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, increase credit, and speed up economic recovery. These effects are larger the lower the sensitivity of banks' capital to capital requirements. According to our simulation, the expected fiscal costs of the scheme are small and they critically depend on the loan guarantee fee. The size, duration, and timing of the scheme impact its effectiveness.

JEL: E3, E44, G01, G21, O52

Keywords: COVID-19 pandemic, sovereign loan guarantees, Financial stability.

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1. Introduction

Sovereign guarantees on firm loans 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 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 guarantees.

We find that sovereign guarantees on firm loans 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 capital requirements and the loan guarantee fee play an important role in the financial stability effects and in the costs of the policy, respectively.

Our results are explained by two key effects of sovereign 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 less bank capital. Firms use the additional credit to invest more than they would in a setting without sovereign guarantees, and output recovers faster. At the same time, firms' default rate increases because of their higher leverage. The default rate of banks, on the other hand, decreases. Banks' capital reduces by less than the expected credit losses transferred to the sovereign, thus increasing the banks' capacity to withstand losses on the loans without sovereign guarantees.

We explore alternative designs of the scheme to assess the impact of its size, duration and timeliness. Increasing the scheme's size enhances its effect on bank default, on credit, and on economic recovery but entails higher expected fiscal costs. Extending the maturity of sovereign guarantees has a marginal effect on bank default and credit. But it increases the benefits to the economy and postpones the drop in output associated with the phasing out of the scheme. Finally, delaying the implementation of the scheme past the quarter of the COVID-19 shock would lengthen the economic recovery and increase banks' default probability at the time of the shock.

To our knowledge, this work represents one of the first attempts to assess the impact on financial stability of the COVID-19 sovereign guarantees on firm loans 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 sovereign guarantees increased corporate lending. Falagiarda *et al.* (2020) also show that sovereign 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 guarantees.

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 on the 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 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

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

arising from firms' default, and can default themselves. Thus, the model can capture the role of sovereign guarantees in safeguarding banks against loan losses and in reducing loan risk-weights.

Figure 1 summarizes the key relationships between economic agents. The 3D model synthesizes an economy composed of households, entrepreneurs, and 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 insurance agency in the same period of bank default.

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 insurance agency which has the power to tax households. In our modeling of sovereign 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:

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

with b_t^e being corporate loans.

We also reduce banks' minimum capital requirements 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' capital 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 $\bar{\phi}^F$ is the fraction of risk-weighted assets that banks must hold as capital to comply with regulatory requirements. Risk-weighted assets, $(1 - g_t)b_t^e$, result from a zero percent risk-weight on the share g_t of guaranteed credit and a hundred

