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Government intervention and bank markups: Lessons from the global financial crisis for the COVID-19 crisis[☆]

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ABSTRACT

The COVID-19 pandemic could result in large government interventions in the banking industry. To shed light on the possible consequences on markups, we rely on the experience of the Global Financial Crisis and exploit granular data on government interventions in more than 800 banks across 27 countries between 2007 and 2017. Using a multivariate matching method, we find no evidence of an increase in markups. Interventions—especially longer and larger ones—have no significant impact on prices but they increase costs, mostly because of higher loan impairment charges, lowering markups.

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1. Introduction

The dire economic consequences of the COVID-19 pandemic are unlikely to spare the banking industry, even though the crisis did not start as a financial shock. While banks entered the pandemic better capitalized than before the Global Financial Crisis (GFC)—in large part thanks to the reform efforts that followed—they could still experience capital shortfalls, especially once policy support measures expire. In fact, following a wave of business failures, non-performing loans are expected to increase sharply (Gourinchas et al., 2020; Banerjee et al., 2021) and a sizeable tail of banks is expected to be pushed below the minimum capital requirements (International Monetary Fund, 2020). Hence, despite post-GFC efforts to improve banks' resolvability, to make bailing-in of private stakeholders a viable option, and to limit too-big-to-

fail, government interventions in banks might still be inevitable. Some governments might resort to interventions in order to prevent system-wide distress and to contain the economic and social fallout of a crisis (Dell'Ariccia et al., 2018).

In light of this scenario, it is crucial to understand whether and how government interventions might impact the functioning of the banking industry. In particular, a first-order problem is the potential impact on markups, as changes in the banks' cost structure and pricing practices have implications for real economic activity, by affecting the cost and availability of credit (Carbò-Valverde et al., 2009; Deli et al., 2019), the responsiveness of investment to monetary policy (Drechsler et al., 2017; Wang et al., 2021), and bank profitability, with ambiguous results on financial stability (Beck, 2008). In this respect, the risk that government interventions may result in consumer welfare losses coming from higher prices and markups on bank products is a relevant concern for policymaking and financial sector regulation.

In this paper, we explore the implications of government interventions on banks' markups by studying the experience of the GFC, when many governments provided direct injections of equity debt and/or hybrid instruments to support weak financial institutions with the aim to prevent further financial and economic de-

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terioration.¹ Our analysis relies on granular data on government interventions in banks across countries for the period 2007–2017 (Igan et al., 2019). We combine this information with bank-level balance sheet and income statement data from Fitch Connect to examine the behavior of banks' markups in 27 countries, along with its associated components, around interventions. We corroborate our baseline findings using loan-level data on syndicated bank lending in the United States, which allow us to control for the effects of loan characteristics on loan pricing.

We measure markups using the Lerner index. This index is computed as the difference between the average price received on bank assets and the marginal costs of expanding such assets, expressed as a share of the price. In a static equilibrium, such quantity is equal to the inverse of the elasticity of residual demand faced by a firm. This measure is the most commonly used one in the banking literature (e.g., Carbó-Valverde et al., 2009; Beck et al., 2013; Calderon and Schaeck 2016; Delis et al., 2016). Contrary to measures of market concentration, one advantage of the Lerner index is that it does not necessitate any assumption on the definition of local markets (Nickel 1996; Aghion et al., 2005; Berger et al., 2009).² In addition, the Lerner index, by looking at the markup of prices above marginal costs, captures the main channel through which government intervention can affect bank competition (Gropp, Hakenes, and Schnabel 2011).

There are several ways in which interventions could affect banks' prices and costs, thus impacting markups. On the one hand, government interventions could increase banks' markups by reducing their marginal cost of funding. This could happen either if the cost of raising capital or borrowing from the government is lower than doing so from markets, or if government support translates into lower cost of external financing because intervened banks are perceived to be safer. A perception that intervened banks are safer or better in other ways could also allow them to be able to charge higher prices (rates) on loans, resulting in higher markups. Markups for intervened banks could also be higher if intervention leads to a perceived increased probability of future bailouts that goes hand in hand with lower market discipline, more risk-taking, and higher loan rates. On the other hand, if intervened banks use government support to compete more aggressively by cutting prices, markups could be squeezed. Intervened banks may also be subject to moral suasion by the government to extend loans and services to a broader clientele at lower prices. Similarly, but from the cost side, if as a result of government support intervened banks are able or are encouraged (due to more stringent oversight) to recognize realized or potential loan losses, banks' costs could increase and markups could drop post-intervention. Hence, the net effect of government interventions on markups is an empirical question.

A simple comparison between the dynamics of banks that received or did not receive equity or debt injections from the government would be misleading, as these interventions were non-randomly targeted to troubled financial institutions. Hence, to better identify the effects of government interventions on intervened banks' markups, our analysis relies on a multivariate matching procedure on a parsimonious set of covariates (Diamond and

Sekhon, 2013). Once we match banks on these covariates, the level and evolution of non-targeted observables in the pre-intervention period is very similar between the treated and control groups, allowing for a difference-in-difference empirical design. In this setting, we can compare the differential evolution of the Lerner index between treated and non-treated banks after government intervention.

We find that markups for intervened banks decrease following government interventions and this effect is more pronounced for larger and longer interventions. The drop is driven by a rise in costs and is not associated with an increase in prices for interest or non-interest products. The increase in costs is mainly the result of higher loan impairment charges (also referred to as provisions). At the same time, we do not observe a rise in risky lending or lending maturity. Moreover, we find no impact on market shares which, along with the evidence on the drop of markups for intervened banks, could reduce concerns that interventions hurt competition and bring about consumer welfare losses.

