The COVID-19 Pandemic, Sovereign Loan Guarantees, and Financial Stability

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Abstract
We analyze the effects of the Portuguese COVID-19 sovereign loan guarantee scheme on financial stability. The sovereign loan guarantees decrease banks' default rate, speed up economic recovery, and entail small expected fiscal costs according to our simulation. The sensitivity of bank's capital to required capital and the loan guarantee fee affect the financial stability effects and the scheme's costs, respectively. The size, duration, and timing impact the effectiveness of the scheme.

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1. Introduction

Sovereign loan guarantees are among the policy measures adopted to counteract the effects of the COVID-19 pandemic outbreak. In this paper we quantify the financial stability implications of these guarantees in Portugal, specifically observing how they affect the probability of default of banks and credit to the economy.

To measure the effect of sovereign loan guarantees we use and extend the DSGE model in Clerc *et al.* (2015). We hit the model's steady-state with a series of shocks that mimic the evolution of the economy after the onset of the COVID-19 pandemic, and we compare the response of variables of interest in two scenarios: one with and another without sovereign loan guarantees.

We find that sovereign loan guarantees reduce banks' default rate, increase credit and speed up economic recovery. Our results suggest that the expected fiscal cost of the policy is small. In addition, we show that the sensitivity of banks' capital to required capital and the loan guarantee fee play an important role in the financial stability effects and in the costs of the policy, respectively.

These results are explained by two key effects of sovereign loan guarantees: they transfer loan losses from banks to the sovereign and they reduce the regulatory risk-weights on firm loans. Banks, operating in a competitive environment, respond to higher profits and lower risk-weights with more credit to firms and lower capital. Firms use the additional credit to invest more than they would without loan guarantees, and output recovers faster. Due to the additional credit, firms' default rate increases. The default rate of banks, on the other hand, decreases. Their capital reduces by less than the share of credit losses transferred to the sovereign.

We explore alternative designs of the scheme to assess the impact of its size, duration and timeliness. Increasing the size enhances the effect on bank default, credit, and the economic recovery but entails higher expected fiscal costs. Longer schemes – where most of the guaranteed loans have longer maturity – have a marginal effect on bank default and credit. But they increase the benefits to the economy and postpone the drop in output associated with the phasing out of the scheme. In a delayed implementation of the scheme banks' default probability increases at the time of the COVID-19 shock. Missing the period of higher financial instability affects the scheme's ability to restore the economy to pre-crisis levels in a timely way.

To our knowledge, this work represents one of the first attempts to assess the impact on financial stability of the COVID-19 sovereign loan guarantees in a general equilibrium setup that allows firms and banks to default. We can quantify how the scheme impacts firms' credit, banks' default probabilities, output and expected fiscal costs. Moreover, the framework allows for the comparison of different schemes, and hence for a more comprehensive evaluation of the scheme in place.

The literature on the effects of sovereign loan guarantees during the COVID-19 pandemic crisis includes Falagiarda *et al.* (2020), Budnik *et al.* (2021), Demmou and Franco (2021), and Rancoita *et al.* (2020). Falagiarda *et al.* (2020) and

Budnik *et al.* (2021) show that loan guarantees increased corporate lending. Falagiarda *et al.* (2020) also show that loan guarantees helped in maintaining favorable lending conditions. The results in Demmou and Franco (2021) suggest that increased lending on favorable terms and conditions did not come at the expense of credit misallocation: loan guarantees protected high productivity firms while barely sustaining zombie firms. On an aggregate level, Rancoita *et al.* (2020) estimate a positive impact on GDP for the euro area arising from sovereign loans.

The paper is organized as follows. Section 2 summarizes the main features of the baseline model and how the guarantees are included in it. Section 3 defines the shocks, the calibration and the numerical approximation we implement. Main results, sensitivity analysis and alternative policies are discussed in section 4. Finally, section 5 concludes.

2. Modeling sovereign loan guarantees

2.1. The sovereign loan guarantee scheme in Portugal

In March 2020, Portugal authorized a loan guarantee scheme to support the economy after the COVID-19 shock. The scheme complies with the rules in O.J. (C 91I) 1 set by the European Commission (EC). The scheme consists of 13 billion euros of guaranteed loans, notably for firms in the sectors most affected by the pandemic – for example, restaurants, tourism, travel agencies. The guarantee's coverage varies between 80 and 90 percent depending on firm size but cannot exceed 90 percent. The maximum maturity of the guarantee is six years, and borrowers pay a guarantee fee that depends on the maturity of the loan and firms' size. In October 2021, the amount of new guaranteed loans reached 8.87 billion euros, eighty-five percent of which issued in 2020. Most guarantees were granted with the maximum allowed maturity, and in October 2021 the average residual maturity was about 4.5 years.[1]

2.2. The original model

We start with the model in Clerc *et al.* (2015) – henceforth the 3D model – and extend it to include loans with sovereign guarantees. The model is particularly suited to assess the effect of loan guarantees on financial stability as it captures an economy where banks are subject to capital requirements, can have loan losses arising from firms' default, and can default themselves. Thus, the model can capture the role of sovereign loan guarantees in safeguarding banks against loan losses and in reducing loan risk-weights.

Figure 1 summarizes the key relationships between economic agents. The original model synthesizes an economy composed of households, entrepreneurs, and

1. Data from Banco de Portugal Financial Stability Report, December 2021.

banks. Patient households save and finance banks with deposits, while impatient households borrow. Both types of households consume, invest in housing, and work in the production sector. Entrepreneurs run firms and invest in capital with inherited equity and with credit granted by the banking sector. Mortgage banks lend to impatient households for investment in housing and corporate banks lend to entrepreneurs. Banks operate with limited liability, and are subject to minimum capital requirements.

In the model, all agents can default, including banks. A bank defaults when the losses in its loan portfolio are higher than its capital. Losses in a bank's loan portfolio can arise from bank's idiosyncratic shocks and from the default of entrepreneurs and impatient households.

When banks default, depositors' losses are covered with lump-sum taxes levied on patient households. These taxes are charged by the deposit guarantee system in the same period of bank default.

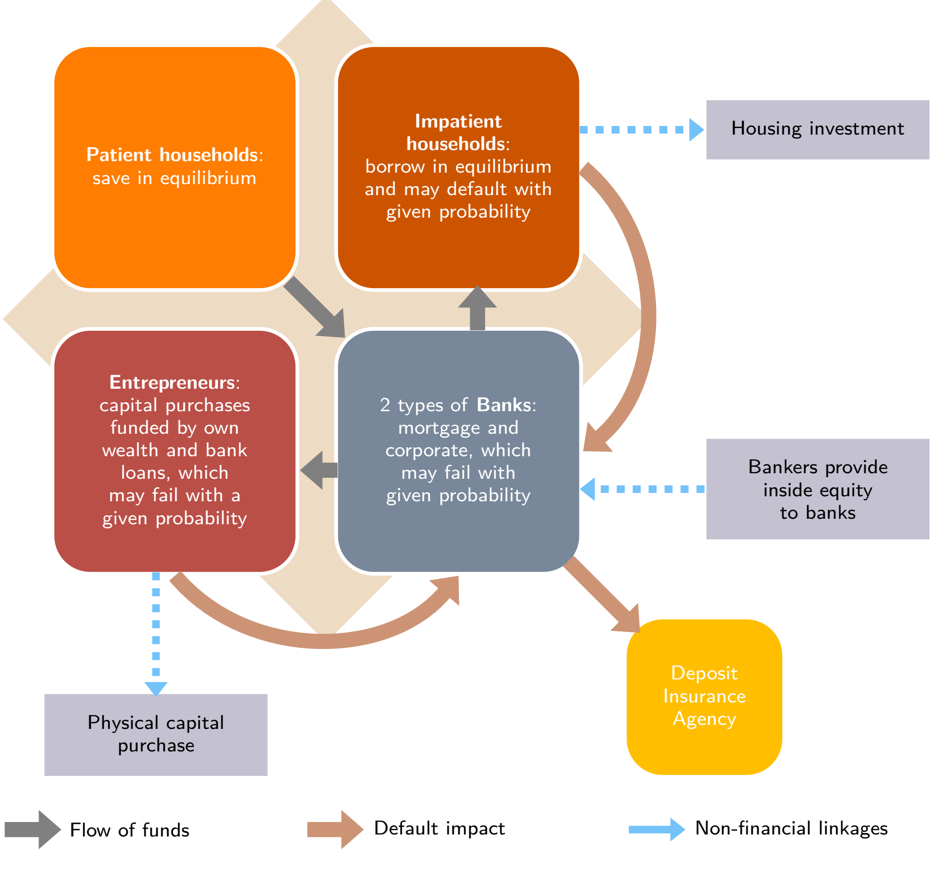


Figure 1: Main features of the 3D model

2.3. Adding sovereign loan guarantees to the 3D model

In the 3D model there is no sovereign. That role is played implicitly by the deposit guarantee system which has the power to tax households. In our modeling of sovereign loan guarantees we follow a similar approach.

