einer Schuldenkrise hin.

Bundesbank Discussion Paper No 35/2020

Fiscal sustainability during the COVID-19 pandemic*

Patrick Hürtgen†

Abstract

The "Great Lockdown" implemented in response to the COVID-19 pandemic has led to a severe world-wide economic crisis. In euro area countries, sovereign debt-to-GDP ratios are on the rise and reductions in expected fiscal surpluses raise sustainability concerns amongst investors. This paper provides novel estimates of non-linear state-dependent fiscal limits based on Bi (2012) for the five largest euro area countries. Within the DSGE model I build a COVID-19 scenario calibrated to match the decline in real GDP growth forecasts between April and February 2020 and the fiscal stimulus packages announced up to the end of March 2020. On average, fiscal space contracts by 58.4 percent of national GDP. In a worst-case scenario fiscal space is 28.6 percent for Italy and 65.9 percent of national GDP for Germany.

Keywords: State-dependent fiscal limits, fiscal space, sovereign debt, Laffer curve, COVID-19.

JEL classification: E32, H30, H60.

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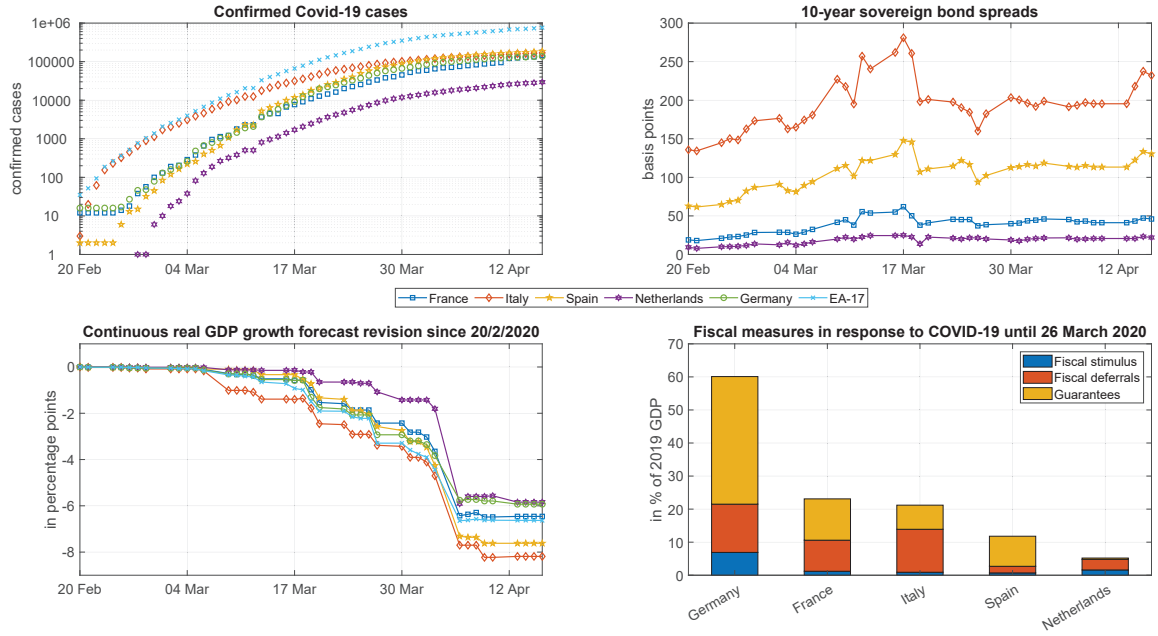
1 Introduction

The COVID-19 pandemic challenges policymakers and societies around the globe. One of the epicentres of the coronavirus is the euro area. 40 percent of the 1.32 million reported cases are in the EA-17 countries according to the Johns Hopkins University on April 6th, 2020. Figure 1 illustrates that in the first weeks after the outbreak the number of COVID-19 cases grows exponentially. To contain the spread of the virus, i.e. to 'flatten the curve' of newly infected human beings, many governments have initiated an unprecedented lockdown of economic and social activity. Towards the end of March the lockdown policies show their efficacy in the slowdown of the growth rates across all countries. While the lockdown is essential to save lifes and support public health systems, they also have tremendous adverse macroeconomic effects.

Figure 1: The macroeconomy in the unfolding of the COVID-19 pandemic



Notes: Sovereign bond spreads are shown against German 10-year sovereign bond yields. *Data sources:* Bruegel, Consensus Economics Inc., Johns Hopkins University, and Thomson Reuters.

As the virus has spread, forecasters have on average revised annual euro area growth forecasts for 2020 by a sizable 6.9 percentage points between April and February 2020 according to Consensus Economics (see Figure 1). The continuous forecasts reveal that the pace of downward revisions has gained momentum since the last week of March and stabilized by mid-April. At the same time, sovereign risk premia for most euro area countries against Germany are rising, among these Italy and Spain (see Figure 1). Investors seem to anticipate the imminent risk of rising sovereign debt burdens and a massive decline in expected fiscal surpluses. Many, if not all, euro area countries will

face a substantial increase in their sovereign debt-to-GDP ratios; further fueled by a substantial decline in GDP until the end of the year. Against this background, a key macroeconomic question is by how much the COVID-19 pandemic reduces fiscal space and whether a resurfacing of the European sovereign debt crisis is imminent.

This paper provides novel estimates on the amount of fiscal space amongst euro area countries and the extent to which fiscal space could shrink due to the COVID-19 pandemic. For this purpose I employ a DSGE model with a non-linear state-dependent fiscal limit as in Bi (2012). I estimate the underlying shock processes and calibrate the fiscal sector using data from 1991 to 2020 for France, Germany, Italy, the Netherlands, Spain and the euro area. The model features a fiscal sector with government spending shocks, a regime-switching process for stable and non-stationary government transfers, a distortionary tax on labor giving rise to a dynamic Laffer curve, and shocks to productivity. The fiscal limit is the maximum level of debt that is sustainable, i.e. the present discounted value of all future fiscal surpluses when raising taxes at the peak of the Laffer curve. Economic fundamentals such as tax revenues and government spending-to-output ratios differ across countries, and hence the fiscal limit is very different across countries. Fiscal space is the difference between the fiscal limit and the government debt stock relative to GDP.