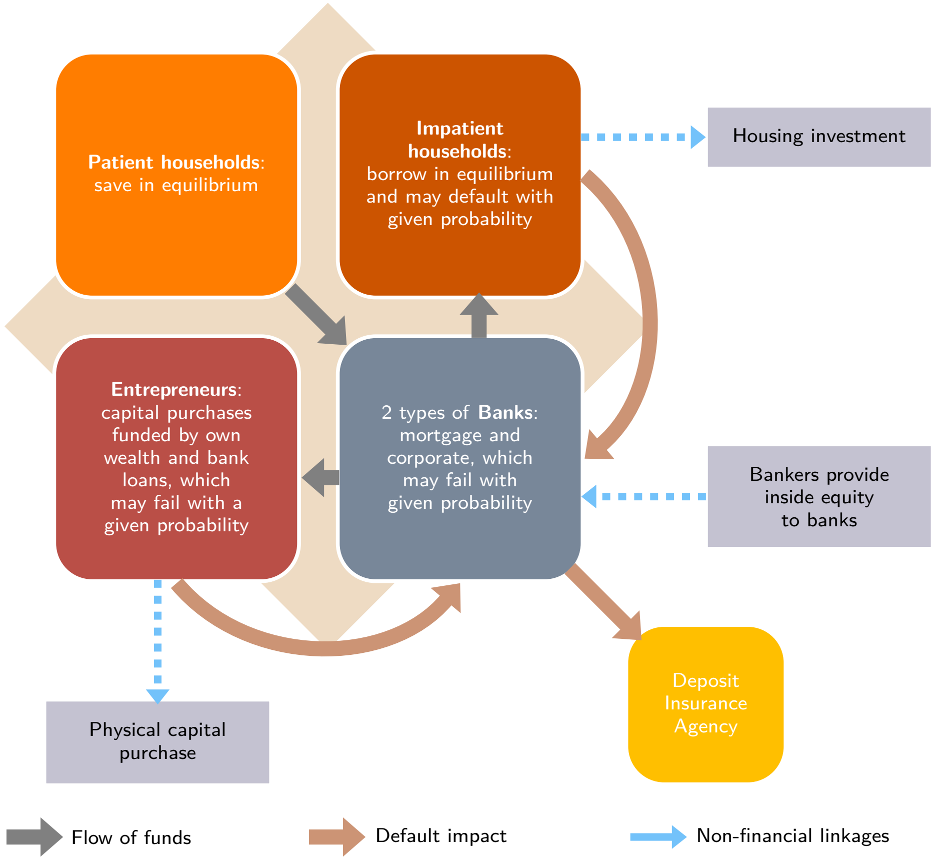


Figure 1: Main features of the 3D model

percent risk-weight on the remaining credit. Parameter $\bar{\kappa}^F$ in equation 2 controls the sensitivity of banks' capital to capital requirements. It is a generalization of the 3D model and 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 shocks to the loan returns of corporate banks, 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 being 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 the minimum capital ratio as key drivers of corporate banks' default.

The sovereign loan guarantee scheme has direct and indirect fiscal costs. Transfers T_{t+1}^G 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. Clerc *et al.* (2015) offer a similar interpretation.

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 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 which effect dominates.

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 the capital requirements constraint has relevant implications for the effects of the loan guarantee scheme.

3. Shocks, parameters and numerical approximation

We 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.

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.

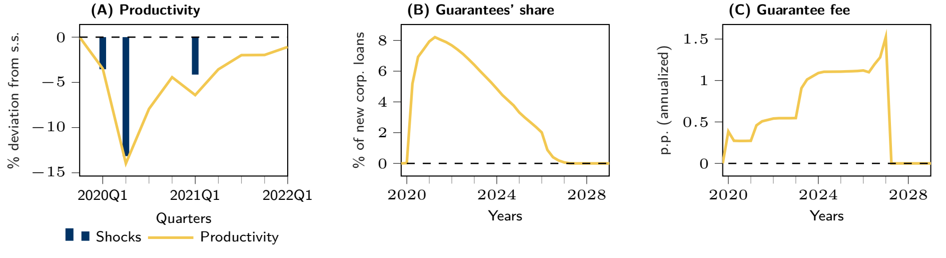


Figure 2: Exogenous paths of productivity, guaranteed loans and guarantee fee

3.2. The share of guaranteed loans

We use granular data from Banco de Portugal's Credit Register 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.

The exogenous path of the fraction g_t of guaranteed loans over time (Panel B of Figure 2) is defined as:

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

where $\text{Guaranteed amount}_t$ is the amount of credit guaranteed in quarter t and $\text{Total credit amount}_t$ is the total amount of non-defaulted credit to non-financial firms. $\text{Total credit amount}_t$ 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 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.[3] The fee' 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 average fees across loans 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.[4] 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

3. 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.