Our findings are robust to a number of checks and are not driven by specific countries. Loan-level data confirm that the relative decrease in the Lerner index for intervened banks is driven by an increase in costs, while loan prices remain in line with those of non-intervened banks, even controlling for loan characteristics. We also find evidence that intervened banks do not request more collateral or lend at shorter maturities. Combined, our results suggest that loan impairment charges might have risen either because capital injections allowed banks to recognize losses that they had not before or because of the more stringent oversight exercised by the government in the post-intervention period.

While there are many studies on the drivers of interventions (Bayazitova and Shivdasani, 2012; Duchin and Sosyura, 2012) and the impact of interventions on lending, risk-taking, and economic activity (Black and Hazelwood, 2013; Li, 2013; Calomiris and Khan, 2015; Berger and Roman, 2017; Berger et al., 2019; Acharya et al., 2021; Bassett et al., 2020; Berger et al., 2020; Brandao-Marques et al., 2020; Duchin and Sosyura, 2020), the empirical literature on the effects on banks' markups is relatively scant and primarily focused on the United States.³ The closest papers to ours are Berger and Roman (2015) and Calderon and Schaeck (2016), who document opposite effects of government intervention.

Analyzing the experience of banks that benefited from the Troubled Assets Relief Program (TARP), Berger and Roman (2015) find, in a bank-level difference-in-difference setup, that TARP-recipient banks increased market shares and markups (as measured by the Lerner index). These results are mostly due to the fact that TARP-recipient banks were perceived to be safer than non-TARP-recipient ones, because of additional capital and/or a positive signaling effect. In contrast, looking at a large sample of countries, Calderon and Schaeck (2016) show that government interventions are associated with a decline in the Lerner index (and in net interest margins), suggesting that claims that interventions can reduce banking competition are overstated. We contribute to this literature by conducting a bank-level analysis of how interventions affect markups and its components across a large sample of countries and exploring different types of interventions which vary in size, and duration.⁴ We also take into account the non-

¹ Other measures to support banks included guarantees and impaired asset relief but these are not considered here.

² This is not to say that that relying on the Lerner index, calculated on the basis of bank-level data, does not also entail some drawbacks. For instance, banks' markups could be different across different geographical areas according to the degree of competition faced and on local economic conditions. However, we do not have detailed data on pricing of loans (or other products) in different locations. Similarly, bank-level balance-sheet data does not allow us to estimate the cost associated to a specific line of business or product. Also, the interpretation of the Lerner requires a static equilibrium and, hence, the mapping between the Lerner index and market power may not be valid in a dynamic competition setting.

³ The theoretical literature has looked at the potential distortive effects of government intervention on bank competition, as bailouts could result in lower margins for non-intervened competitor banks (Hakenes and Schnabel 2010; Gropp, Hakenes, and Schnabel 2011).

⁴ A caveat to keep in mind in interpreting our results is that the analysis focuses on the changes in markups for intervened banks (relative to a matched sample), while it is silent on the indirect effects of government intervention on unsupported and unmatched banks. For studies on the indirect effects of bailouts on bank com-

random nature of interventions by using a multivariate matching procedure.

Is the GFC experience informative for the COVID-19 crisis? Both crises result(ed) in large economic disruption and depression of firms' sales and hit the income of—at least some—households. Absent direct support to firms and households, the rise of SME bankruptcies and credit losses would have been similar in the two crises (Carletti et al., 2021; Diez et al., 2021). Nonetheless, these two episodes are different in one important respect. The GFC originated in the financial sector as some risks, especially the ones related to subprime mortgages, were neglected, while COVID-19 was a truly exogenous shock. As the mechanism we highlight is related to the inaccuracies in recognition of credit risk and associated losses, this may cast doubt on the relevance of the findings for the current crisis. On the contrary, several elements suggest proper measurement of credit risk is even more challenging during the COVID-19 pandemic. Given the abrupt and large decline in sales, temporary difficulties in facing financial obligations may convey little information about borrowers' long-run viability. Moreover, policy support measures, such as debt moratoria, relaxation of accounting practices, and liquidity support, have avoided a rise in illiquidity-induced bankruptcies and large credit losses for the banking sector. However, this powerful shield may also have obscured some risks that could materialize down the road, as SMEs may face solvency issues. Thus, appropriate provisioning and loss recognition is as critical as ever.

Governments and central banks around the world have promptly responded to the pandemic with sizeable support measures. As of the time of writing, the bulk of these measures have avoided a large wave of defaults, by directly supporting borrowers, providing credit guarantees, relaxing buffers and, in many cases, allowing for forbearance. As long as these measures are in place, they may avoid altogether the materialization of losses on banks' lending portfolios and thus avoid the need for government intervention. However, some of these losses could likely occur as policy support is gradually lifted. We show that, in case governments need to step in to provide debt or equity to banks, there is no strong evidence—at least based on the experience from the GFC—to be excessively concerned about such interventions leading to a rise in markups for intervened banks.

The remainder of the paper is organized as follows. Section 2 describes the data used and offers some descriptive statistics on government interventions in banks. Section 3 discusses the empirical methodology, while Section 4 presents the main findings and a set of robustness exercises and extensions. Section 5 concludes.