Before the outbreak of the pandemic, euro area countries already had very heterogeneous debt-to-GDP ratios. In November 2019 the OECD projected the following debt-to-GDP ratios for 2020: France (99.5%), Germany (59.0 %), Italy (136.1%), the Netherlands (48.2%), Spain (96.4%) and the euro area (86.0%). While the debt-to-GDP ratio typically evolves gradually in most advanced economies, the perception of investors regarding the fiscal limit can change quickly, leading to sudden increases in risk premia. For example, Spanish and Italian 10-year bond spreads (relative to German 10-year bonds) increased markedly between February 20th and April 16th, 2020 by 68 and 96 basis points, respectively.[1] In the most extreme case, a vicious circle of debt could be initiated by sudden increases in the risk premium. Estimates prior to the pandemic reveal substantial heterogeneity, but sufficient fiscal space across countries: France (191.9%), Germany (238.0%), Italy (136.9%), the Netherlands (289.6%), Spain (329.5%) and the euro area (228.3%). These estimates imply that, for example, Germany can increase its debt-to-GDP ratio by 238.0% before investors expect a default probability of five percent.[2] The Netherlands and Spain have the most fiscal space due to lower government transfer spending to output

[1] On March 12th, 2020 the spreads increased dramatically due to the market reaction to ECB president Ms. Lagarde, who said that it was not the ECB's role to "close the spread" in yields in the euro area. This market reaction was undone on March 18th, 2020 by her decisive support of the Eurosystem: "Extraordinary times require extraordinary action. There are no limits to our commitment to the euro. We are determined to use the full potential of our tools, within our mandate."

[2] The model maps fiscal space into default probabilities. The reported fiscal limits are conditional on a small default probability of five percent.

ratios compared to the other countries.

In a second step, I estimate by how much fiscal space tightens in a COVID-19 scenario. The scenario is a combination of a negative supply-side effect and an expansionary government spending response. Both shocks contribute to a downward shift in the fiscal limit. The lockdown, i.e. the negative productivity shock, causes a decrease in wages and, thus, labor tax revenues. Output and consumption decrease as a result. I calibrate the country-specific fiscal responses according to the fiscal stimulus packages announced up to the end of March 2020 in response to the pandemic (see Figure 1). In addition, I exploit the continuous forecast revisions for real GDP growth in 2020 (see Figure 1) since the spread of the virus began to compute back-of-the-envelope estimates of the productivity decline. A robust finding across all countries is that the pandemic scenario reduces fiscal space between 43.0% (France) and 68.1% (Germany) percent of national GDP.

In addition, I examine two further scenarios. A common assumption in the fiscal limit literature is to set the income tax rate at the peak of the Laffer curve. The tax rate is endogenously determined and is around 60 percent for all five countries. When I relax this assumption and set the income tax to the maximum of each country, which ranges between 44 and 55 percent, all countries remain solvent in the COVID-19 scenario. Nonetheless, fiscal space shrinks on average by close to 100 percent of national GDP.

There is high uncertainty associated with the COVID-19 crisis, due to its unknown duration or further waves of the pandemic and lockdown measures. It also entails the features of a rare event, so that there is little experience amongst households, entrepreneurs, and policy makers. To address this concern, I consider a worst-case scenario, where the negative supply shock is twice as large as in the baseline scenario. In addition, I assume that all government guarantees have to be paid out to the private sector (see Figure 1) and tax rates remain at the maximum income tax rate. In this case, fiscal space shrinks between 58.0% and 81.0% net of the previously mentioned tax rate effect. Total fiscal space is only 28.6 percent of national GDP for Italy, 65.9 percent for Germany and 72.2 percent for Spain.

The risk of a resurfacing European sovereign debt crisis becomes even more prevalent when taking into account that the actual debt-to-GDP ratio, too, will rise until the end of 2020.[3] Despite the attention currently devoted to the COVID-19 pandemic, it is clear, that other economic shocks will hit the economies. Therefore, having sufficient fiscal space, i.e. operating at a debt-to-GDP ratio before a positive default risk and risk premia emerge, is likely to be essential to deal not only with the current crisis, but also to be able to use fiscal policy measures when facing economic shocks in the future.

[3]For example, if output were to decrease by 10 percent and debt increases by 20 percent, the debt-to-GDP ratio will increase by around 33 percent for each country by the end of 2020, leading to even smaller fiscal space and a rise in the default probabilities.

Related literature:

The paper is most closely related to the ones that assess macroeconomic dynamics in the presence of a state-dependent fiscal limit pioneered by Bi (2012). Two papers provide a non-linear estimation of a DSGE model. Bi and Traum (2012) estimate a dynamic model with fiscal rules and a fiscal limit for Greece. Bocola (2016) estimates a model with a sovereign-bank nexus for Italy. However, for tractability the authors assume that the default probability only depends on the debt-to-GDP ratio rather than on all current (and possible future) states of the economy.

Further papers have used fiscal limit models to study the macroeconomic effects when fiscal space shrinks. Bi (2017) provides calibrated fiscal limits for several countries. Italy and Greece have very little fiscal space, whereas the U.S. and Japan have substantial fiscal space where risk premia emerge only if debt-to-GDP ratios exceed 300 percent. Further papers apply fiscal limits to different countries. These include Abad (2020), Andrés, Burriel, and Shen (2020) and Coimbra (2020) for Spain, Bi, Shen, and Yang (2016) for Argentina, and Hürtgen and Rühmkorf (2014) for Greece. This paper complements the fiscal limit literature with estimates for the state-dependent fiscal limit for an extended set of European countries using harmonized data sources and sample length for all countries. This approach helps to make the comparison between country-specific fiscal limits more transparent. In addition, the main focus of this paper is to show by how much fiscal space shrinks in COVID-19 pandemic scenarios.