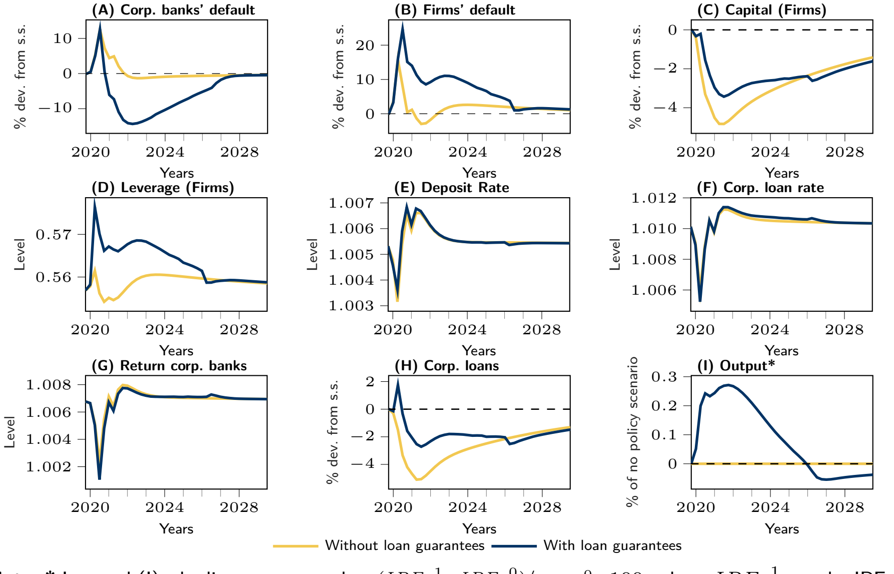
4. Source: Portuguese banks' Common Reporting (COREP) reports.

scheme. We use a second order approximation around the steady state, as non-linear effects are relevant for our analysis.

We assume that the loan guarantee scheme is a shock to agents at the time of its introduction. But, once the scheme is introduced, we assume that agents perfectly foresee the dynamics of the share of guaranteed loans.

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 the wealth of entrepreneurs. 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.



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

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 matches well with the observed increase in total credit in Portugal and is robust to alternative magnitudes of the COVID-19 shock.

The average over time of the corporate bank default rate in the presence of sovereign loan guarantees is around 5.6 percent lower than without the scheme. Cumulatively, the scheme reduces corporate banks' default probability by 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 the 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 existence 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).