2. Data

We use cross-country data on bank interventions collected by Igan et al. (2019) for the period 2007–2017 (Table A1). This novel, hand-collected dataset differs from other bank-level datasets constructed and used in the recent literature across three main dimensions. First, it covers a broader set of countries spanning both advanced economies and emerging markets compared to, for instance, Acharya et al. (2021), who collect data for eurozone countries, and Bassett et al. (2020), who build a comprehensive dataset of government support to banks, but only for the United States. Second, it also covers a longer time period, relative to others focusing on the few years around the GFC and the eurozone crisis (e.g., Acharya et al., 2021 cover 2007–2012 while Bassett et al., 2020 cover 2007–2010). Third, the coverage in Igan et al. (2019) focuses more narrowly on government support in the form of equity,

Table 1
Differences in pre-intervention characteristics across banks in full sample.

Dependent Variable:	Assets (1)	ROA (2)	NPL/Loans (3)	Lerner (4)
Intervention	1.599*** (0.077)	−0.156*** (0.042)	−0.214** (0.086)	−0.034*** (0.004)
Country FE	Yes	Yes	Yes	Yes
Observations	16,964	16,964	16,964	16,636
Adjusted R ²	0.513	0.092	0.516	0.056

Notes: This table presents OLS estimates at the bank level on the full sample. Intervention indicates that the bank is a recipient of a government intervention. Pre-intervention characteristics are defined as the mean over years 2004–2006. Standard errors, clustered by bank, in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

debt, hybrid securities (e.g., contingent convertible bonds) in addition to guarantees and impaired asset relief. In our analysis, we focus on equity, debt and hybrid securities. While this leaves out other forms of government support, most notably, direct liquidity support through discount windows and other dedicated facilities, Igan et al. (2019) track government stakes over time, hence providing information on whether and after what period of time these stakes were divested.⁵

We combine the data on interventions from Igan et al. (2019) with balance sheet and income statement information for banks from Fitch Connect, which we use to construct the Lerner index (Lerner, 1934) and to capture other bank characteristics used as controls in the analysis. We match banks in the two datasets by name and we are able to trace 76.4 percent of intervened banks in the Fitch Connect dataset. The matched banks—those present both in Fitch Connect and in Igan et al. (2019)—are not particularly different from the non-matched ones (those missing in Fitch Connect) in terms of assets, return on assets (ROA) and capitalization (Fig. A1), neither are they concentrated in any given country. Also, if we consider the type and size of the intervention, the non-matched cases (those in Igan et al., 2019 but not in Fitch Connect) tend to involve smaller interventions but the magnitude of the differences across matched and non-matched banks is insignificant (Fig. A2).

Our combined dataset covers 27 countries and 25,998 banks, 813 of which has experienced at least one intervention. In total, we have 1123 interventions which can be classified into equity injections (773 cases), debt support (43 cases), and hybrid securities (88 cases).

The median number of interventions across countries was 7 (the average 42). The majority of the interventions took place in the United States, Russia, and Spain. In terms of size (measured relative to GDP), the median intervention, aggregated at the country level, was 5 percent of GDP. The largest interventions occurred in Greece (45 percent of GDP) and the smallest in Lithuania (0.1 percent of GDP). The median length of interventions (defined as the time from the first intervention until the government stake was fully divested) was 3 years, with the longest intervention lasting 11 years and the shortest just 1 year.

Intervened banks in the sample are very different from non-intervened banks on the basis of pre-intervention characteristics (Table 1). Intervened banks tend to be larger (as defined by the log of total assets), less profitable (according to the ratio of returns or net income to assets, ROA), hold more loans as a percentage of bank assets, and have smaller markups (as measured by the Lerner index). These significant differences across banks indicate that a simple difference-in-difference strategy to examine the behavior of banks' markups for intervened banks post-intervention is not ap-

petition, see Hakenes and Schnabel (2010), Gropp, Hakenes, and Schnabel (2011), and Koetter and Noth (2016).

⁵ Bassett et al., (2020) also has information on these patterns as they focus on outstanding amounts, while Acharya et al., (2021) focus on initial interventions.

propriate. We address this problem using a multivariate matching algorithm (Diamond and Sekhon, 2013), which we describe in the Section 3.2.

3. Empirical methodology

3.1. Measuring markups

The first step in our empirical approach requires computing markups for each bank in the sample for the period 2007–2017. We rely on the Lerner index, defined as:

$$\text{Lerner} = \frac{p - mc}{p} = 1 - \frac{mc}{p} \quad (1)$$

where p is the ratio of total income to quantity $Q_{b,t}$ (assets) and marginal costs (mc) are:

$$mc_{b,t} = \frac{\partial C_{b,t}}{\partial Q_{b,t}} = \varepsilon_{b,t} \frac{C_{b,t}}{Q_{b,t}} \quad (2)$$

with $\varepsilon_{b,t}$ indicating the elasticity of costs $C_{b,t}$ to quantity.⁶ This elasticity is estimated from a trans-log cost function:

$$\log C_{b,t} = \alpha \log Q_{b,t} + \frac{\delta}{2} \log Q_{b,t}^2 + \sum_{j=1}^J \beta_j w_{j,b,t} \log Q_{b,t} + \sum_{j=1}^J \sigma_j w_j + \sum_{j=1}^J \sum_{k=1}^J \sigma_{jk} w_{j,b,t} w_{k,b,t} + \gamma X_{b,t} + \mu_b + \pi_t + \varepsilon_{b,t} \quad (3)$$

where the w_j is a set of bank-specific input prices for funds, labor, fixed capital and risk (in logs); $X_{b,t}$ is a set of bank-level time-varying controls to account for banks' capitalization (equity over assets), business model (loans to assets) and loan quality (non-performing loans, NPLs, over gross loans); and μ_b and π_t are bank and year fixed effects. The vector of input prices includes, as standard in the literature (e.g., Berger et al., 2009; Beck et al., 2013; Love and Martínez Pería 2015): total interest expenses over deposits as the price of borrowed funds, personnel expenses over assets as the price of labor, and other operating expenses over assets as the price of fixed assets. As pointed out by Berger et al. (2009), the traditional Lerner index does not capture risk premia in the prices of banks' products and services, breaking down its positive association with the size of monopoly rents. Thus, to take into account the price of credit risk (Al-Azzam et al., 2019; Gunes et al., 2016), we also include in the vector w_j loan impairment charges or provisions (as a share of total assets).⁷ The model is estimated by OLS separately for each country and the estimated (country-specific) parameters are used to calculate the elasticity as:

$$\varepsilon_{b,t} = \alpha + \delta \log Q_{b,t} + \sum_{j=1}^J \beta_j w_{j,b,t} \quad (4)$$

which then allows to calculate the Lerner index as:

$$\text{Lerner}_{b,t} = 1 - \frac{mc}{p} = 1 - \varepsilon_{b,t} \frac{C_{b,t}}{\text{Income}_{b,t}} \quad (5)$$

The average Lerner index in our sample is equal to 0.236 and shows a relatively stable pattern over time. There is a certain degree of variation both between countries (with the Lerner ranging from 0.027 for Austria to 0.452 for Finland) and within country

⁶ Quantity Q is total assets. Total costs C are the sum of total interest expenses and total operating expenses (which, in turn, include total non-interest expenses, loan impairment charge, and equity-accounted profit/loss - operating). Price p is the ratio of total income (which is the sum of gross interest and dividend income plus total non-interest operating income) over Q . Note that while c and q are the logs of costs and quantities, C and Q are the actual values.

⁷ Imposing additional structure to the cost function, for instance homogeneity of degree one in input prices, does not significantly affect the results.

Table 2

Differences in pre-intervention characteristics across banks in matched sample.

Dependent Variable:	Assets (1)	ROA (2)	NPL/Loans (3)	Lerner (4)
Intervention	0.462 (0.316)	0.025 (0.052)	−0.095 (0.111)	−0.002 (0.004)
Country FE	Yes	Yes	Yes	Yes
Observations	2253	2253	2253	2253
Adjusted R ²	0.770	0.035	0.185	0.078

Notes: This table presents OLS estimates at the bank level on the matched sample as explained in Section 3. Intervention indicates that the bank is a recipient of a government intervention. Pre-intervention characteristics are defined as the mean over the 4 pre-intervention periods. Country fixed effects are included. Standard errors, clustered by bank, in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 3

Summary statistics for matched sample.

	N	# of Banks	25th	Median	75th
Lerner	18,024	2253	0.0094	0.1089	0.1900
Net Loans	18,024	2253	125.0	498.0	1992.7
Total Assets	18,024	2253	178.9	721.5	2899.8
Deposits	18,024	2253	144.3	556.2	2026.2
Net Interest Margin	18,024	2253	3.10	3.65	4.20
Loan Impairment	18,024	2253	0.1212	0.2989	0.7103
Charges / Assets					
ROE	18,024	2253	1.680	6.460	10.981
ROA	18,024	2253	0.1257	0.5558	0.9521
Revenue / Assets	18,024	2253	0.0508	0.0590	0.0678
Marginal Cost	18,024	2253	0.0448	0.0541	0.0638

Notes: This table presents summary statistics for variables measured at the bank-year level for the matched sample.

over time (in the United States, for instance, the average Lerner is 0.236 with a standard deviation of 0.112).

3.2. Matching

Because intervened banks are different than non-intervened banks pre-intervention, we follow Diamond and Sekhon (2013) and construct a control group using a multivariate matching algorithm based on the pre-intervention values of the Lerner index, bank assets, total costs, revenues, and NPLs (additional variables are added in a set of robustness exercises, see Section 4.2).⁸ The algorithm implements a Mahalanobis Distance matching procedure to maximize covariate balance, meaning that the treatment and control groups have a similar joint distribution of observed covariates. We include country fixed effects in the matching algorithm. The Kolmogorov-Smirnov and the paired t-tests indicate a successful matching, given that the p-values are larger than 0.10 across all matched variables.

After the matching, the sample of treated banks and the control group do not show any statistical difference along observables in the pre-intervention period (Table 2). Moreover, there are no differential pre-trends between the groups, as illustrated by Figs. 1–3. Our results are also robust to changes in the number of matches or to variations in the variables used for matching (see Section 4.3). Table 3 presents summary statistics for the matched sample.

3.3. Empirical specifications

To examine the impact of government interventions on the bank-level outcomes of interest—the Lerner index in particular—we

⁸ Table A2 illustrates that the distributions of these variables have common support across the intervened and non-intervened banks.

(a) Lerner index

(b) Price

(c) Marginal cost

Fig. 1. Lerner index, marginal costs, and prices.

adopt an event-study design:

$$y_{b,t,c} = \alpha_c + \tau_t + \sum_{j=-4}^3 \beta_j * Intervention_b * 1\{t = T + j\} + \varepsilon_{b,t,c} \quad (6)$$

where $y_{b,t,c}$ is an outcome for bank b in year t in country c , $Intervention_b$ is a dummy variable indicating whether bank b re-

ceived a direct government intervention, T is the year of such intervention (if any), and j , is the time with respect to the intervention. α_c , τ_t are country and time fixed effects, respectively.⁹ Eq. (6) is estimated with a balanced panel considering four pre- and four post-intervention periods (including the year of the intervention) in the baseline and the set of β coefficients trace the difference in the evolution of the outcome variable between the intervened banks and similar (matched) banks around the time of the intervention.