Another strand of papers model the macroeconomic effects of a COVID-19 pandemic and the effects of the lockdown. Concerning the effects of the spreading of the virus, economists have combined epidemiological SIR ("Susceptible-Infected-Recovered") models with dynamic macroeconomic models. Among these, Eichenbaum, Rebelo, and Trabandt (2020) model the lockdown by an increase in the value-added tax. Guerrieri, Lorenzoni, Straub, and Werning (2020) model the lockdown in a multisector New Keynesian model, where negative supply shocks are the driving force. Regarding the effects of a lockdown, Fornaro and Wolf (2020) assess the effects of a decrease in productivity growth in the basic New Keynesian model. Dietrich, Kuester, Müller, and Schoenle (2020) employ expectations of U.S. consumers to calibrate a COVID-19 scenario with negative productivity and productivity news shocks. Coibion, Gorodnichenko, and Weber (2020) use U.S. household survey data to establish novel facts on the labor marketas the pandemic unfolded. Binder (2020) examines how U.S. consumer expectations responded to the coronavirus at the beginning of March during the early phase of the pandemic. Unlike the previous papers, this paper also takes into account the announced fiscal packages and focuses on the effects of the pandemic on fiscal space.

2 Model setup

I employ a simple non-linear DSGE model with a state-dependent fiscal limit. The model and the fiscal limit description is largely based on Bi (2012), Hürtgen and Rühmkorf (2014) and Bi (2017). The main differences are that I calibrate the fiscal limit to a new set of euro area countries and the euro area using data from 1991 to 2020. In a second step I estimate by how much fiscal space shrinks in a COVID-19 scenario.

2.1 Model setup

Consider an economy populated by an infinite number of identical households that choose consumption C_t, leisure L_t, and government debt B_t to maximize

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t u\left(C_t, L_t\right) \ , \tag{1}$$

where $\beta \in (0,1)$ is the discount factor, subject to the budget constraint

$$C_t = W_t\left(1-\tau_t\right)\left(1-L_t\right) + Z_t + B_t Q_t - (1-\Delta_t)B_{t-1} \ , \tag{2}$$

and a no-Ponzi scheme condition. The budget constraint includes consumption, wages W_t, labor taxes τ_t, government transfers Z_t to the households and a one-period government bond B_t. The government can default on the fraction $\triangle_t$ as specified below.

The production function of output is linear in labor:

$$Y_t = A_t\left(1-L_t\right). \tag{3}$$

The process of total factor productivity, A_t, follows an AR(1) process:

$$\ln\left(\frac{A_t}{A}\right) = \rho_A \ln\left(\frac{A_{t-1}}{A}\right) + \epsilon_{A,t} \ , \qquad \epsilon_{A,t} \sim \mathcal{N}\left(0, \sigma^2_{\epsilon_A}\right) \ , \tag{4}$$

where A denotes steady state productivity.

Wages are determined on a competitive labor market. Thus, the wage equals the marginal product of labor, which in our case equals productivity:

$$W_t = A_t \ . \tag{5}$$

Later, the lockdown is modelled through a negative productivity shock, which reduces labor income and, thus, tax revenues.

The government receives tax revenues $\tau_t W_t (1 - L_t)$ through distortionary labor taxation and issues new public debt B_t at a given price Q_t. It finances government purchases G_t and transfers Z_t. In addition, the government can default on the fraction $\triangle_t$ of its outstanding debt and pays back the remaining debt from last period $B_t^d = (1 - \triangle_t) B_{t-1}$. Hence, the government budget constraint is:

$$\tau_t W_t (1 - L_t) + B_t Q_t = B_t^d + G_t + Z_t \ . \tag{6}$$

Government purchases are stationary and the parameter ρ_g measures the persistence of government purchases G_t:

$$\log\left(\frac{G_t}{G}\right) = \rho_G \log\left(\frac{G_{t-1}}{G}\right) + \epsilon_t^G \ . \tag{7}$$

Government transfers follow a Markov switching process with a stationary and a non-stationary regime as in Davig, Leeper, and Walker (2010):

$$z_t = \begin{cases} Z & \text{for } S_{Z,t} = 1 \\ \mu_Z Z_{t-1} & \text{for } S_{Z,t} = 2 \ , \mu_Z > 1 \ . \end{cases} \tag{8}$$

In this setting, transfers follow a stationary path when $S_{Z,t} = 1$ and an explosive path when $S_{Z,t} = 2$, where the regimes, $S_{Z,t}$, follow a Markov chain with transition matrix MS

$$MS = \begin{pmatrix} p^{MS} & 1 - p^{MS} \\ 1 - p^{MS} & p^{MS} \end{pmatrix}. \tag{9}$$

With probability p^{MS}, government transfers stay in one of the regimes. For example, in case of a high probability (p^{MS} close to one), transfers are likely to grow for many periods in the non-stationary regime leading to government debt accumulation. The probability of switching from one regime to the other is $1 - p^{MS}$, such that transfers are ultimately stabilized. Non-stationary transfers are observed in a number of countries (see, for example, Bi, 2012). If transfers stay in the non-stationary regime for a prolonged period, the increase in government expenditures causes a progressive government debt accumulation, leading to an increase of government default risk premia and possibly to a government default.

The government default scheme depends on the effective fiscal limit b_t^*, which is drawn from a conditional fiscal limit distribution $\mathcal{B}^*(A_t, G_t, S_{Z,t})$ introduced in the next section. If the government debt stock at the beginning of period t is below the effective fiscal limit then the government repays the debt in full. If the government debt stock is higher, the government defaults on the fraction δ_t of outstanding bonds.

3 Fiscal space during the COVID-19 pandemic

Section 3.1 introduces state-dependent fiscal limits and fiscal space. Section 3.2 outlines the calibration of the country-specific fiscal limits. Section 3.3 shows by how much fiscal space shrinks in a COVID-19 pandemic scenario. Section 3.4 examines two more severe scenarios and Section 3.5 closes with a more general discussion.