We assume that a sovereign guarantee fund guarantees an exogenous fraction g_t of every firm loan. The fund charges corporate banks a fee f_t per unit of guaranteed credit. In return, it compensates corporate banks for loan losses by transferring the difference between the contractual and the realized gross interest rates of loans, R_t^F and $\tilde{R}_{t+1}^F$. The fund raises the necessary revenue to compensate corporate banks by charging lump-sum taxes, T_{t+1}^G, on patient households:

$$T_{t+1}^G = \left(R_t^F - f_t - \tilde{R}_{t+1}^F\right) g_t b_t^e \tag{1}$$

with b_t^e being corporate loans.

In addition, banks' required capital reduces in proportion to the share of guaranteed credit. This reduction reflects the fact that sovereign guaranteed loans receive a zero percent risk-weight. Corporate banks' equity e_t^F must then satisfy the following constraint:

$$e_t^F \geq \left(\bar{\kappa}^F + \bar{\phi}^F \left(1 - g_t\right)\right) b_t^e \tag{2}$$

where $\bar{\kappa}^F$ is a parameter controlling the sensitivity of banks' capital to required capital and $\bar{\phi}^F$ is the fraction of credit that banks hold as capital to comply with regulatory requirements. The risk-weight on firm loans is implicitly 100 percent, so that after the sovereign guarantees it becomes 100 percent times (1-g_t). The addition of $\bar{\kappa}^F$ in equation 2 is a generalization of the 3D model. We will return to it in Subsection 2.5.

Given our modelling choices, corporate banks' profits are described by:

$$\max\left[\left(R_t^F - f_t\right) b_t^e g_t + \omega_{t+1}^F \tilde{R}_{t+1}^F b_t^e (1 - g_t) - R_t^D d_t^F, 0\right] \tag{3}$$

where ω_{t+1}^F captures idiosyncratic corporate bank loan return shocks, R_t^D is the deposit interest rate and d_t^F are corporate banks' deposits.

Corporate banks will default if the shock ω_{t+1}^F is lower than a threshold $\bar{\omega}_{t+1}^F$, with the threshold defined as:

$$\bar{\omega}_{t+1}^F = \frac{R_t^D d_t^F - g_t \left(R_t^F - f_t\right) b_t^e}{\left(1 - g_t\right) \tilde{R}_{t+1}^F b_t^e} \tag{4}$$

$$= \frac{1}{\tilde{R}_{t+1}^F} \frac{R_t^D \left[1 - \left(\bar{\kappa}^F + \bar{\phi}^F \left(1 - g_t\right)\right)\right] - \left(R_t^F - f_t\right) g_t}{1 - g_t}. \tag{5}$$

The last equality in the previous equation follows from the accounting identity between banks' assets and liabilities, $b_t^e = e_t^F + d_t^F$, and from a binding capital requirement constraint in equation 2. Equation 5 highlights the fraction of guaranteed loans, the fee and capital ratios as key drivers of corporate banks' default.

The sovereign loan guarantee scheme has direct and indirect fiscal costs. Transfers T^G_{t+1} in equation 1 represent the direct costs. The indirect costs of the scheme include the additional costs borne by the deposit insurance agency after the implementation of the guarantees. These additional costs can be negative – if banks' default rate decreases – or positive – if banks' default rate increases.

We now move to comments about our modeling of sovereign loan guarantees. Assuming that a fraction g_t of every firm loan is guaranteed is without loss of generality. In the context of the 3D model, firms are identical. It is irrelevant whether only a share g_t of firms have guaranteed credit or whether each firm has a fraction g_t of its loans that is guaranteed. Outside the model, our assumption fails to capture the fact that sovereign loan guarantees are mainly targeted to small and medium enterprises operating in sectors most affected by the COVID-19 pandemic crisis. To the extent that these firms are more likely to generate losses for banks, our results are underestimating the positive effect of loan guarantees on financial stability and the cost of the scheme.

We assume that loan guarantees protect banks against losses that arise from banks' *idiosyncratic* shocks. While the assumption may seem odd, we interpret banks' idiosyncratic shocks in the 3D model as shocks arising from undiversified credit risk.[2] Sovereign loan guarantees insure banks against all credit risk, diversified or not.

Finally, we deviate from the terms and conditions of the Portuguese sovereign loan guarantee scheme and assume that banks, rather than borrowers, pay the guarantee fee. This assumption is for expediency and it is without loss of generality. The credit market equilibrium would be unchanged if we assumed otherwise. Note further that our assumption is in line with the typical terms and conditions of loan guarantees.

2.4. The effects of loan guarantees on the credit market equilibrium

The sovereign loan guarantee scheme impacts the credit market equilibrium and has three different first-order effects on bankers' returns. The guarantees (i) reduce loan returns' risk, (ii) increase the expected loan return when the fee is lower than the fee that makes expected net transfers equal to 0, and (iii) decrease required banks' capital. The last two effects increase bankers' returns, while lower loan risk decreases them – risk-neutral bankers are ultimately risk-loving due to limited liability.

Changes in bankers' returns are passed on to borrowers, since banks operate in a competitive environment. This result implies that entrepreneurs would not

2. Clerc *et al.* (2015) offer a similar interpretation.

demand sovereign guarantees if their effect was to only reduce loan returns' risk. It also implies that when bankers' returns do increase, entrepreneurs are granted loans with lower interest rates or higher credit amounts, or a combination of both.

The reduction in the risk of loan returns and the increase in expected loan returns improve financial stability, as both effects reduce the probability of banks' default. On the other hand, lower loan's risk-weights raises bank leverage, which increases bank default probability. The model parameterization is decisive in determining whether the decrease in bank default due to the borrowers' debt compensation of the scheme outweighs the increase in bank default due to the increase in bank leverage.

2.5. Generalization of the capital requirements' constraint

Departing from the original 3D model, we generalize the capital requirements constraint to include a parameter that determines the sensitivity of banks' capital, e_t^F, to required capital, $\bar{\phi}^F b_t^e$. We want the model to be more realistic and include the possibility that the elasticity of banks' capital to required capital is less than one. Generalizing banks' capital constraint as we did in equation 2 is a reduced-form approach of capturing this possibility. Since equation 2 is always binding in equilibrium, the elasticity of bank capital to required capital is given by $\varepsilon^F = \bar{\phi}^F / (\bar{\kappa}^F + \bar{\phi}^F)$, which is less than one if parameter $\bar{\kappa}^F$ is positive.

As we shall see in Section 4, the generalization of capital requirements has relevant implications for the effects of the loan guarantee scheme.

3. Shocks, parameters and numerical approximation

We need to calibrate a COVID-19 shock consistent with the pandemic crisis, the path of the guaranteed loans' share g_t, the loan guarantee fee f_t, the different components of capital ratio $\bar{\phi}^F$ and $\bar{\kappa}^F$, and the remaining parameters of the 3D model.