For ease of exposition, we also estimate a simple difference-in-difference specification:

$$y_{b,t,c} = \alpha_c + \tau_t + \beta * Intervention_b * 1\{t > T\} + \varepsilon_{b,t,c} \quad (7)$$

in which the coefficient β summarizes the differential evolution of the outcome variable between intervened and non-intervened banks four years after the government intervention (we confirm robustness to different post-intervention time windows in Section 4.2). In both approaches, we cluster the standard errors at the bank level, to allow for within-cluster correlation between government intervention and the error term.

The empirical analysis is designed to correctly assess the impact of interventions under the assumption that—after the matching procedure—there is no unobservable characteristic impacting the change in markups post-intervention for treated banks with respect to the untreated ones. This assumption could be violated if, for instance, governments knew which banks were going to increase or decrease their markups and decided to target banks along this dimension (e.g., to avoid losses of consumers' welfare or, conversely, to support bank profitability). However, the fact that there are no different pre-trends between control and treated groups (see Section 4) mitigates such a concern.

3.4. The dynamics of the lerner index, marginal costs, and prices

Fig. 1 plots the averages, across both treated and control group, of the Lerner index, marginal costs, and prices. There are no detectable pre-trends as the evolution of the three variables is the same for both groups. However, the intervened banks experience a larger decrease in the Lerner index and an increase in marginal costs—with respect to the non-intervened ones—during the year of the intervention. Marginal costs and the Lerner index follow the same pattern post-intervention, and the differences between the two groups remain approximately constant (panels A and C). Prices, instead, are indistinguishable between the two groups at any point in time (panel B).

4. Results

4.1. Main results

The main result of the paper is illustrated by Fig. 2, which plots the difference in the Lerner index between intervened banks and the matched (non-intervened) ones over an 8-year window around the intervention. The estimates indicate a 0.02 reduction in the Lerner index in the year of the government intervention, confirming the patterns of Fig. 1. This drop is statistically significant and persists in the three years post-intervention. The drop is sizeable in magnitude; it is equal to about 20 percent of the median Lerner index in the matched sample. By contrast, there is no difference in the Lerner between the treated and matched control groups in the pre-intervention period (i.e., the difference is precisely estimated and close to zero).

⁹ We also conduct regressions with bank fixed effects as detailed below in Section IV.B.

Fig. 2. Impact of banking intervention on Lerner index.

Notes: This figure plots the coefficients β_r and standard errors from the event study specification in Section 3 (Eq. (6)) with the Lerner index as $y_{b,t,c}$. Country fixed effects are included.

Table 4
Difference-in-differences effect of interventions on Lerner index.

Dependent Variable:	Lerner (1)	Price (2)	MC (3)
Intervention x Post	-0.020*** (0.003)	0.000 (0.001)	0.004*** (0.001)
Country FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Window	4	4	4
# of Matches	2	2	2
# of Treatment Obs.	730	730	730
Adjusted R ²	0.215	0.559	0.420

Notes: This table presents OLS estimates of Eq. (7) at the bank-year level on the matched sample as explained in Section 3. Intervention indicates that the bank is a recipient of a government intervention. Post indicates the year is after the bank intervention. Lerner, Price and Marginal Cost (MC) are constructed as in Section 3.1. Country and time fixed effects are included. Standard errors, clustered by bank, in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

The reduction in the Lerner index is entirely driven by an increase in the marginal cost of assets, which is not matched by an equivalent increase in prices (see Table 4, columns 2 and 3). In fact, prices are not affected at all by government interventions, which indicates that the cost increase is fully absorbed by intervened banks and not passed on to the borrowers or other clients. This suggests that intervened banks experience a decrease in their ability to price over marginal costs.

To dig deeper into the mechanisms behind the change in markups, we further decompose total costs into the main components: interest expenses and total operating costs. The latter is further decomposed into wages, other operating expenses, and loan

impairment charges.¹⁰ As shown in Table 5, we find that the rise in costs is not driven by a higher cost of funding (column 2) nor by higher wages (column 3), but mostly by loan impairment charges (column 5), which drive the evolution of total operating expenses (column 6). The dynamic response of these last two variables post-intervention is similar, with a sharp increase in the year of intervention, a further acceleration the year after and then a gradual decline (although operating expenses and loan impairment charges are still significantly higher than pre-intervention even after three years, see Fig. 3). Similarly, we split the effect of prices between interest and non-interest revenues and we find that the lack of a significant effect on prices is confirmed in the two components (Table 6).

Given the key role of loan impairment charges in driving the variation in markups after government intervention, we test whether this is associated with an expansion of the loan portfolio of intervened banks (Table 7). We find that this is not the case, looking either at net loans or loans over assets (columns 2–3). By contrast, higher impairment charges seem to go hand in hand with an increase in NPLs (column 1). Since, as mentioned earlier, we observe no increase in prices, we rule out the possibility that the change in loan impairment charges resulted from an increase or shift towards riskier loans.

Our evidence shows that the intervened banks increase costs following intervention (relative to matched banks) while changing prices in a similar way—causing a compression of their margins. Thus, we do not find evidence pointing towards government interventions leading to an increase in markups. At the same time, we detect no impact on market shares of the intervened banks, as illustrated by Fig. 4.

¹⁰ More precisely, total operating expenses is the sum of personnel and other operating expenses (which correspond to non-interest expenses), plus loan impairment charges and equity-accounted profit/loss.

(a) Total Operating Expenses

(b) Loan Impairment Charges

Fig. 3. Impact of banking intervention on costs.

Notes: This figure plots the coefficients β_r and standard errors from the event study specification in Section 3 (Eq. (6)) with total operating expenses over assets as $y_{b,t,c}$ in Figure (a) and loan impairment charges over assets as $y_{b,t,c}$ in Figure (b). Total operating expenses is the sum of personnel and other operating expenses (which correspond to non-interest expenses), plus loan impairment charges and equity-accounted profit/loss. Country fixed effects are included.