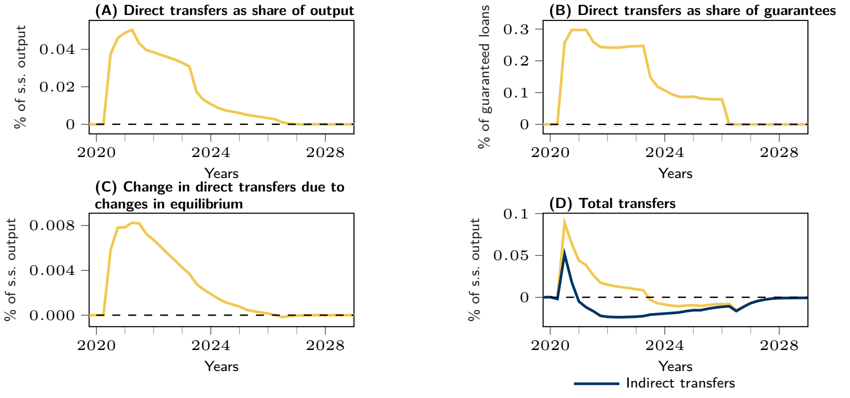


Figure 4: The costs of the sovereign loan guarantee scheme

4.1. *Sensitivity analysis*

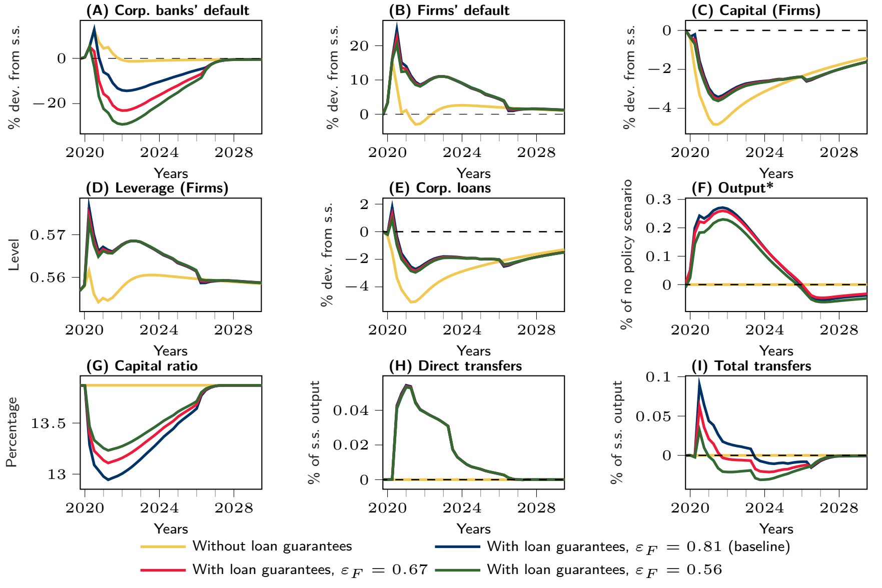
Alternative calibrations of the sensitivity of banks' capital to regulatory requirements. Figure 5 shows results under two alternative calibrations of the elasticity of banks' capital, ε^F, to required capital, $\bar{\phi}^F b_t^e$. The red and green lines correspond to an elasticity of 0.67 and 0.56.

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 firms' earnings. To calibrate the increase in earnings' uncertainty, we use the VSTOXX index, a measure of the volatility of the Eurostoxx 50 equity index.[5]

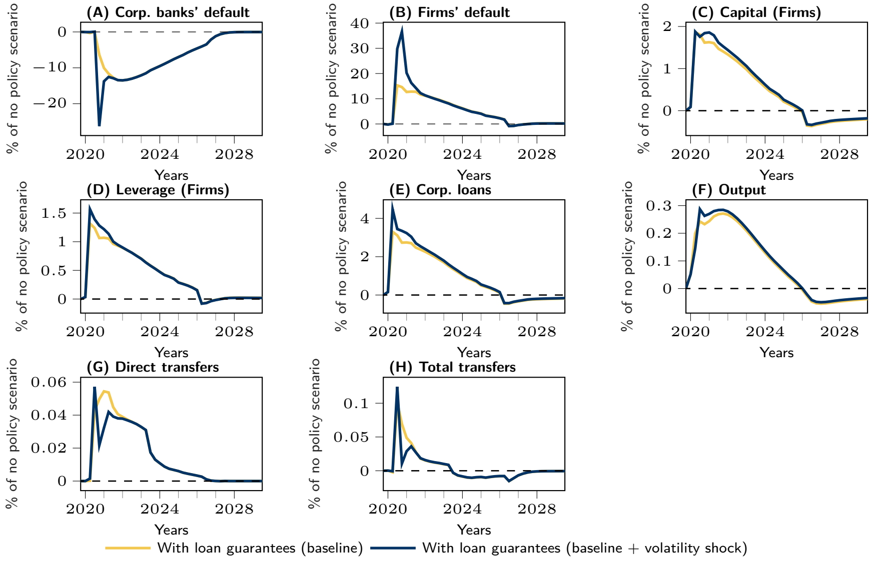
We increase the volatility of firms' idiosyncratic shocks by 2.5 times the baseline level. This increase is based on the change in the VSTOXX index between 2019Q4 and 2020Q2. The volatility shock is relatively short-lived. Its persistence is calibrated so that the the volatility of firms' idiosyncratic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