3.1 State-dependent fiscal limits and fiscal space

The state-dependent fiscal limit $\mathcal{B}^*(A_t, G_t, S_{Z,t})$ is the maximum level of debt that the government is able to service, i.e. the present discounted value of all possible future fiscal surpluses. Following Bi (2012), I use the revenue-maximizing tax rate to derive the fiscal limit which is a state-dependent distribution.[4] Later I relax the assumption and replace the revenue-maximizing tax rate with the highest income tax rate of each country. The fiscal limit depends on the exogenous states A_t, G_t and $S_{Z,t}$ as well as their future realizations ($j \geq 1$) and the parameters of the model:

$$\mathcal{B}^*(A_t, G_t, S_{Z,t}) = \sum_{j=0}^{\infty} \beta^{t+j} \frac{u_c^{max}(A_{t+j}, G_{t+j})}{u_c^{max}(A_t, G_t)} \left(T_{t+j}^{\max}(A_{t+j}, G_{t+j}) - G_{t+j} - Z_{t+j}(S_{Z,t+j})\right) .$$

I derive the fiscal limit from the perspective of risk-averse households, who price the bonds based on the stochastic discount factor. The marginal utility of consumption today and in the future (u^{max}) is evaluated at the peak of the Laffer curve. To simulate the fiscal limit $\mathcal{B}^*(A_t, G_t, S_{Z,t})$ for given initial conditions $(A_t, G_t, S_{Z,t})$, I randomly draw future shocks A_{t+j}, G_{t+j} and $S_{Z,t+j}$ for $j = 1, 2, .., N$.[5] Based on $m = 1, 2, ..., M$ simulations of $\mathcal{B}^*_m(A_t, G_t, S_{Z,t})$, I approximate the state-dependent fiscal limit $\mathcal{B}^*(A_t, G_t, S_{Z,t})$ by a distribution for each state of the economy.

Given the structural parameters of the model and the specifications of shock processes, the unique mapping between the peak of dynamic Laffer curve, and the exogenous state of the economy determines the state-dependent distribution of the fiscal limit. The conditional distribution implies that households' expectations about the government's ability to pay back its debt hinges on the current state of the economy, for instance, whether the current productivity level is high or low. In the following analysis, fiscal space refers to the difference between the fiscal limit and government debt relative to GDP.[6]

[4] As Bi (2012) I do not consider the expected value of the fiscal limit, but all possible realizations and thus the fiscal limit is a distribution.

[5] I simulate $N = 200$ periods and repeat this calculation $M = 100000$ ($m = 1, 2, ...M$) times. At longer horizons the discounted value of government fiscal surpluses is virtually zero.

[6] A different fiscal space concept is based on Ghosh, Kim, Mendoza, Ostry, and Qureshi (2013). They estimate the responses of primary surpluses to debt levels for advanced economies. Based on backward-

3.2 Calibration to euro area countries

The model is calibrated at annual frequency to France, Germany, Italy, the Netherlands, Spain, and the EA-17. It is noteworthy that the EA-17 does not have a fiscal authority on its own, but the euro area fiscal limit can be computed by following the same steps as national fiscal limits and may serve as a benchmark. Table 1 summarizes the calibration for all countries and the Appendix provides more details on the data sources. The discount rate is 0.98. The total amount of time and the productivity level at steady state are normalized to one. The household spends 25 percent of its time working. The leisure preference parameter ϕ is calibrated to match the consumption-to-GDP ratio and tax rate for different countries. As a result the leisure preference parameter can vary across countries. The exogenous processes for discretionary government spending and productivity, i.e. real GDP per worker, are calibrated to country-specific data for the period 1991 to 2020 from the most recent OECD Economic Outlook in November 2019.[7] Based on this data set, I also extract the average government spending-to-output ratio (G/Y), the tax rate (τ) and the government transfer-to-GDP ratio (Z/Y). The growth rate of transfers (μ_Z) is based on the European Commission's projections for 2016-2040 from the Ageing Report 2018.[8] These government transfer increases capture many factors, among these, demographic changes, costs to the public health systems, and pensions. Broadly in line with the previous literature I assume that the persistence of the regimes lasts 40 years ($p^{MS} = 0.975$).

Next I turn to the calibration of the COVID-19 pandemic scenario, which causes perhaps the most severe economic crisis in peacetime. It is crucial to create a scenario within the model to capture these large adverse effects. I employ the fiscal stimulus programs (G_{2020}) announced in response to the pandemic up to the end of March 2020. Later, I also include fiscal deferrals ($G_{2020,deferral}$) and fiscal guarantees ($G_{2020,backing}$). By the end of March the Eurogroup had not announced a direct fiscal stimulus, but I use the potential loans of 540 billion Euros (4.5% of EU-17 GDP) agreed by the Eurogroup in early April. For an overview of the size of the fiscal packages in percent of national 2019 GDP, see Table 1 and Figure 1.

looking computations they back out a debt limit. Fiscal space is the difference between the long-run average debt ratio and the debt limit.

[7]The data for 2019 and 2020 are forecasts when the pandemic was not expected. The results are not sensitive to the inclusion of these two data points. I estimate an AR(1) process for both series on the HP-filtered ($\lambda = 100$) data.

[8]When using historical data to calibrate transfer growth, these are much larger than the transfer growth projections. The main reason is that governments have already implemented policies to reduce the burden of future fiscal commitments (e.g. increasing the retirement age).

Table 1: Calibration to euro area countries

Variables	France	Germany	Italy	Netherlands	Spain	EA-17
$\frac{G}{Y}$	0.24	0.19	0.19	0.24	0.18	0.20
$\frac{Z}{Y}$	0.19	0.18	0.18	0.12	0.14	0.17
τ	0.45	0.40	0.41	0.37	0.33	0.40
μ_Z	1.0008	1.0053	1.0049	1.0050	1.0041	1.0034
ρ_A	0.612	0.294	0.675	0.708	0.823	0.557
σ_A	0.010	0.015	0.015	0.014	0.016	0.013
ρ_G	0.649	0.655	0.791	0.643	0.848	0.758
σ_G	0.007	0.009	0.012	0.015	0.016	0.006
COVID-19 scenario						
ΔGDP^e_{2020}	-6.5	-5.8	-7.8	-5.9	-7.3	-6.7
A_{2020}	-9.2	-13.2	-10.5	-8.8	-9.5	-8.6
G_{2020}	1.2	6.9	0.9	1.6	0.7	0.0
$G_{2020,deferral}$	10.6	21.5	13.9	5.8	2.7	0.0
$G_{2020,backing}$	12.5	38.6	7.3	0.4	9.1	4.5
τ^{income}	55.1	47.5	52.8	52.2	43.5	50.0

Data sources: Bruegel, Consensus Economics Inc., European Commission: The Ageing Report 2018, OECD Economic Outlook 106, and author's calculations.