3.1. The COVID-19 shock

We model the COVID-19 shock as a series of productivity shocks to simulate a generalized adverse impact on the production of final goods and approximate the drop in GDP experienced in Portugal during the pandemic crisis. This strategy follows De Lorenzo Buratta *et al.* (forthcoming) and Banco de Portugal (2020), in which authors argue that supply-side factors, and especially the decline in global productivity, mainly determined the GDP contraction. A similar approach was followed in Fornaro and Wolf (2021). Alternatively, Guerrieri *et al.* (2020) and Bodenstein *et al.* (2021) model the COVID-19 shock as a negative labour supply shock.

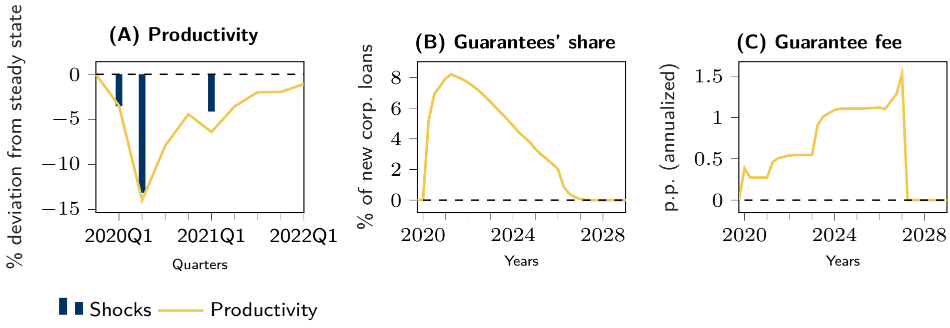


Figure 2: Exogenous paths of productivity, guaranteed loans and guarantee fee

Productivity shocks mimic the partial or total closure of firms, the lockdown effects on specific economic activities at the global level, and the efficiency disruptions impacting both labor and capital. As in De Lorenzo Buratta *et al.* (forthcoming), we consider a series of productivity shocks decreasing output and set their magnitude to reproduce the fall in GDP observed in the two lockdown periods of March 2020 and January 2021. In addition, we calibrate the persistence of the productivity shocks to mimic the recovery in GDP observed before the second lockdown. Panel A of Figure 2 shows the productivity shocks and dynamics from 2019Q4 to 2021Q4.

3.2. The share of guaranteed loans

We use granular data[3] to compute the share of guaranteed loans. Granular data is necessary because the amount of guaranteed credit depends on which loans received a COVID-19 sovereign guarantee, on the fraction of each loan that is guaranteed, and on loans' maturity and amortization schedules. Our identification of loans with a COVID-19 sovereign guarantee runs from March 2020 until July 2021.

In the model, we assume that agents perfectly foresee the dynamics of the share of guaranteed loans at the time of the introduction of the loan guarantee scheme. The exogenous path of the fraction g_t of guaranteed loans over time (Panel B of Figure 2) is thus defined as:

$$g_t = \frac{\text{Guaranteed amount}_t}{\text{Total credit amount}_t} \tag{6}$$

where Guaranteed amount$_t$ is the amount of credit guaranteed in quarter t and Total credit amount$_t$ is the total amount of non-defaulted credit to non-financial firms. Total credit amount$_t$ for periods beyond July 2021 is forecasted.

The share of guaranteed credit rises rapidly to 8.21 percent between 2020Q1 and 2021Q2, decreases steadily until 2026, and then abruptly converges to 0 in

3. Source: Banco de Portugal's Credit Register.

2027. The abrupt fall in the share of guaranteed loans towards the end of the scheme raises the possibility of cliff-effects. We will discuss them in Section 4.

3.3. The loan guarantee fee

To compute the aggregate time series for the fee, we rely on Portuguese credit lines guidelines, regulating the amount of the guarantees' premia[4]. The fees' value varies with the number of repayment years, the size of the firm (micro, small, medium, small cap, mid cap, large), and the credit line at stake. Using the information on the specific credit lines - that also identifies firms' sector and characteristics - and merging it with data on maturity, we compute a fee term structure for each loan contract. To obtain the aggregate time series, we compute average fees weighting each loan by its guaranteed amount at each point in time (Panel C of Figure 2).

3.4. Required capital ratio and $\bar{\kappa}^F$

We calibrate the required capital ratio $\bar{\phi}^F$ and the parameter $\bar{\kappa}^F$ so that their sum equals the asset-weighted average of the observed capital ratio of the largest Portuguese banks in the period between 2017 and 2019 – 13.87 percent[5]. In the absence of an estimate of the elasticity of banks' capital to required capital, we set the required capital ratio $\bar{\phi}^F$ equal to 11.25 percent. It corresponds to the sum of the required total capital ratio (8 percent), the asset-weighted average of the OSII capital buffer (0.75 percent), and the capital conservation buffer (2.5 percent). Parameter $\bar{\kappa}^F$ is then 2.62 percent. With this calibration the elasticity of banks' capital, ε^F, to required capital, $\bar{\phi}^F b_t^e$, is 0.81. In section 4 we show results with different calibrations of parameters $\bar{\phi}^F$ and $\bar{\kappa}^F$, corresponding to different elasticities of bank's capital to required capital.

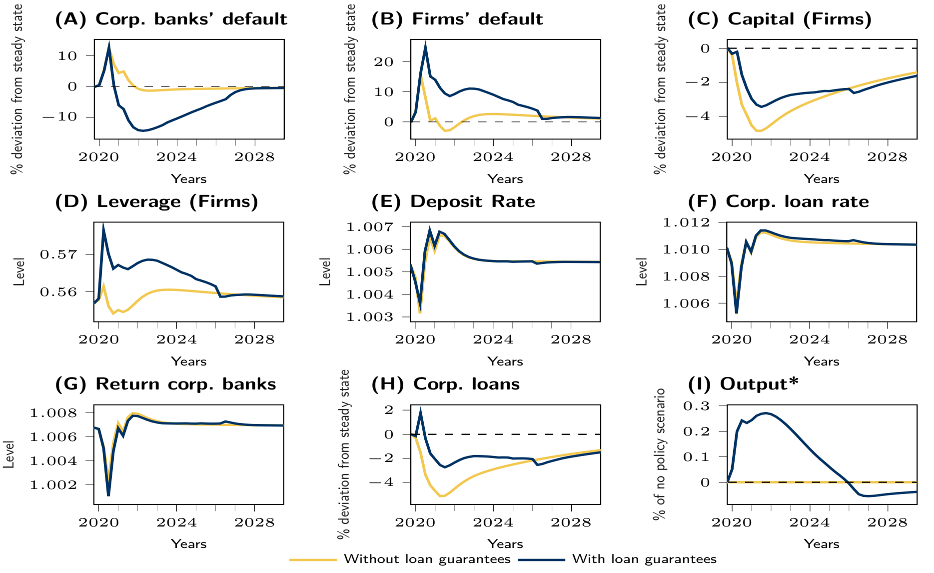
3.5. The remaining parameters and numerical approximation

The rest of the parameters results from the calibration of the 3D model for the Portuguese economy using quarterly data from 2001Q1 to 2020Q1. Calibration data targets and the obtained parameter values are the same as in De Lorenzo Buratta *et al.* (forthcoming).

We use Dynare to numerically compute the model's steady-state and the impulse response functions resulting from the COVID-19 shock and loan guarantee scheme. We use a second order approximation around the steady state, as non-linear effects are relevant for our analysis.

4. For details, see https://financiamento.iapmei.pt/inicio/home. The fee term structures follow the EC rules for the minimum amounts as in O.J. (C 91I) 1.

5. Source: Portuguese banks' Common Reporting (COREP) reports.



Note: * In panel (I), the lines correspond to $(IRFs_t^1 - IRFs_t^0)/IRFs_t^0 \cdot 100$, where $IRFs_t^1$ are the IRFs after the introduction of the loan guarantee scheme, and $IRFs_t^0$ are the IRFs when there is no policy.