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



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

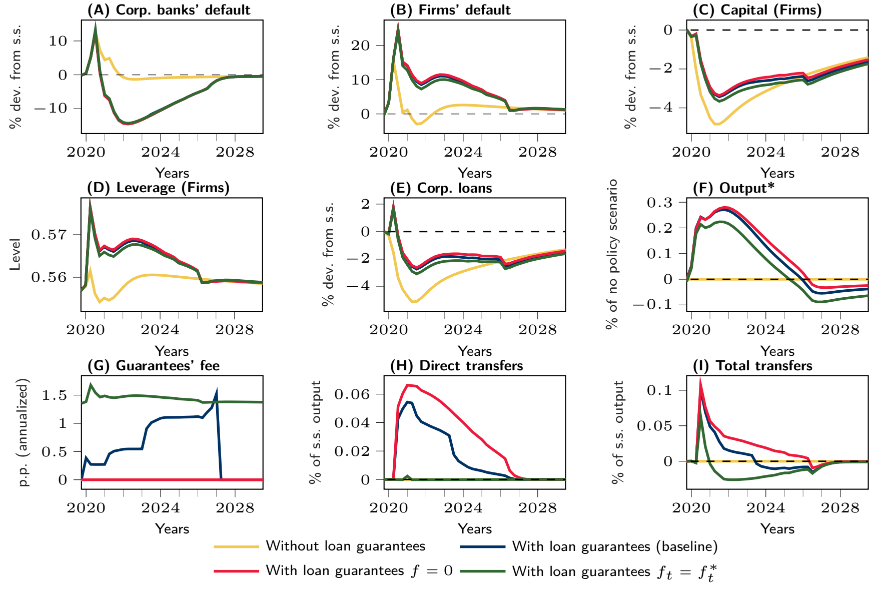


Note: * In panel (F), the lines correspond to $(IRFs_t^1 - IRFs_t^0)/IRFs_t^0 \cdot 100$, where $IRFs_t^1$ are the IRFs after the introduction of the loan guarantee scheme, and $IRFs_t^0$ are the IRFs when there is no policy.

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

The shock to the volatility of firms' earnings affects firms' and banks' default rates. 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 specifications of the COVID-19 shock.

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 value f_t^* that ensures that in every period the expected direct transfers are equal to 0 (blue line).[6]



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

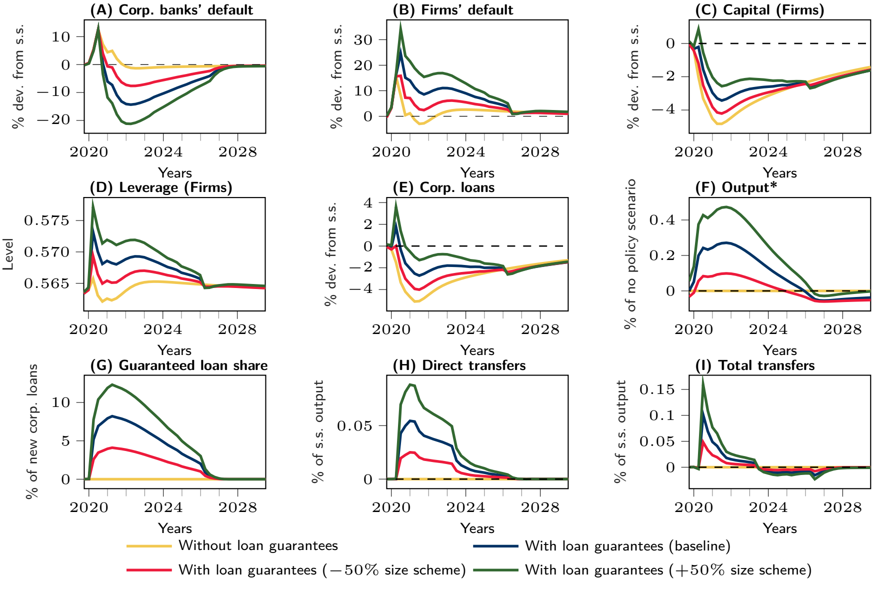
Smaller values of the fee significantly increase the expected total fiscal cost of the scheme, driven by the higher direct transfers. The fee's amount slightly affects firms' choice of leverage and capital and the quantity of corporate loans in the economy. The small effect of the fee on firms' and banks' choices translates into a

6. 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 $b_t^e > 0$.

negligible impact on their default rate, and on output. The key effect of the fee is thus on the fiscal costs of the loan guarantee scheme.

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.