Table 5
Difference-in-differences effect of interventions on components of cost.

Dependent Variable:	MC (1)	Interest (2)	Personnel (3)	Other Operating (4)	Loan Impairment (5)	Total Operating (6)
Intervention x Post	0.002*** (0.001)	0.000 (0.001)	−0.013 (0.013)	0.0005* (0.0003)	0.214*** (0.028)	0.003*** (0.001)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Window	4	4	4	4	4	4
# of Matches	2	2	2	2	2	2
# of Treatment Obs.	730	730	730	730	730	730
Adjusted R ²	0.420	0.658	0.420	0.471	0.235	0.412

Notes: This table presents OLS estimates of Eq. (7) at the bank-year level on the matched sample as explained in Section 3. Intervention indicates that the bank is a recipient of a government intervention. Post indicates the year is after the bank intervention. Marginal Cost (MC) is constructed as in Section 3.1. All components of cost in Columns 3–6 are divided by total assets. Total operating expenses is the sum of personnel and other operating expenses (which correspond to non-interest expenses), plus loan impairment charges and equity-accounted profit/loss. Country and time fixed effects are included. Standard errors, clustered by bank, in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Fig. 4. Impact of banking intervention on market share.

Notes: This figure plots the coefficients β_r and standard errors from the event study specification in Section 3 (Eq. (6)) with country market share as $y_{b,t,c}$. Country fixed effects are included.

4.2. Robustness

We substantiate our results running a set of checks aimed at testing their robustness to changes in the timing, the methodology, and the sample used in our analysis.

First, we address two concerns related to the length of the post-intervention window. As arguably the 4-year period post-intervention could still include the fallout of the GFC for many banks in the sample, we start by varying the event window and consider between 1 and 6 years around the intervention to show that the drop in the Lerner index persists over a longer time horizon (up to 6 years), although the point estimate becomes somewhat smaller with time (Table A3).¹¹ A related concern is

that, because of weaknesses in regulatory, supervisory, and accounting frameworks, under-provisioning was a common feature for all banks, but government interventions induced some banks to recognize it earlier. If this were the case, we should see that the drop in markups gradually vanishes over time, as banks adjust to the post-GFC regulatory reforms. However, the persistent drop in markups for at least 6 years post intervention shown in Table A3 suggests that our findings cannot be entirely driven by differences in the timing of recognition of under-provisioning between intervened and non-intervened banks.

Second, we use between 1 and 4 matches for each intervened bank to construct the control group, and substitute country fixed effects with bank fixed effects, to better control for unobserved bank-specific characteristics which may explain differences in the dynamics of the Lerner index. Results are shown in Appendix (Tables A4–A5) and confirm our baseline estimates, as the point es-

¹¹ Expanding the post-intervention horizon reduces the sample size and, beyond six years, the coefficient on the interaction term *Intervention x Post* is no more statistically significant, although the point estimate remains negative and stable.

Table 6
Difference-in-differences effect of interventions on components of price.

Dependent Variable:	Price (1)	Interest (2)	Non-Interest (3)
Intervention x Post	0.000 (0.001)	0.001 (0.003)	0.000 (0.002)
Country FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Window	4	4	4
# of Matches	2	2	2
# of Treatment Obs.	730	730	730
Adjusted R ²	0.559	0.512	0.498

Notes: This table presents OLS estimates of Eq. (7) at the bank-year level on the matched sample as explained in Section 3. Intervention indicates that the bank is a recipient of a government intervention. Post indicates the year is after the bank intervention. Price is constructed as in Section 3.1. Interest is defined as total interest revenue over loans, and non-interest is defined as total non-interest revenue over assets. Country and time fixed effects are included. Standard errors, clustered by bank, in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 7
Difference-in-differences effect of interventions on lending.

Dependent Variable:	NPL / Loans (1)	Net Loans (2)	Loans / Assets (3)
Intervention x Post	0.441*** (0.112)	0.080 (0.066)	0.005 (0.007)
Country FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Window	4	4	4
# of Matches	2	2	2
# of Treatment Obs.	730	730	730
Adjusted R ²	0.339	0.540	0.128

Notes: This table presents OLS estimates of Eq. (7) at the bank-year level on the matched sample as explained in Section 3. Intervention indicates that the bank is a recipient of a government intervention. Post indicates the year is after the bank intervention. Net loans is measured in logarithms, while Loans/Assets is the ratio between gross loans and total assets. Country and time fixed effects are included. Standard errors, clustered by bank, in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

timates remain very close to that of the baseline and significant at 1 percent.

We then consider differences in the matching procedure. First, we show that the decline in the Lerner index is similar when using the propensity score matching rather than nearest neighborhood matching (Table A6, columns 1 and 2). Second, as our baseline matching algorithm may not fully account for differences across bank characteristics, we expand the set of variables included in the matching. We start considering market share, capitalization, and provisioning (as measured by provisions over loans). As reported in Table A6, we find that the point estimate of the coefficient of the interaction between the intervention and the post dummies remain significant and stable (column 3). Then, we also include in the set of matching variables four indicators which control for difference in business models across banks: loans over assets, corporate and commercial loans over total loans, the ratio between non-interest and interest income, and the ratio of wholesale funding over total liabilities. Results are virtually unchanged when all of these variables are included (column 4), indicating that the results are not driven by differences in banks' business model or other bank characteristics.¹²

¹² From a methodological standpoint, a potential concern is that the estimates of equation (7) may suffer from a form of "generated regressor" problem (Pagan 1984)—and the relative standard error estimates may be invalid—as the main variable of interest, the Lerner index, is estimated in a first stage (which also uses some of the covariates entering the main equation). As it is common in the literature (e.g. Ashraf and Galor 2013), we perform a bootstrapping procedure by re-estimating both the first stage (Lerner Index) and second stage (equation (7)) with

Table 8
Estimations weighting each country equally.