Figure 3: The impact of the loan guarantee scheme after the COVID-19 shock

4. Results

Figure 3 presents the main results of the impact of the sovereign loan guarantee scheme. The yellow lines describe the dynamics of key variables after the COVID-19 shock in a setting without loan guarantees. When a temporary total factor productivity shock hits the economy, firms' losses increase, and so does firms' default rate. Entrepreneurs' net wealth decreases significantly because they are leveraged. Since the shock is temporary, the optimal physical capital falls by less than entrepreneurs' wealth. Firm leverage thus increases while entrepreneurs replenish their net wealth. Higher firm leverage increases the likelihood that firms default, which put banks' portfolios at a risk of higher losses. The decrease in physical capital and the higher firms' default rate erode bank capital and their capacity to provide new loans. The higher default rate for banks increases deposit funding cost for patient households, further downgrading their capital choice decisions.

The introduction of the loan guarantee scheme in this setting (blue lines), reduces banks' loan losses and banks' required capital. Since banks operate in a competitive environment, the combination of lower required capital and loan losses makes its way to firms in the form of increased lending. Firms use the additional lending to increase physical capital investments. The beneficial cumulative effect on new corporate credit until the end of 2022 is around 28 percent, over three times higher than the value estimated by Budnik *et al.* (2021) for the euro area. The result is robust to alternative magnitudes of the COVID-19 shock.

Average corporate bank default in the presence of sovereign loan guarantees is around 5.6 percent lower than without the scheme, with a cumulative impact of -1 percentage point. The sovereign loan guarantee scheme mitigates the link between firms and banks default: even if firms' leverage and default increase more in the presence of loan guarantees, bank default ends up decreasing, as the burden of guaranteed loans' losses is passed on to the sovereign. Moreover, since the elasticity of banks' capital to regulatory requirements is less than one, banks are not reducing capital in proportion to the increase in the share of guaranteed loans, preventing their default rate from rising. This feature implies that the scheme indirectly makes banks more resilient to non-guaranteed credit.

The presence of sovereign loan guarantees speeds up the recovery, as capital and credit are not falling as much as in the scenario without the scheme. This result reverses – in what we call a phasing-out effect – as the scheme approaches its end. The overall impact on the economy is positive: the average quarterly output growth is 0.08 percent higher than the average output growth without the scheme, with a cumulative effect around 3.4 percent. Comparing our results with the euro area estimates in Rancoita *et al.* (2020), we obtain similar values: a 0.73 percent cumulative impact on output in 2020 and a 1.04 percent cumulative impact on output in 2021.

The expected direct fiscal cost of the loan guarantee scheme is positive but small. Figure 4 depicts the evolution of the transfers from the sovereign to banks as a consequence of the loan guarantee scheme. These transfers are also the taxes charged on patient households as given in equation 1.

Cumulatively, the expected direct fiscal cost of the scheme amounts to 0.6 percent of 2019Q4 output (panel A), with the sovereign losing an average of 4.2 cents for each euro of guaranteed credit (panel B). The small cost is explained by the small default rate of firms. Other effects, namely, equilibrium effects have little impact on the scheme's cost. Panel C in Figure 4 illustrates this point. It shows a small difference between the guarantee fund's transfers and the transfers that would be generated in a scenario in which entrepreneurs and banks take decisions ignoring the existing of the loan guarantee scheme.

The indirect fiscal costs of sovereign loan guarantees – the additional costs borne by the deposit insurance agency after the implementation of the guarantees – are often negative. Loan guarantees reduce banks' default rate, thus reducing the compensation paid to depositors by the deposit insurance agency. From mid-2023 onward, the indirect costs are so low that the total fiscal cost of the loan guarantees scheme become negative (panel D).

4.1. Sensitivity analysis

Alternative calibrations of the sensitivity of banks' capital to regulatory requirements. Figure 5 shows results under two alternative calibrations of the

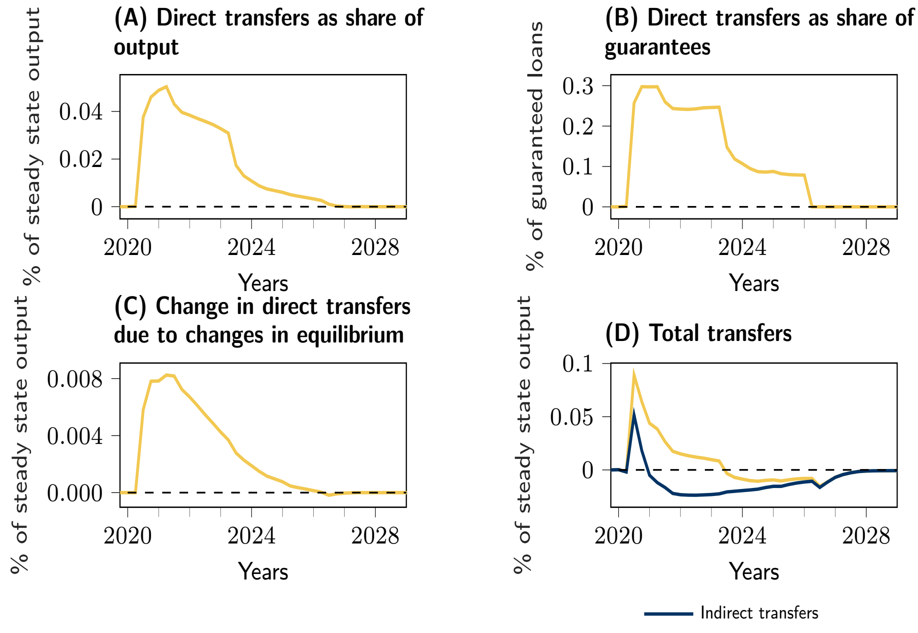
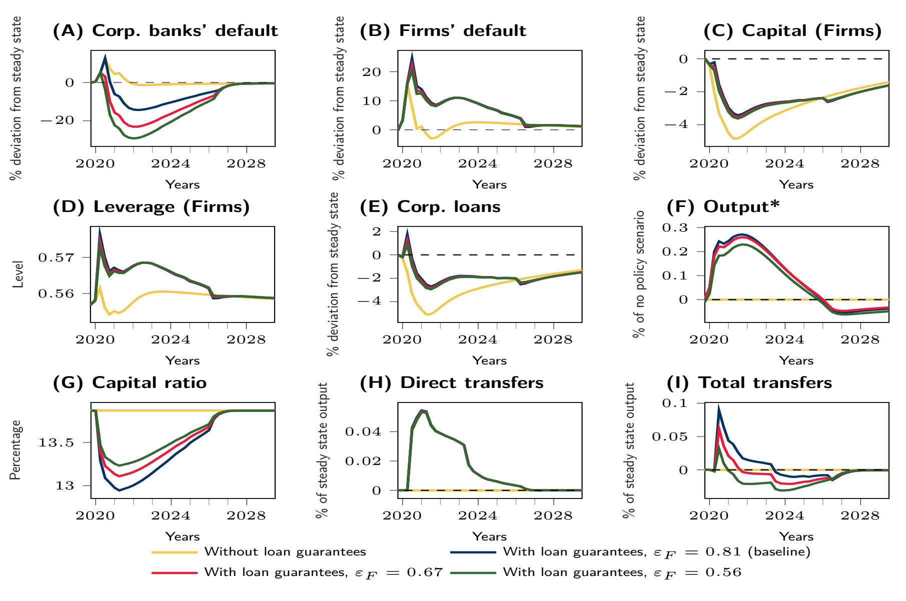


Figure 4: The costs of the sovereign loan guarantee scheme



Note: * In panel (F), the lines correspond to $(IRFs_t^1 - IRFs_t^0)/IRFs_t^0 \cdot 100$, where $IRFs_t^1$ are the IRFs after the introduction of the loan guarantee scheme, and $IRFs_t^0$ are the IRFs when there is no policy.