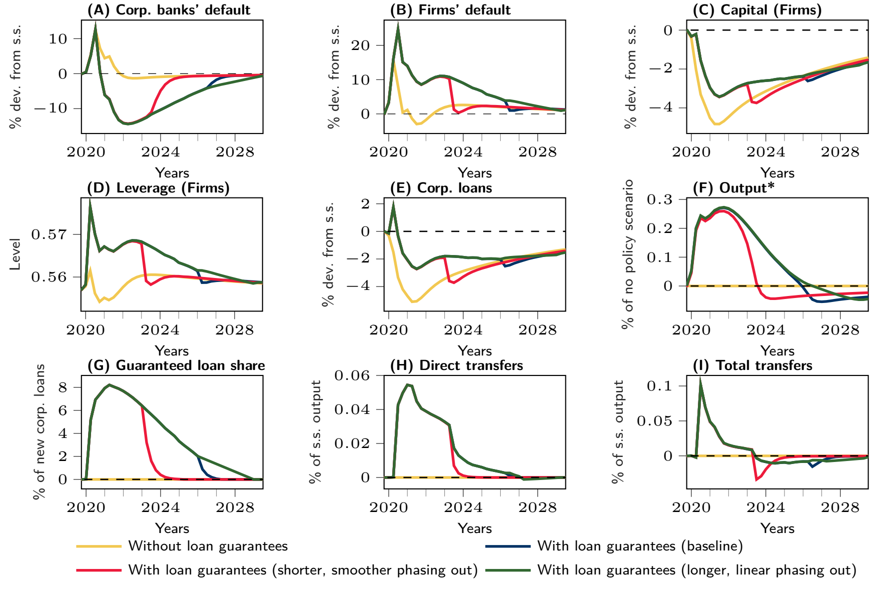
Note: * In panel (F), the lines correspond to $(IRFs_t^1 - IRFs_t^0)/IRFs_t^0 \cdot 100$, where $IRFs_t^1$ are the IRFs after the introduction of the loan guarantee scheme, and $IRFs_t^0$ are the IRFs when there is no policy.

Figure 8: Alternative sizes of the loan guarantee scheme

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.

In our setting, size has a convex effect on financial stability and economic recovery. The impact of increasing the size of the scheme is higher the larger the scheme. 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 the effectiveness of a shorter scheme and analyze the trade-offs it entails. Second, we are interested in the changes that different end-of-scheme dynamics would lead to, 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.

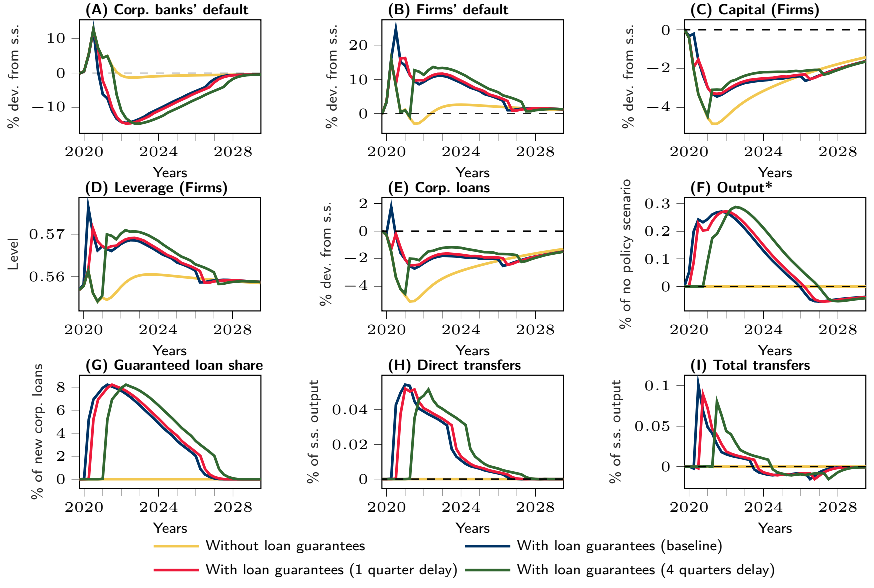


Note: * In panel (F), the lines correspond to $(IRFs_t^1 - IRFs_t^0)/IRFs_t^0 \cdot 100$, where $IRFs_t^1$ are the IRFs after the introduction of the loan guarantee scheme, and $IRFs_t^0$ are the IRFs when there is no policy.