Dependent Variable:	Lerner (1)	MC (2)	Price (3)	Loan Impairment (4)
Intervention x Post	−0.020*** (0.001)	0.003*** (0.0002)	−0.0002 (0.0002)	0.243*** (0.009)
Country FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Window	4	4	4	4
# of Matches	2	2	2	2
# of Treatment Obs.	730	730	730	730
Adjusted R ²	0.209	0.431	0.573	0.233

Notes: This table presents OLS estimates of Eq. (7) at the bank-year level on the matched sample as explained in Section 3. Intervention indicates that the bank is a recipient of a government intervention. Post indicates the year is after the bank intervention. Lerner, Price and Marginal Cost (MC) is constructed as in Section 3.1. Country and time fixed effects are included. Each observation is weighted by the inverse of the number of country banks in the matched sample. Standard errors, clustered by bank, in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

A potential concern with the empirical specification is that government intervention could be correlated with demand shocks. We therefore augment Eq. (7) with country x year fixed effects to capture—at least in part—countrywide fluctuations in the demand for loans. The coefficient of interest does not change, mitigating this concern (Table A7). We further discuss potential demand effects when using loan-level data (see Section 4.4).

Using yearly data may exacerbate the endogeneity of the treatment, as government interventions could happen later in the year in response to the increase in costs (and loan impairment charges) which is driving the Lerner index. To address this concern, we augment our model with a triple interaction with the month of the intervention in a given year. If our results were due mostly to interventions undertaken late in the year in response to a decline in the Lerner index, we should observe a significant and negative coefficient for the triple interaction term. However, this is not the case and the point estimate is very close to zero, suggesting that we can dismiss this concern (Table A8).

Lastly, one could argue that the provisions/impairment charges on pre-intervention income statements (and therefore the estimated marginal costs) are a poor proxy for the true cost of lending, if government intervention forces some banks to recognize the full extent of the credit risk and losses associated with lending. We tackle this issue in Appendix B, where we show that the decline in the Lerner index is not driven by a mechanical measurement error based on the evidence that potential mismeasurement of marginal costs with respect to the costs used by banks in pricing decisions is not different between treatment and control groups.

4.3. Heterogeneity

We present a set of additional results which examine whether there is evidence of heterogeneity in the results based on the geographical location of the bank, the type, size, and duration of the interventions, as well as bank characteristics, and macroeconomic conditions.

One element of novelty of our analysis is the cross-country dimension. However, as our sample of banks is skewed towards US institutions, we replicate our main results weighting each country equally in the estimations (Table 8) and splitting the sample between US and non-US banks (Table 9). Results are qualitatively similar, although the drop in the Lerner index is larger among US banks.

500 bootstrapped samples. Reassuringly, our results remain significant at 1 percent (standard error = 0.005) when relying on the standard errors obtained with this bootstrapping procedure (results unreported for the sake of brevity).

Table 9
United States vs non-United States banks.

Dependent Variable:	Lerner (1)	MC (2)	Price (3)	Loan Impairment (4)
<i>Panel A: United States</i>				
Intervention x Post	−0.018*** (0.005)	0.003*** (0.001)	0.000 (0.001)	0.228*** (0.030)
Country FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Window	4	4	4	4
# of Matches	2	2	2	2
# of Treatment Obs.	642	642	642	642
Adjusted R ²	0.200	0.157	0.188	0.241
<i>Panel B: Non- United States</i>				
Intervention x Post	−0.012* (0.007)	0.005*** (0.0020)	−0.001 (0.0020)	0.226*** (0.0075)
Country FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Window	4	4	4	4
# of Matches	2	2	2	2
# of Treatment Obs.	132	132	132	132
Adjusted R ²	0.520	0.857	0.188	0.499

Notes: This table presents OLS estimates of Eq. (7) at the bank-year level on the matched sample as explained in Section 3, restricted to United States banks in Panel A and restricted to non-United States banks in Panel B. Intervention indicates that the bank is a recipient of a government intervention. Post indicates the year is after the bank intervention. Lerner, Price and Marginal Cost (MC) are constructed as in Section 3.1. Country and time fixed effects are included. Standard errors, clustered by bank, in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 10
European union vs non-European union banks.

Dependent Variable:	Lerner (1)	MC (2)	Price (3)	Loan Impairment (4)
<i>Panel A: Non-European Union</i>				
Intervention x Post	−0.018*** (0.004)	0.003*** (0.001)	0.0001 (0.001)	0.218*** (0.029)
Country FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Window	4	4	4	4
# of Matches	2	2	2	2
# of Treatment Obs.	658	658	658	658
Adjusted R ²	0.197	0.41	0.549	0.235
<i>Panel B: European Union</i>				
Intervention x Post	−0.033*** (0.012)	0.004** (0.002)	−0.001 (0.002)	0.172** (0.092)
Country FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Window	4	4	4	4
# of Matches	2	2	2	2
# of Treatment Obs.	72	72	72	72
Adjusted R ²	0.382	0.336	0.422	0.373