Figure 5: Alternative calibrations of the elasticity of banks capital to required capital

elasticity of banks' capital, ε^F, to required capital, $\bar{\phi}^F b_t^e$. The red and green lines correspond to an elasticity of 0.67 and 0.56.

A lower elasticity of banks' capital to required capital makes their capital less sensitive to the loan guarantee scheme. The drop in banks' capital following the introduction of loan guarantees is thus smaller. A smaller drop in banks' capital entails lower banks' default rates, and a small increase in credit, investment, and output. The expected fiscal cost of the scheme decreases because banks default less, thus reducing the costs of the deposit insurance agency.

Alternative specification of the COVID-19 shock. Uncertainty in firms' earnings increased with the COVID-19 pandemic outbreak. In Figure 6 we analyze a different specification of the COVID-19 shock to capture such an increase. We model the COVID-19 shock as a combination of negative productivity shocks and positive shocks to the volatility of the idiosyncratic risk in firms' earnings. To calibrate the increase in earnings' uncertainty, we use the VSTOXX index[6], a measure of the volatility of the Eurostoxx 50 equity index. We are thus assuming that the increase in the volatility of firms' earnings is equal to the increase in the volatility of equity prices.

We increase the volatility of firms' idiosyncratic risk by 2.5 times the baseline level. This increase is based on the change in the VSTOXX index between 2019Q4 and 2020Q2. The volatility shock is relatively short-lived. Its persistence is calibrated so that the the volatility of firms' idiosyncratic risk converges to its steady-state level in one year.

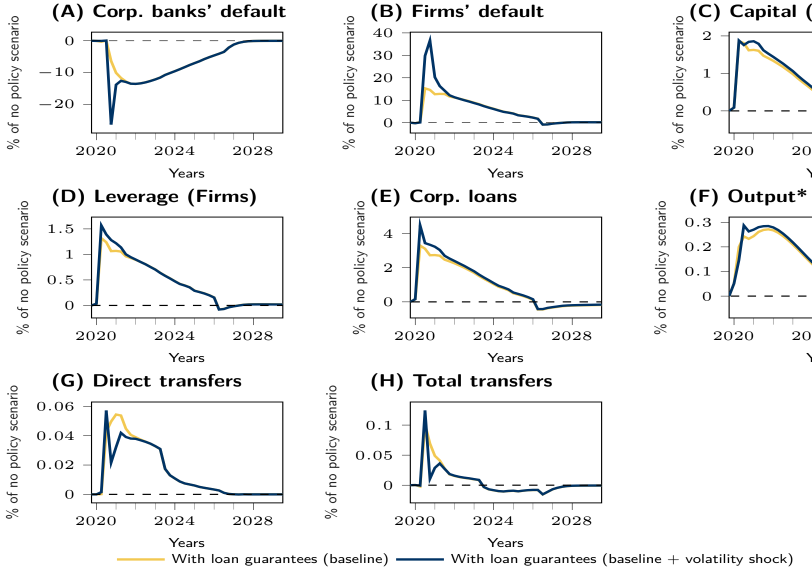
The shock to the volatility of firms' earnings affects their default rate and that of banks. The loan guarantee scheme is able to protect banks from firms' default and performs even better than in the baseline shock specification when we compare the scenarios with and without the sovereign loan guarantees. The impact of the loan guarantee scheme on corporate loans, capital investment and output is slightly higher than in the baseline specification, especially until 2022. Finally, the expected fiscal cost of loan guarantees is similar in both COVID-19 shock specifications.

Alternative calibrations of the sovereign loan guarantee fee. In Figure 7 we explore the effects of different values of the loan guarantee fee. We consider two extreme cases: a scenario where the fee is 0 (red line) and a scenario where the fee is equal to a fee f_t^* that ensures that in every period the expected direct transfers are equal to 0 (blue line).[7]

Smaller values of the fee significantly increase the expected total fiscal cost of the scheme, driven by the higher direct transfers. The fee's amount slightly affects firms' choice of leverage and capital and the quantity of corporate loans in the

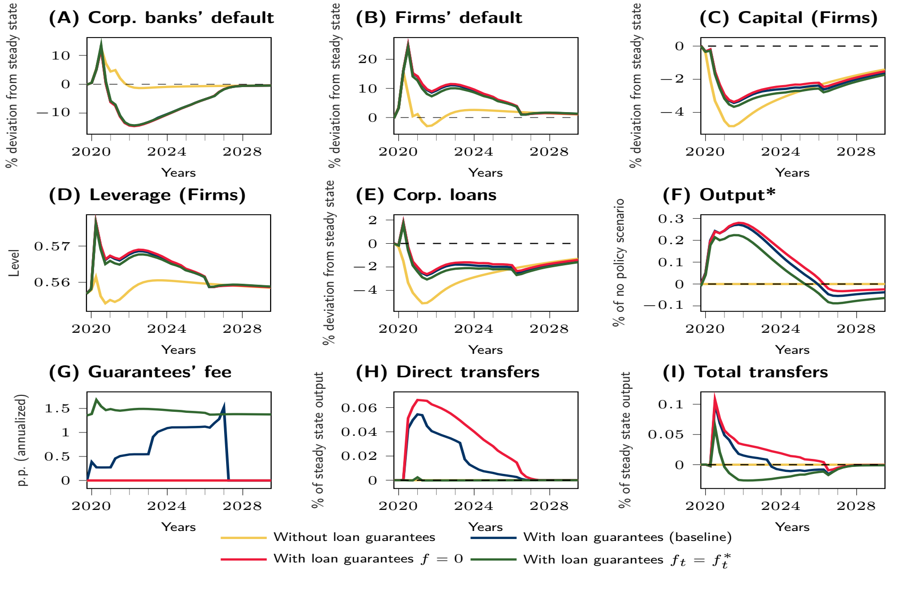
6. Source: https://www.stoxx.com/index-details?symbol=V2TX

7. In this scenario, $f_t^* = R_t^F - E_t[\tilde{R}_{t+1}^F]$ holds. We obtain it by taking the expectation of equation 1, setting the left-hand side equal to 0, and solving for f_t, assuming $g_t > 0$ and $b_t^e > 0$.



Note: * In panel (F), the lines correspond to $(IRFs_t^1 - IRFs_t^0)/IRFs_t^0 \cdot 100$, where $IRFs_t^1$ are the IRFs after the introduction of the loan guarantee scheme, and $IRFs_t^0$ are the IRFs when there is no policy.

Figure 6: The impact of an increase in firms' earnings volatility



Note: * In panel (F), the lines correspond to $(IRFs_t^1 - IRFs_t^0)/IRFs_t^0 \cdot 100$, where $IRFs_t^1$ are the IRFs after the introduction of the loan guarantee scheme, and $IRFs_t^0$ are the IRFs when there is no policy.

Figure 7: The role of the guarantee fee

economy. The small effect of the fee on firms' and banks' choices translates into a negligible impact on their default rate, and on output.

4.2. Alternative designs of the loan guarantee scheme

Alternative size. In this subsection, we explore alternative designs of the loan guarantee scheme to evaluate the effect of its size, dynamics, and timing. Figure 8 presents the results for two scheme sizes. The share of guaranteed loans, g_t, is either 50 percent lower (red line) or 50 percent higher (green line) than its value in the baseline calibration.