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

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 the expected direct costs of the scheme, a shorter length entails larger and earlier phasing-out effects for output growth. A shorter scheme cumulatively reduces the beneficial effects on banks' default probabilities and output by 31 and 39 percent, respectively. The expected direct fiscal costs of the scheme decrease by 14 percent. 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 less credit to firms. A 1-year delay in the implementation (blue line) fails to counteract the increase in banks' default rate observed between 2020 and 2022 in the absence of the loan guarantee scheme. Moreover, a 1-year delayed implementation of the scheme 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.



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

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.

References

Banco de Portugal (2020). "Box 3 - A general equilibrium view on GDP projections." Economic Bulletin, June 2020.

Bodenstein, Martin, Pablo Cuba-Borda, Jay Faris, and Nils Goernemann (2021). "Forecasting During the COVID-19 Pandemic: A structural Analysis of Downside Risk." FEDS Notes 2021/056, FED, Washington: Board of Governors of the Federal Reserve System.

Budnik, Katarzyna, Ivan Dimitrov, Johannes GroSS, Martina Janoková, Max Lampe, Bianca Sorvillo, Anze Stular, and Matjaz Volk (2021). "Policies in support of lending following the coronavirus (COVID 19) pandemic." Occasional Paper Series 257, European Central Bank.

Clerc, Laurent, Alexis Derviz, Caterina Mendicino, Stephane Moyen, Kalin Nikolov, Livio Stracca, Javier Suarez, and Alexandros P. Vardoulakis (2015). "Capital Regulation in a Macroeconomic Model with Three Layers of Default." *International Journal of Central Banking*, 11(3), 9–63.

De Lorenzo Buratta, Ivan, Diana Lima, and Duarte Maia (forthcoming). "Prudential policy treatments to the COVID-19 economic crisis: an assessment of the effects." Working papers, Banco de Portugal.

Demmou, Lilas and Guido Franco (2021). "From hibernation to reallocation: Loan guarantees and their implications for post-COVID-19 productivity." OECD Economics Department Working Papers 1687, OECD Publishing.

Falagiarda, Matteo, Algirdas Prapiestis, and Elena Rancoita (2020). "Public loan guarantees and bank lending in the COVID-19 period." *Economic Bulletin Boxes*, 6.

Fornaro, Luca and Martin Wolf (2021). "Covid-19 Coronavirus and Macroeconomic Poli." CEPR Discussion Paper DP14529, CEPR.

Guerrieri, Veronica, Guido Lorenzoni, Ludwig Straub, and Iván Werning (2020). "Macroeconomic Implications of COVID-19: Can Negative Supply Shocks Cause Demand Shortages?" NBER Working Papers 26918, National Bureau of Economic Research, Inc.

Rancoita, Elena, Maciej Grodzicki, Hannah Hempell, Christoffer Kok, Julian Metzler, and Algirdas Prapiestis (2020). "Financial stability considerations arising from the interaction of coronavirus-related policy measures." Financial Stability Review, Special features A, ECB.

Appendix A: Entrepreneurs' problem and first order conditions

Entrepreneurs' problem

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

with

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

First-order conditions

First-order condition with respect to interest rate:

$$E_t\left[\Gamma^{\prime e}\left(\bar{\omega}_{t+1}^e\right)\right]=\xi_t^e\left(1-g_t\right) \times$$
$$E_t\left[\left(1-G\left(\bar{\omega}_{t+1}^F\right)\right)\left(\Gamma^{\prime e}\left(\bar{\omega}_{t+1}^e\right)-\mu^e G^{\prime e}\left(\bar{\omega}_{t+1}^e\right)\right)+\left(1-F\left(\bar{\omega}_{t+1}^F\right)\right) \frac{g_t}{1-g_t}\right].$$

First-order condition with respect to capital:

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

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.