To refine the COVID-19 pandemic scenario, I use forecast revisions of the annual real GDP growth rate for 2020 during the outbreak of pandemic in the euro area. I use daily forecast data on GDP growth rates from Consensus Economics. More specifically, (ΔGDP^e_{2020}) is the consensus mean of the real GDP growth forecast for 2020 between April 14th, 2020 (when all the fiscal measures have been announced) and February 20th, 2020 (before the outbreak of the pandemic in the euro area).[9] These continuous real GDP growth revisions are illustrated in Figure 1. Based on these forecast revisions due to the pandemic, the aim is to obtain back-of-the-envelope values by calculating how much productivity has declined through the lenses of the model. I solve the linearized

[9]In an alternative specification I used the Continuous Consensus Economics database, which reveals the precise date when the forecast was released. For example, when using only the forecast revisions since April 1st, 2020, the downward revisions reflect an even more pessimistic outlook. In a robustness exercise I therefore examine how fiscal space changes when the productivity decline is doubled.

model for each country and feed in a government spending shock calibrated to the size of the country-specific fiscal stimulus package (G_{2020}). I then search for the size of the productivity shock necessary to match the real GDP forecast revision (ΔGDP^e_{2020}) for the impact period.[10]

For most countries, the size of the productivity shock (A_{2020}) is between -8.6 and 10.5 percent. Germany requires the most negative productivity shock (-13.2%), but has the smallest change in the real GDP growth rate (-5.8%). The reason is that Germany has a fiscal stimulus package that is six times larger in comparison to the other countries. Naturally, the more negative the productivity shock is, the more fiscal space shrinks. Therefore, the results for Germany are even more conservative than for the other countries. Without this positive fiscal stimulus, a negative productivity shock of less than half the size (-7.4%) is required to be consistent with the actual change in the GDP growth rate for 2020.

3.3 How much does fiscal space shrink in a COVID-19 scenario?

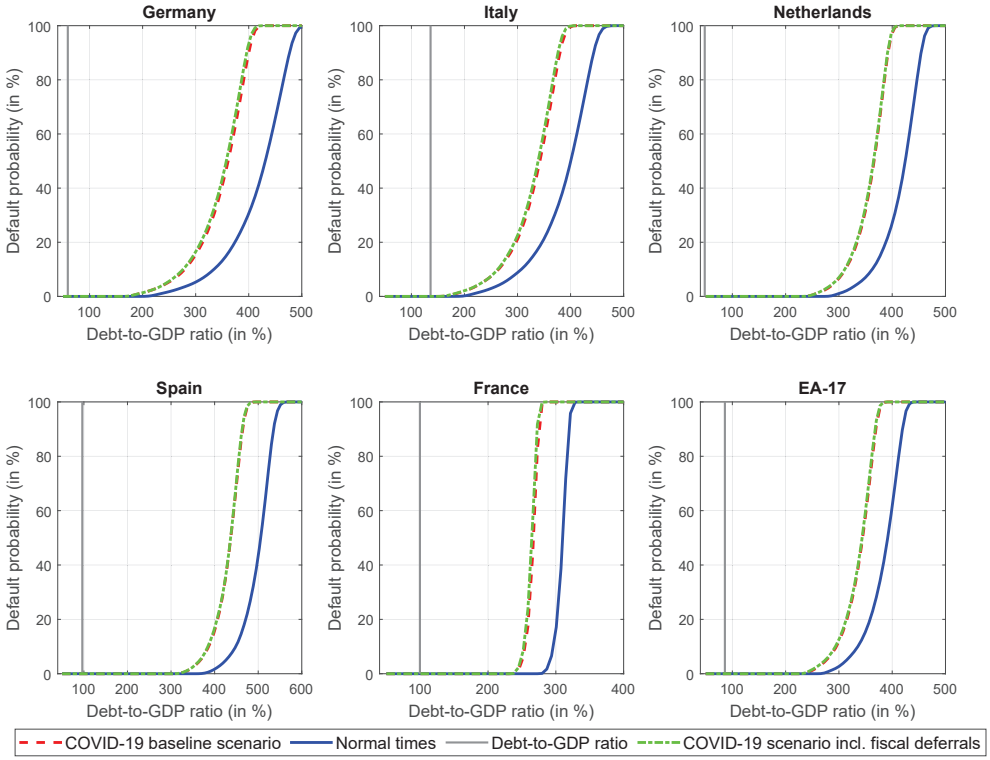
This section shows by how much state-dependent fiscal limits shift downward in two different COVID-19 scenarios. In addition, I provide estimates of the total fiscal space before and during the pandemic.

In the baseline scenario, I show the fiscal limit distribution in Figure 2 for each country at steady state in the non-stationary transfer regime (solid line, 'normal' times) as a function of the default probability. A higher default probability translates into lower fiscal space and the emergence of risk premia demanded by investors. The vertical lines show the debt-to-GDP ratio for 2020 that was projected by the OECD in November 2019 before the outbreak of the pandemic. The horizontal difference measures the prevailing fiscal space for a given default probability.

It is also noteworthy that the fiscal limit in normal times differs across countries. Each country has different fiscal fundamentals. For example, France has a much lower growth in government transfers over the next decades, which is manifested in a higher fiscal limit. Spain and the Netherlands have on average much lower transfer-to-GDP ratios, also giving these governments a relatively higher fiscal limit. Germany has the highest expected transfer expenditures due to an ageing population weighing on its fiscal limit.

[10] Clearly, this is a simplistic method to calibrate the productivity shock. Nonetheless, through the lenses of the model this is what would generate the recession currently expected by forecasters. In the recession household income decreases due to lower wages a situation currently observed. It will take a few more quarters of observations to estimate a historical shock decomposition and larger models could help to shed more light on the shock sources.

Figure 2: State-dependent fiscal limits in the euro area countries



Notes: State-dependent cumulative density functions of the fiscal limit at steady state ("Normal times") and in two COVID-19 scenarios with negative productivity and positive government spending shock. The country-specific difference to the debt-to-GDP ratio is referred to as fiscal space conditional on a specific default probability.