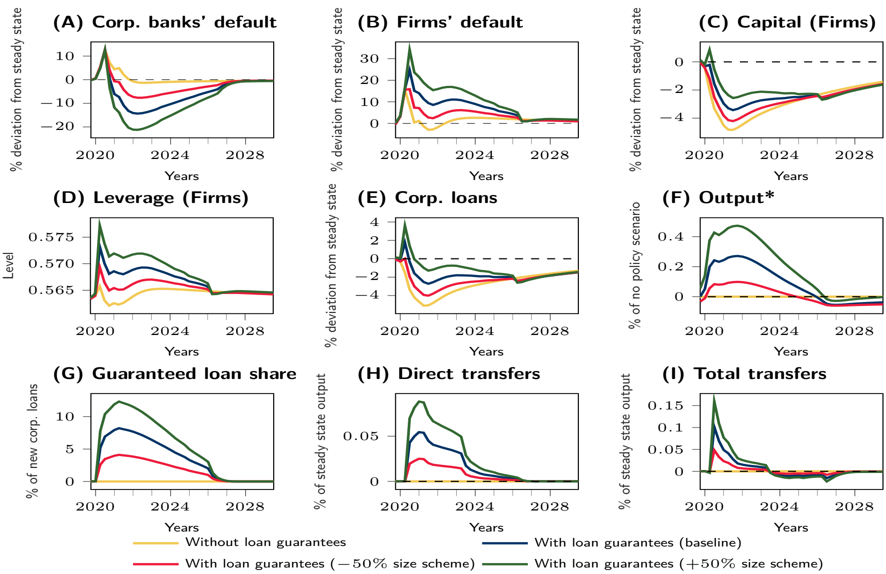
The size of the scheme significantly affects the impact of the loan guarantees. The effects on key variables are higher with a larger scheme and vice-versa. Cumulatively, a 50 percent increase in the size of the scheme decreases banks' default probabilities by 52.96 percent, increases firms' credit until the end of 2022 by 60.14 percent, and increases output by 118.95 percent. All these benefits come at the price of a 63.5 percent higher expected direct fiscal cost.

Size has a non-linear effect on financial stability and economic recovery. The impact of increasing the size of the scheme is higher when the size scheme is higher. Figures C.1 and C.2 in the Appendix C illustrate this point.

Alternative shape and length. In Figure 9 we test the effects of alternative lengths and different end-of-scheme dynamics, namely a (i) longer scheme with a linear decrease in the share of guaranteed loans, and a (ii) shorter scheme with a smoother decrease in the share of guaranteed loans over time. The analysis stems from two main policy questions. First, we want to explore whether a shorter scheme would have been as effective as our calibrated scheme and analyze the trade-offs. Second, we are interested in the changes that different end-of-scheme dynamics would entail, given that an abrupt end of the loan guarantee scheme may generate cliff-effects. Our answer to these questions is with hindsight, as we know how long the COVID-19 shock lasted.

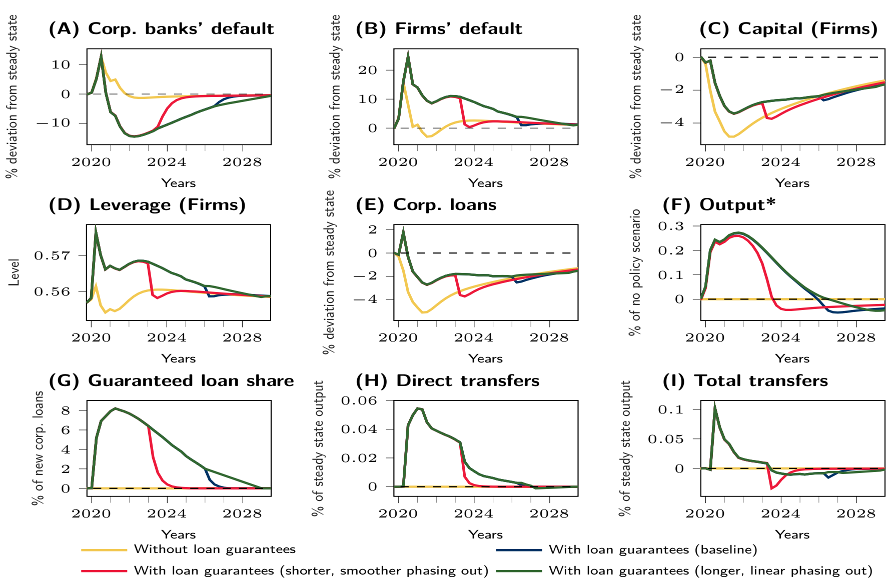
We observe that a shorter and smoother scheme (red line) – a scheme in which most of the loan guarantees have short maturity – has milder effects on banks' default rate and credit. Despite reducing expected direct costs of the scheme, a shorter length entails larger and earlier phasing-out effects for output growth. A linear increase of the scheme length (green line) extends the increase in credit over time, contributes to a greater reduction in bank default rate, and postpones the time of the phasing-out effect. Expected direct costs increase only slightly because the guarantee fee reaches its maximum levels as the end of the scheme approaches.

Alternative timing. In Figure 10 we quantify the costs of delaying the beginning of the loan guarantee scheme. A 1-quarter delay in the implementation of the scheme (red line) has minor consequences on the bank default rate but entails a lower effect on corporate loans. A 1-year delay in the implementation (blue line) fails to counteract the increase in banks' default rate observed between 2020 and



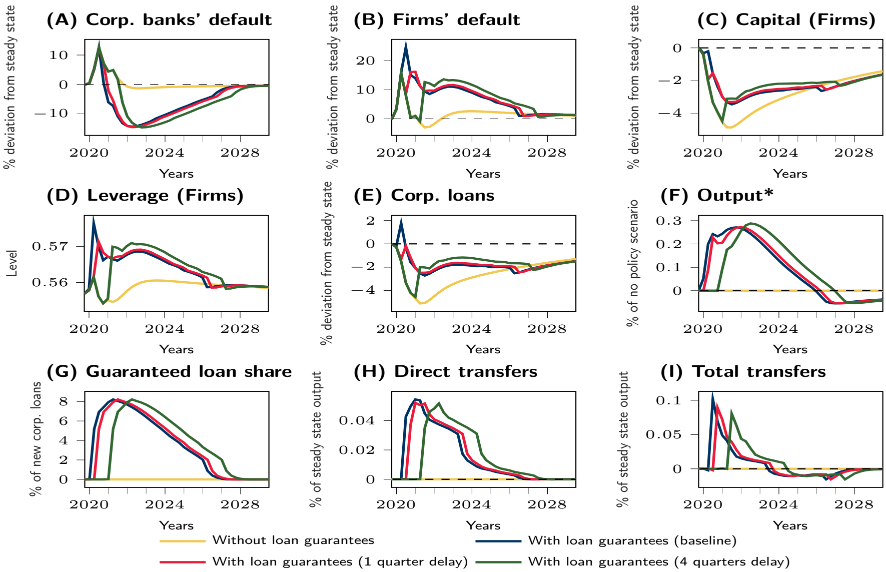
Note: * In panel (F), the lines correspond to $(IRFs_t^1 - IRFs_t^0)/IRFs_t^0 \cdot 100$, where $IRFs_t^1$ are the IRFs after the introduction of the loan guarantee scheme, and $IRFs_t^0$ are the IRFs when there is no policy.

Figure 8: Alternative sizes of the loan guarantee scheme



Note: * In panel (F), the lines correspond to $(IRFs_t^1 - IRFs_t^0)/IRFs_t^0 \cdot 100$, where $IRFs_t^1$ are the IRFs after the introduction of the loan guarantee scheme, and $IRFs_t^0$ are the IRFs when there is no policy.

Figure 9: Alternative shapes and lengths of the loan guarantee scheme



Note: * In panel (F), the lines correspond to $(IRFs_t^1 - IRFs_t^0)/IRFs_t^0 \cdot 100$, where $IRFs_t^1$ are the IRFs after the introduction of the loan guarantee scheme, and $IRFs_t^0$ are the IRFs when there is no policy.

Figure 10: Alternative timing of the loan guarantee scheme

2022, missing the period of greater instability, and it is unable to promptly stimulate credit. This lack of timeliness keeps capital investment and corporate loans' interest rates at the levels of the no-policy scenario until 2021. A delayed implementation of the scheme has a small impact on average and cumulative output growth.

5. Conclusion

In this paper, we measure the financial stability effects of the COVID-19 sovereign loan guarantee scheme and explore the impact of its size, duration, and timeliness.