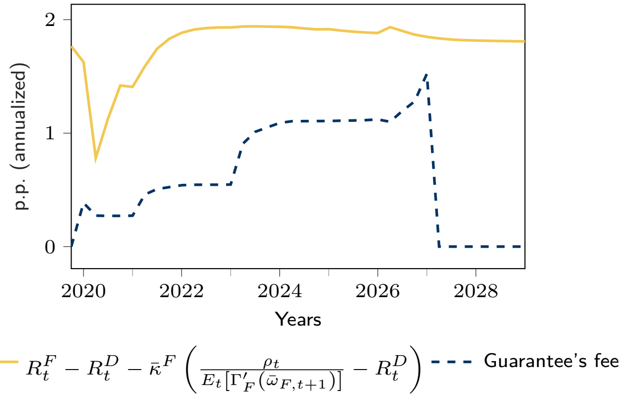
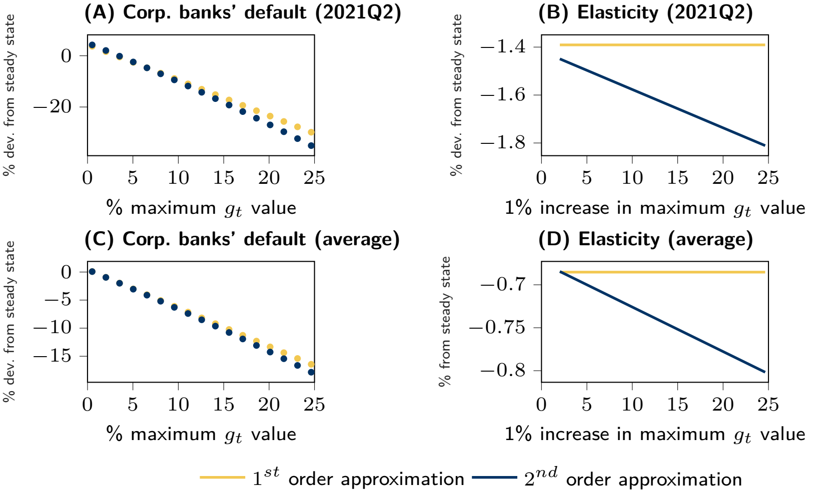


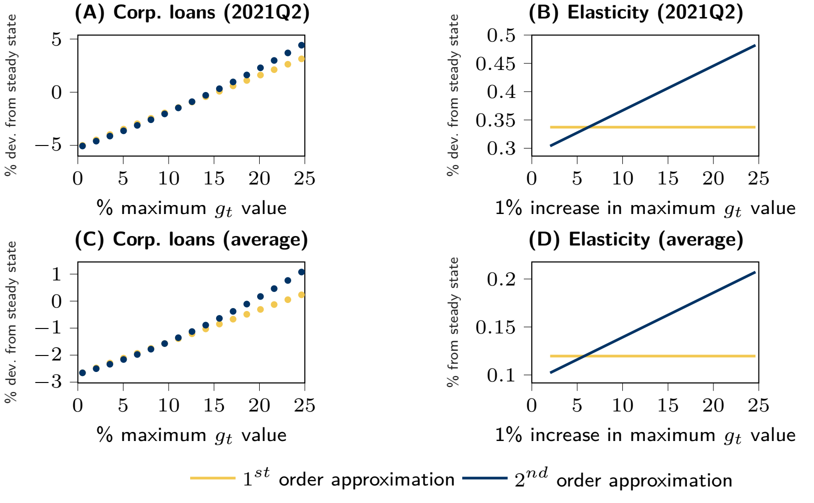
Figure B.1: Optimality of the sovereign loan guarantees

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