In the COVID-19 baseline scenario (dashed line), each country moves into a crisis state in 2020 with a severe productivity shock (A_{2020}) and a fiscal stimulus (G_{2020}) specified in Table 1. The fiscal limit shifts downward in the COVID-19 scenario in comparison to the baseline scenario. Intuitively, the lockdown reduces total labor income and thus tax revenues. Higher government spending increases output, but at the same time reduces the fiscal surpluses in the current period. Germany, Spain, and the Netherlands have the largest fiscal space after the shock, whereas Italy and France have much less fiscal space. The euro area currently has no fiscal stimulus, so the shift is only driven by the negative productivity shock, which leads to a slightly smaller downward shift compared to the other countries.

In the second experiment, I increase the fiscal stimulus effect by taking into account the fiscal deferrals ($G_{2020,deferrals}$) as indicated by the dashed-dotted line in Figure 2. Despite a large increase in fiscal spending in each country, the effect on the fiscal limit is negligible. This is interesting, as much higher short-term government spending does not have a significant impact on the fiscal limit. Intuitively, the fiscal limit is the present

discounted value of all future fiscal surpluses and the fiscal package mainly affects the fiscal limit on impact, but has no long-run effects.[11] Therefore, the fiscal deferrals do not have such a strong effect as the productivity shock.[12]

Table 2 reports the country-specific fiscal space and by how much fiscal space decreases in both COVID-19 scenarios compared to the baseline situation. I report the fiscal space available to each country conditional on a five percent default probability. Germany has a fiscal space of 188.0 percent of national GDP, whereas Italy has a fiscal space of only 96.5 percent of national GDP. The table also shows the mean fiscal space decline as well as the minimum and maximum decline (conditional at a default probability between 5 and 95 percent). Irrespective of the initial conditions, the baseline COVID-19 scenario is estimated to reduce fiscal space between 43.0 percent (France) and 68.1 percent (Germany) of national GDP. As mentioned earlier, the result for Germany is partly driven by a much larger fiscal stimulus that requires a stronger productivity shock to be consistent with the expected drop in real GDP growth. Therefore, Germany has substantial fiscal space left despite the much larger fiscal stimulus packages and fiscal deferrals compared to the other countries.

Table 2: COVID-19 scenarios: fiscal space in euro area countries

	Total fiscal space		**Decrease in fiscal space**	
	COVID-19	incl. deferrals	COVID-19	incl. deferrals
Germany	188.0	186.2	68.1 [50.0 - 78.2]	71.6 [52.4 - 82.4]
Italy	96.5	96.1	55.9 [40.3 - 64.3]	58.1 [39.2 - 67.3]
Netherlands	243.7	242.0	57.4 [45.8 - 62.6]	57.5 [45.6 - 63.3]
Spain	270.9	269.7	67.5 [58.6 - 71.8]	68.0 [59.9 - 73.6]
France	150.8	148.5	43.0 [41.1 - 44.6]	45.5 [43.4 - 47.5]
EA-17	190.2	188.2	46.2 [38.1 - 50.2]	47.5 [41.2 - 51.5]

Notes: The table shows results for two scenarios: COVID-19 and COVID-19 including fiscal deferrals. The total fiscal space, i.e. the country-specific fiscal limit net of the debt-to-GDP ratio, is reported conditional on a five percent default probability. The decrease in fiscal space reports the average decrease and in brackets the minimum and maximum decrease conditional on the default probability between 5 and 95 percent.

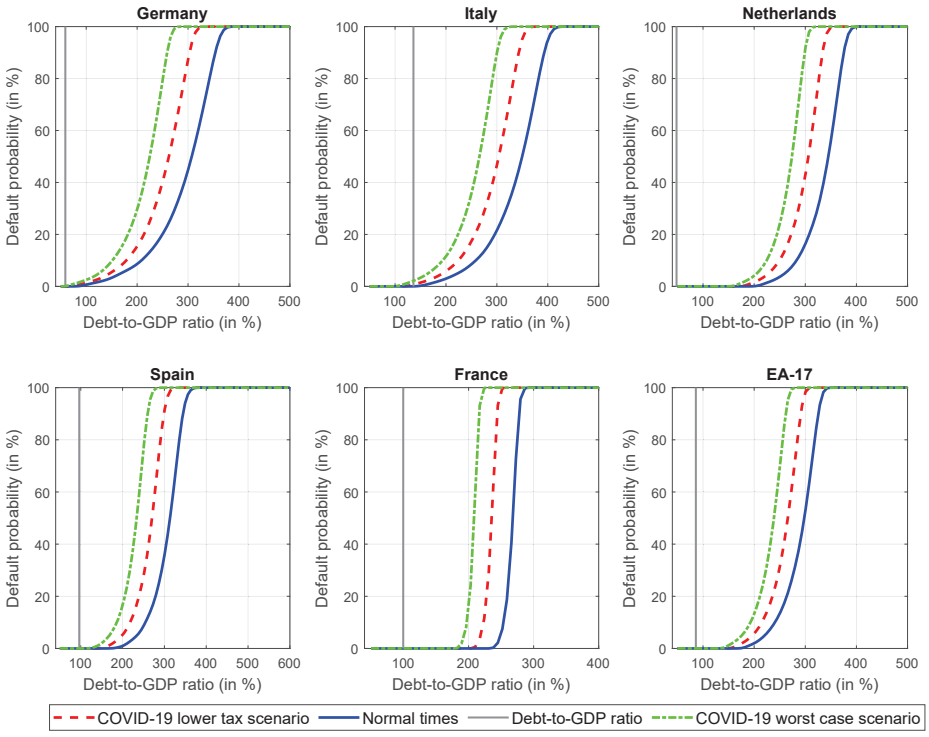
[11] For example, changing the peak of the Laffer curve has an effect in each period and the effect is much stronger.

[12] Auerbach and Gorodnichenko (2017) also find that fiscal stimulus in highly-indebted economies only has a small effect on risk premia.