The scope for improvement of our analysis is twofold. Modeling heterogeneous firms would allow us to capture the fact that the scheme is mainly designed for small and medium enterprises operating in specific sectors. Including a sovereign balance sheet would shed light on the feedback loop between firms, banks, and the sovereign.

Note finally that the low expected fiscal cost of the scheme that results from our analysis hinges on the steady-state default probability of firms. This default probability is an input parameter that reflects expectations at the time of the model's calibration, but it can suddenly increase in the face of a recession or other shocks. If firms' default probability does increase, so do the fiscal costs of the scheme.

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Appendix A: Entrepreneurs' problem and first order conditions

Entrepreneurs' problem

$$\max_{k_t, R_t^F} E_t \left[\left(1 - \Gamma^e \left(\frac{R_t^F \left(q_t^K k_t - n_t^e \right)}{R_{t+1}^K q_t^K k_t} \right) \right) R_{t+1}^K \right] q_t^K k_t +$$
$$\xi_t^e \Bigg(E_t \Bigg[\left(1 - \Gamma^F \left(\bar{\omega}_{t+1}^F \right) \right) \Bigg(\Gamma^e \left(\frac{R_t^F \left(q_t^K k_t - n_t^e \right)}{R_{t+1}^K q_t^K k_t} \right)$$
$$- \mu^e G^e \left(\frac{R_t^F \left(q_t^K k_t - n_t^e \right)}{R_{t+1}^K q_t^K k_t} \right) \Bigg) R_{t+1}^K \Bigg] q_t^K k_t \left(1 - g_t \right) - \rho_t \left(\bar{\kappa}^F + \bar{\phi}^F \left(1 - g_t \right) \right) \left(q_t^K k_t - n_t^e \right) \Bigg)$$

with

$$\begin{aligned} \bar{\omega}_{t+1}^F &= \frac{1}{\tilde{R}_{t+1}^F} \frac{R_t^D \left[1 - \left(\bar{\kappa}^F + \bar{\phi}^F \left(1 - g_t \right) \right) \right] - \left(R_t^F - f_t \right) g_t}{1 - g_t} \\ &= \frac{\frac{R_t^D \left[1 - \left(\bar{\kappa}^F + \bar{\phi}^F \left(1 - g_t \right) \right) \right] - \left(R_t^F - f_t \right) g_t}{1 - g_t}}{\left(\Gamma^e \left(\frac{R_t^F \left(q_t^K k_t - n_t^e \right)}{R_{t+1}^K q_t^K k_t} \right) - \mu^e G^e \left(\frac{R_t^F \left(q_t^K k_t - n_t^e \right)}{R_{t+1}^K q_t^K k_t} \right) \right) \frac{R_{t+1}^K q_t^K k_t}{q_t^K k_t - n_t^e}} \end{aligned}$$

First-order conditions

First-order condition with respect to interest rate:

$$E_t \left[- \Gamma'^e \left(\bar{\omega}_{t+1}^e \right) \frac{\left(q_t^K k_t - n_t^e \right)}{R_{t+1}^K q_t k_t} R_{t+1}^K \right] q_t^K k_t +$$
$$\xi_t^e E_t \Bigg[- \Gamma'^F \left(\bar{\omega}_{t+1}^F \right) \frac{1}{\tilde{R}_{t+1}^F} \frac{R_t^D \left(1 - \phi \left(1 - g_t \right) \right) - \left(R^F - f_t \right) g_t}{1 - g_t} \times$$
$$\left(- \frac{1}{\tilde{R}_{t+1}^F} \left(\Gamma'^e \left(\bar{\omega}_{t+1}^e \right) - \mu^e G'^e \left(\bar{\omega}_{t+1}^e \right) \right) \frac{\left(q_t^K k_t - n_t^e \right)}{R_{t+1}^K q_t^K k_t} \frac{R_{t+1}^K q_t^K k_t}{q_t^K k_t - n_t^e} \right) \times$$
$$\left(\Gamma^e \left(\bar{\omega}_{t+1}^e \right) - \mu^e G^e \left(\bar{\omega}_{t+1}^e \right) \right) R_{t+1}^K +$$
$$\Gamma'^F \left(\bar{\omega}_{t+1}^F \right) \frac{g_t}{1 - g_t} \frac{1}{\tilde{R}_{t+1}^F} \times \left(\Gamma^e \left(\bar{\omega}_{t+1}^e \right) - \mu^e G^e \left(\bar{\omega}_{t+1}^e \right) \right) R_{t+1}^K \Bigg] q_t^K k_t +$$
$$\xi_t^e \left(1 - g_t \right) E_t \left[\left(1 - \Gamma^F \left(\bar{\omega}_{t+1}^F \right) \right) \left(\Gamma'^e \left(\bar{\omega}_{t+1}^e \right) - \mu^e G'^e \left(\bar{\omega}_{t+1}^e \right) \right) \frac{\left(q_t^K k_t - n_t^e \right)}{R_{t+1}^K q_t^K k_t} R_{t+1}^K \right] q_t^K k_t = 0$$

which simplifies to:

$$\begin{aligned} & E_t \left[\Gamma'^e \left(\bar{\omega}_{t+1}^e \right) \right] = \xi_t^e \left(1 - g_t \right) \times \\ & E_t \left[\left(1 - G \left(\bar{\omega}_{t+1}^F \right) \right) \left(\Gamma'^e \left(\bar{\omega}_{t+1}^e \right) - \mu^e G'^e \left(\bar{\omega}_{t+1}^e \right) \right) + \left(1 - F \left(\bar{\omega}_{t+1}^F \right) \right) \frac{g_t}{1 - g_t} \right]. \end{aligned}$$

First-order condition with respect to capital:

$$E_t\left[\left(1-\Gamma^e\left(\bar{\omega}^e_{t+1}\right)\right)R^K_{t+1}\right]+$$
$$\xi^e_t\left(1-g_t\right)\left(E_t\left[\Gamma'^F\left(\bar{\omega}^F_{t+1}\right)\bar{\omega}^F_{t+1}\left(\left(\Gamma'^e\left(\bar{\omega}^e_{t+1}\right)-\mu^e G'^e\left(\bar{\omega}^e_{t+1}\right)\right)\frac{R^F_t n^e_t}{q^K_t k_t}-\frac{n^e_t}{q^K_t k_t}\tilde{R}^F_{t+1}\right)\right]\right)+$$
$$\xi^e_t\left(1-g_t\right)\left(E_t\left[\left(1-\Gamma^F\left(\bar{\omega}^F_{t+1}\right)\right)\left(\Gamma'^e\left(\bar{\omega}^e_{t+1}\right)-\mu^e G'^e\left(\bar{\omega}^e_{t+1}\right)\right)\frac{R^F_t n^e_t}{q^K_t k_t}\right]\right)+$$
$$\xi^e_t\left(1-g_t\right)\left(E_t\left[\left(1-\Gamma^F\left(\bar{\omega}^F_{t+1}\right)\right)\left(\Gamma^e\left(\bar{\omega}^e_{t+1}\right)-\mu^e G^e\left(\bar{\omega}^e_{t+1}\right)\right)R^K_{t+1}\right]\right.$$
$$\left.-\rho_t\left(\frac{\bar{\kappa}^F}{1-g_t}+\bar{\phi}^F\right)\right)=E_t\left[\Gamma'^e\left(\bar{\omega}^e_{t+1}\right)\frac{R^F_t n^e_t}{q^K_t k_t}\right]$$

which can be further simplified to:

$$E_t\left[\left(1-\Gamma^e\left(\bar{\omega}^e_{t+1}\right)\right)R^K_{t+1}\right]+$$
$$\xi^e_t\left(1-g_t\right)\left(E_t\left[\left(1-G\left(\bar{\omega}^F_{t+1}\right)\right)\left(\left(\Gamma'^e\left(\bar{\omega}^e_{t+1}\right)-\mu^e G'^e\left(\bar{\omega}^e_{t+1}\right)\right)\frac{R^F_t n^e_t}{q^K_t k_t}-\frac{n^e_t}{q^K_t k_t}\tilde{R}^F_{t+1}\right)\right]\right)+$$
$$\xi^e_t\left(1-g_t\right)\left(E_t\left[\left(1-\Gamma^F\left(\bar{\omega}^F_{t+1}\right)\right)\left[\left(\Gamma'^e\left(\bar{\omega}^e_{t+1}\right)-\mu^e G'^e\left(\bar{\omega}^e_{t+1}\right)\right)\frac{R^F_t n^e_t}{q^K_t k_t}+\right.\right.\right.$$
$$\left.\left.\left.\left(\Gamma^e\left(\bar{\omega}^e_{t+1}\right)-\mu^e G^e\left(\bar{\omega}^e_{t+1}\right)\right)R^K_{t+1}\right]\right]-\rho_t\left(\frac{\bar{\kappa}^F}{1-g_t}+\bar{\phi}^F\right)\right)=E_t\left[\Gamma'^e\left(\bar{\omega}^e_{t+1}\right)\frac{R^F_t n^e_t}{q^K_t k_t}\right].$$