3.4 Sensitivity of fiscal space in alternative COVID-19 scenarios

As a robustness analysis I assess two more severe COVID-19 scenarios. In the first case, I assume that taxes are not set at the peak of the Laffer curve, but they are set at the highest income tax rate of each country based on the OECD 2018 report (see τ^{income} in Table 1). One reason could be that tax payers are not willing to support a government that sets very high tax rates. Therefore, I use the actual tax rates of each country, which range from 45 to 54 percent. There is no common euro area income tax rate. I choose to set it to 50 percent, which is similar to the observed tax rates of the other countries. In comparison, the model-implied revenue-maximizing tax rates are around 60 percent; very similar to the estimates in Trabandt and Uhlig (2011). Intuitively, when tax revenues are smaller in each period from today onwards, the effect on the fiscal limit is substantial. The effect of reducing the tax rate can be seen when comparing the solid lines in Figure 3 and Figure 2. Spain has the smallest income tax rate and thus the fiscal limit shifts down the strongest. On average, the fiscal limit in steady state declines by around 100 percent of national GDP, when taxes are set to the actual rates instead of at the peak of the Laffer curve.

Figure 3: Sensitivity of state-dependent fiscal limits in the euro area



Notes: State-dependent cumulative density functions of the fiscal limit at steady state ("Normal times") and in two COVID-19 scenarios with negative productivity and positive government spending shock. The country-specific difference in the debt-to-GDP ratio is referred to as fiscal space conditional on a specific default probability.

The COVID-19 crisis is a rare event that entails high uncertainty among consumers (see Binder, 2020), entrepreneurs, forecasters and policymakers. There is a risk that the lockdown continues or is reactivated due to a second wave of infections. To capture the possibility that the crisis is more severe than reflected by current forecasts, I construct a worst-case scenario. In this scenario I assume that, in addition to these lower tax rates, the productivity decline (A_{2020}) is doubled and that the government actually has to pay in full the guarantees pledged to the private sector. These guarantees are intended to stabilize sovereign spreads pre-emptively; nonetheless, investors are likely to consider the consequences when these guarantees actually have to be paid out. Total government spending in 2020 in this scenario amounts to the sum of G_{2020}, $G_{2020,deferral}$ and $G_{2020,backing}$ as reported in Table 1.

Table 3: Alternative COVID-19 scenarios: fiscal space in EA countries

	Total fiscal space		**Decrease in fiscal space**	
	Lower taxes	Worst case	Lower taxes	Worst case
Germany	87.0	65.9	42.7 [21.9 - 51.5]	79.6 [44.0 - 96.7]
Italy	57.1	28.6	44.1 [29.7 - 51.3]	81.5 [62.1 - 94.3]
Netherlands	180.0	157.1	38.3 [31.7 - 42.1]	69.8 [55.0 - 77.2]
Spain	102.1	72.2	42.3 [35.6 - 46.1]	77.7 [64.0 - 86.2]
France	118.8	93.2	32.2 [30.4 - 33.8]	59.3 [56.1 - 61.6]
EA-17	110.6	89.8	31.0 [24.0 - 34.6]	58.0 [45.5 - 65.2]

Notes: The table shows results for the COVID-19 scenarios with lower tax rates and in a worst-case scenario. The total fiscal space, i.e. the country-specific fiscal limit net of the debt-to-GDP ratio, is reported conditional on a five percent default probability. The decrease in fiscal space reports the average decrease and in brackets the minimum and maximum decrease conditional on the default probability between 5 and 95 percent.

As before, Table 3 shows how fiscal space shifts in these two scenarios. In the worst-case scenario, fiscal space shrinks between 59.3 percent (France) and 81.5 percent (Italy) of national GDP and on average across all countries by 73.5 percent.[13] In this case, total fiscal space in Italy decreases to only 28.6 percent of national GDP. In other words, if the Italian debt-to-GDP ratio were to increase by an additional 28.6 percent, investors expect

[13]Note that the decline assumes in both situations that governments set taxes at the actual maximum tax rate (τ^{income}) not at the peak of the Laffer curve (τ^{max}). The difference between the baseline COVID-19 scenario and the worst-case scenarios implies a much larger decline in fiscal space due to the differences in the tax rates.

a five percent default probability when pricing government bonds. The Netherlands have the largest fiscal space with 157.1 percent of GDP, whereas Germany and the euro area as a whole still have fiscal space of 65.9 percent and 89.8 percent, respectively.

So far I considered a scenario for the current year that leads to a direct decrease in the fiscal limit, and hence to less fiscal space in the current period. At the end of 2020, the actual debt-to-GDP ratio is likely to increase markedly, such that fiscal space is likely to be even smaller. For example, when GDP decreases by close to 10 percent and government debt increases by 20 percent, the debt-to-GDP ratio increases by a factor of 1.33. Therefore, governments will be faced with strongly diminished fiscal space over the next years and might face higher sovereign risk-premia down the road.

3.5 General discussion

Several other, potentially important, factors are not explicitly included in the model. The state-dependent fiscal limit is an upper bound of the maximum sovereign debt capacity. In practice the fiscal limit could be smaller. One potential reason for a lower fiscal limit is a political risk factor through which investors discount future surpluses more strongly (see Bi, 2012). Relatedly, a further aspect that could affect risk premia is the investor's perception about a government's willingness to default (see Arellano, 2008). A government that is heavily indebted by foreign investors (rather than their own citizens) may have a stronger incentive to default. In addition, in the model the negative productivity shock mainly reduces wages and therefore tax revenues. A further possible channel is that labor supply declines meaning that tax revenues and output decreases even further. Moreover, there is uncertainty about GDP growth expectations that could even surpass the assumptions in the worst-case scenario.

Eichenbaum et al. (2020) combine an epidemiological SIR ("Susceptible-Infected-Recovered") model with a RBC model to assess the pandemic. They model the lockdown by an increase in the value-added tax. The effect on fiscal space is ambiguous. Lower consumption decreases tax revenues, but a higher tax also increases tax revenues. Furthermore, increasing tax revenues, for example, through a wealth tax could help to generate more fiscal space. However, such a tax could also discourage investors to buy sovereign bonds leading to lower bond prices.

Clearly, monetary policy also has a strong impact on sovereign risk premia dynamics. For example, the ECB's Pandemic Emergency Purchase Programme announced on March 19th, 2020 to buy up to 750 billion of sovereign bonds has reassured investors at least temporarily leading to decrease in bond spreads. Finally, a more favorable economic outlook in 2021 or 2022 is likely to increase the fiscal limit albeit at a higher debt-to-GDP ratio. Therefore, there is uncertainty surrounding the developments of future fiscal space.

Nonetheless, the fiscal space squeeze in 2020 and the increase in the debt-to-GDP ratio will require not only policies to overcome this crisis, but also to set the ground for ways to increase fiscal space over the next years. Sufficient fiscal space is crucial to use fiscal policy in response to future economic crises.

4 Conclusion

The COVID-19 crisis brings not only public health systems under severe stress, but also the entire economy as a result of the economic lockdown. Monetary and fiscal authorities have implemented a range of programs to support the economy. The ECB provides support through the Pandemic Emergency Purchase Programme. National fiscal stimulus packages and negotations about fiscal support by the Eurogroup have initiated the fiscal response. As with every disaster, there is also the opportunity to learn from the current situation and contain the seeds that could nourish future disasters, such as keeping an eye on a possible resurfacing of the European sovereign debt crisis.

It is also certain that a new unexpected crisis will happen again. While there is much uncertainty reagarding what will cause the next recession, a challenge already known today is how to deal with the large government debt burden. Perhaps this crisis may help to foster structural changes, thereby reducing the debt burden over the next years so that each European country can use fiscal policy without any looming default risk. Containing risk premia through a 'whatever it takes' policy approach so far has helped to regain the trust of investors, but this crisis response is not an adequate policy during normal times. In addition, the European Maastricht Treaty is still in place urging countries to have a debt-to-GDP ratio of no more than 60 percent and a deficit above -3.0 percent. Any effort to achieve a lower debt-to-GDP ratio over the next years improves the fiscal fire power to stand ready to counteract future crises. In times of economic crisis, having both enough fiscal and monetary fire power is crucial to employing these policy instruments when necessary.

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A Appendix

A.1 Simulation procedure for fiscal limits

Household consumption and labor supply choices only depend on the income tax rate and the exogenous state variables. I assume the following utility function $u(c, L) = \log c + \phi \log L$. The households' first-order conditions are:

$$1 - L_t = \frac{A_t(1-\tau_t) + \phi g_t}{A_t(1+\phi-\tau_t)} \tag{10}$$

$$c_t = \frac{(A_t - g_t)(1-\tau_t)}{1+\phi-\tau_t} \, . \tag{11}$$

The tax revenue (T_t) is:

$$T_t = \tau_t \frac{A_t(1-\tau_t) + \phi g_t}{A_t(1+\phi-\tau_t)} \tag{12}$$

$$= (1+2\phi)A_t - \phi g_t - (A_t(1+\phi-\tau_t) + \frac{(A_t - g_t)(1+\phi)\phi}{1+\phi-\tau_t}) \, . \tag{13}$$

The tax revenue reaches the maximum level (T_t^{max}) when the tax rate reaches the peak point of the Laffer curve (τ^{max}):

$$\tau_t^{max} = 1 + \phi - \sqrt{\frac{(1+\phi)\phi(A_t - g_t)}{A_t}} \tag{14}$$

$$T_t^{max} = (1+2\phi)A_t - \phi g_t - 2\sqrt{(1+\phi)\phi(A_t - g_t)} \, . \tag{15}$$

I use Markov Chain Monte Carlo methods to simulate the conditional distribution of the fiscal limit. It works as follows: assuming the economy starts at a certain state $(A_t, g_t, S_{Z,t})$, I simulate a path for the productivity level and the transfer regime going forward for a long period of time, which follow their stochastic processes. Given this path, I compute the path of stochastic discount factors, which depend on people's optimization conditions from above, and the path of maximum fiscal surpluses, which depend on the peak of the Laffer curve. With those in hand, I can compute the discounted sum of future maximum surpluses, $\mathcal{B}^*(A_t, g_t, S_{Z,t})$, that is associated with this specific path of future shocks. Next, I carry out another simulation with a different path of future shocks and compute another discounted sum of future maximum surpluses. I repeat this process many times. A sufficiently large number of simulations provides a good approximation of all possible fiscal limits conditional on the current state $(A_t, g_t, S_{Z,t})$, from which I can compute its distribution.

A.2 Data sources

This section provides an overview of all variables, descriptions and the data sources.

Table 4: List of variables, definitions and data sources

Variable	Source	Code	Description
Government debt	EO106	GGFLMQ	Gross public debt, Maastricht criterion as a percentage of GDP
Output	EO106	GDPV	Gross domestic product (volume), market prices
Nominal output	EO106	GDP	Gross domestic product (value), market prices
Transfers	EO106	SSPG, TKPG, TKTRG	Social security benefits paid by general government (value) plus capital transfers paid and other capital payments (value) minus capital tax and transfers receipts (value)
Tax revenues	EO106	SSRG, TIND, TY	Social security contributions received by general government (value) plus taxes on production and imports (value) plus total direct taxes received by general government (value)
Government purchases	EO106	CGV	Government final consumption expenditure (volume)
Working age population	EO106	POP1574	Working age population between the age of 15 and 74
Transfer growth rates	European Commission: The Ageing Report 2018		Annual growth rate of long-term budget projections for 2016-2040; Table 1, column: total age relate items
Top income rates	OECD 2018	TOP_TRATE	Top tax rates on personal income
Bond yields	Thompson Reuters		10-year sovereign bonds
COVID-19 cases	Johns Hopkins University CSSE		Number of cases of infected human beings
Fiscal support packages	Bruegel		Fiscal stimulus, fiscal deferrals and guarantees as of March 26th, 2020 from website: https://www.bruegel.org/publications/datasets/covid-national-dataset/
Real GDP growth rates	Consensus Economics Inc, April 2020		CCF Replacement Basis - Continuous Consensus Forecasts calculated each business day between monthly survey dates on a Replacement Basis (prior monthly survey panel with subsequent new or revised forecasts replacing old).