Appendix B: Optimality of the sovereign loan guarantees

To obtain the condition determining the use of the sovereign loan guarantees, we differentiate the entrepreneurs' problem w.r.t. to the share of guaranteed loans, use the envelope theorem, and note that the multiplier ξ_t^e is positive:

$$\begin{aligned}
&-E_t\left[\left(1-\Gamma^F\left(\bar{\omega}_{t+1}^F\right)\right)\left(\Gamma^e\left(\bar{\omega}_{t+1}^e\right)-\mu^e G^e\left(\bar{\omega}_{t+1}^e\right)\right)R_{t+1}^K\right]q_t^K k_t+\\
&+\rho_t\bar{\phi}_F\left(q_t^K k_t-n_t^e\right)+\\
&+E_t\left[-\Gamma'^F\left(\bar{\omega}_{t+1}^F\right)\frac{R_t^D\left(1-\bar{\kappa}^F\right)-\left(R_t^F-f_t\right)}{\left(1-g_t\right)^2}\left(q_t^K k_t-n_t^e\right)\left(1-g_t\right)\right]\Bigg)>0
\end{aligned}$$

which simplifies to:

$$f_t<R_t^F-R_t^D-\bar{\kappa}^F\left(\frac{\rho_t}{E_t\left[\Gamma'^F\left(\bar{\omega}_{t+1}^F\right)\right]}-R_t^D\right)$$

by noting that the following equality holds:

$$\begin{aligned}
&E_t\left[\left(1-\Gamma^F\left(\bar{\omega}_{t+1}^F\right)\right)\left(\Gamma^e\left(\bar{\omega}_{t+1}^e\right)-\mu^e G^e\left(\bar{\omega}_{t+1}^e\right)\right)R_{t+1}^K\right]q_t^K k_t=\\
&=\rho_t\left(\frac{\bar{\kappa}^F}{\left(1-g_t\right)}+\bar{\phi}_F\right)\left(q_t^K k_t-n_t^e\right)
\end{aligned}$$

because bankers' participation constraint is binding. Figure B.1 shows that the sovereign loan guarantees are optimal in our simulation as the blue dotted line is always below the yellow line.

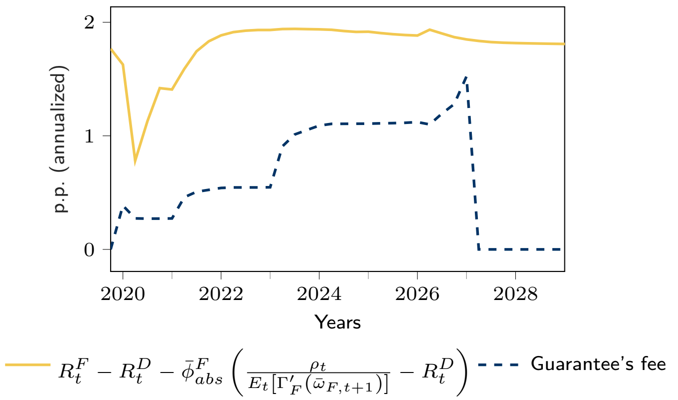
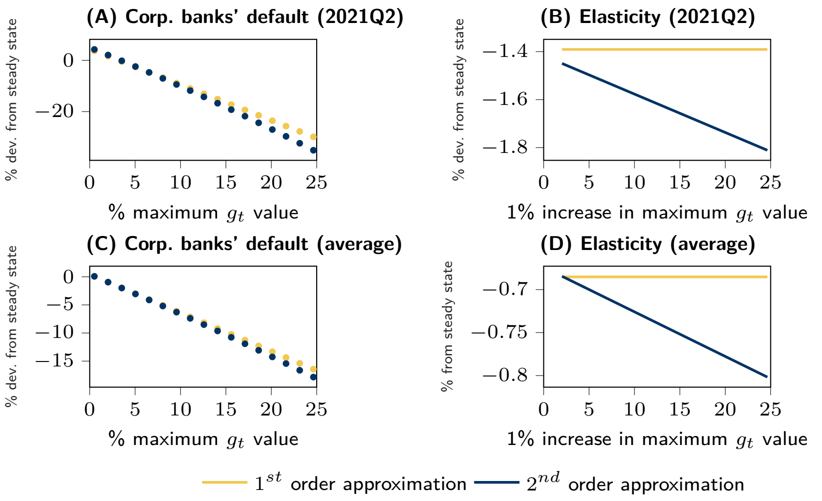


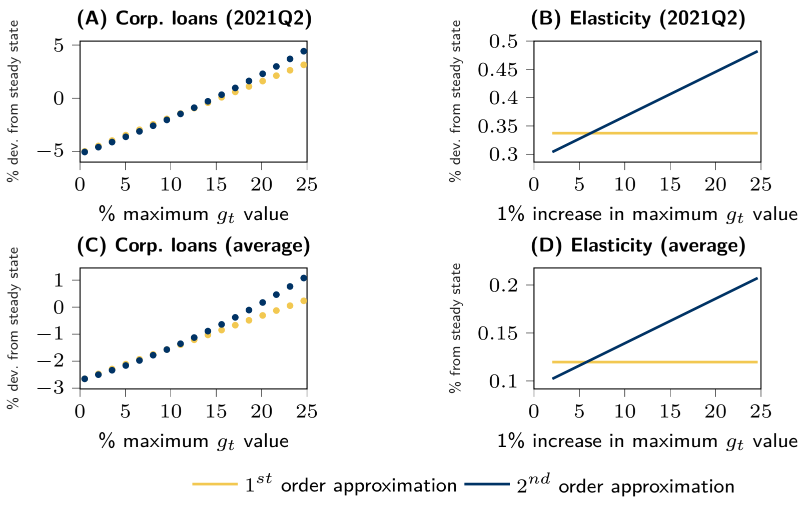
Figure B.1: Optimality of the sovereign loan guarantees

Appendix C: First and second order effects



Note: The elasticities in panel B and D are computed as $\frac{\Delta\% PD^F_{2021Q2}}{\Delta g_{2021Q2}}$ and $\frac{\Delta\% \overline{PD^F}}{\Delta g_{2021Q2}}$ respectively, where PD^F_t is corporate bank's default rate and $\overline{PD^F}$ is its mean over the sample period.

Figure C.1: Impact of the size of the loan guarantee scheme on corporate banks' default: comparison between 1^{st} and 2^{nd} order effects



Note: The elasticities in panel B and D are computed as $\frac{\Delta\% b^e_{2021Q2}}{\Delta g_{2021Q2}}$ and $\frac{\Delta\% \overline{b^e}}{\Delta g_{2021Q2}}$ respectively, where b^e_t are corporate loans and $\overline{b^e}$ is their mean over the sample period.

Figure C.2: Impact of the size of the loan guarantee scheme on corporate loans: comparison between 1^{st} and 2^{nd} order effects