Notes: This table presents OLS estimates of Eq. (7) at the bank-year level on the matched sample as explained in Section 3, restricted to European Union banks in Panel A and restricted to non-European Union banks in Panel B. Intervention indicates that the bank is a recipient of a government intervention. Post indicates the year is after the bank intervention. Lerner, Price and Marginal Cost (MC) are constructed as in Section 3.1. Country and time fixed effects are included. Standard errors, clustered by bank, in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Similarly, the unfolding of additional financial shocks in the European Union (EU)—at least in part triggered by the institutional features of the EU and necessitating a new round of government interventions in banks in the post-GFC period—could be driving the findings. So, we also estimate the impact of government interventions within and outside the EU. While the impact on the Lerner is qualitatively similar, we find a much larger decrease following government intervention in the EU (about 80 percent larger than in non-EU countries, see Table 10). Notwithstanding the rel-

atively small sample size, this highlights the importance of the constraints set in place by the EU institutions, which prescribed that interventions through state aid needed to be done in a way that preserves competition and without providing an unfair advantage to any bank.¹³ These constraints exerted a stronger disciplining impact on intervened banks, increasing the recognition of risk through provisioning and limiting the markups.¹⁴ However, the fact that our results are robust to the exclusions of any of the larger geographical areas points towards our results not being driven by a specific institutional context and therefore supports their external validity.

We also exploit the granular information on government interventions, which allows us to test for variations in the size (measured by the injection over assets), duration (measured by the number of years until the end of public support measures) and type (equity version non-equity injections).

When looking at different types of interventions, we focus on asset purchases, since they capture the stake a government takes in a bank more directly.¹⁵ Splitting the sample between equity and non-equity interventions, we find that markups decline significantly only for banks that experienced equity injections and not for other interventions (debt or hybrid, Table 11). While this result should be interpreted with caution, given the limited sample size for non-equity interventions, it is consistent with equity injections giving greater power, incentives, and responsibilities to governments to either directly control banks' operations or, at least, monitor them more closely and require banks to recognize losses appropriately. We also find larger effects on markups and on the cost components for interventions involving larger amounts of government support and lasting over longer periods (duration from initial injection to divestment) (Table 12). This is again consistent with the idea that a more sizeable involvement of public authorities leads to an increase in costs due to a more appropriate recognition of risks. Larger injections of taxpayer money may also align banks' objectives closer to those of their clients, diminishing any incentive to pass the cost increases to them.

We also explore heterogeneity in the effects of government interventions on banks depending on bank and country characteristics. We consider bank's market share, size, profitability, leverage and asset quality and find that our results do not vary based on pre-intervention bank characteristics (Table 13). The lack of differences depending on leverage is also confirmed when looking at the country level (Table 14, column 1). However, we do find that the decline in the Lerner index is larger for banks headquartered in countries that suffered a deeper economic contraction during the GFC. To quantify this result, the decline in Lerner is 0.0085 greater for an intervened bank in a country where GDP per capita fell by an additional 1 percent (Table 14, column 2). This is a substantial difference as it represents more than a third of the baseline effect. A likely explanation of this heterogeneity is that countries where the crisis was more severe also experienced a larger increase in credit risk, which, once banks were forced to recognize losses in a prompter way, led to a larger increase of the marginal costs of lending.

¹³ For instance, see Official Journal of the European Union C 195/9 and C 10/2, available at [https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52009XC0819\(03\)&from=EN](https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52009XC0819(03)&from=EN) and <https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2009:010:0002:0010:EN:PDF>.

¹⁴ Such constraints could be imposed not only by the introduction of new regulatory frameworks (as it has also been the case in the US) but also by the empowerment of new supranational supervisors and/or by the influence of competition authorities.

¹⁵ Guarantees, by contrast, are extended but not always incurred, while impaired asset relief is counted only when the transfer value exceeds the market value.

Table 11
Heterogeneity by intervention type.

Dependent Variable:	Lerner (1)	MC (2)	Price (3)	Lerner (4)	MC (5)	Price (6)
Intervention x Post	−0.019*** (0.004)	0.003*** (0.001)	0.004 (0.001)	−0.010 (0.013)	−0.001 (0.004)	−0.003 (0.003)
Intervention Type	Equity	Equity	Equity	Non- Equity	Non- Equity	Non- Equity
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Window	4	4	4	4	4	4
# of Matches	2	2	2	2	2	2
# of Treatment Obs.	650	650	650	50	50	50
Adjusted R ²	0.220	0.242	0.309	0.288	0.836	0.872

Notes: This table presents OLS estimates of Eq. (7) at the bank-year level on the matched sample as explained in Section 3, restricted to equity interventions in Columns 1–3 and restricted to non-equity interventions in Columns 4–6. Intervention indicates that the bank is a recipient of a government intervention. Post indicates the year is after the bank intervention. Lerner is constructed as in Section 3.1. Country and time fixed effects are included. Standard errors, clustered by bank, in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 12
Heterogeneity by intervention characteristics.

Dependent Variable:	Lerner (1)	Lerner (2)	Lerner (3)	Loan Imp. (4)	Loan Imp. (5)	Loan Imp. (6)
Intervention x Post x Size	−0.663*** (0.112)			2.518*** (0.905)		
Intervention x Post x Duration		−0.005*** (0.001)			0.051*** (0.010)	
Intervention x Post x M&A			−0.001 (0.008)			−0.073 (0.062)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Window	4	4	4	4	4	4
# of Matches	2	2	2	2	2	2
# of Treatment Obs.	730	730	730	730	730	730
Adjusted R ²	0.223	0.234	0.218	0.259	0.246	0.236

Notes: This table presents OLS estimates of a regression at the bank-year level on the matched sample as explained in Section 3. Intervention indicates that the bank is a recipient of a government intervention. Post indicates the year is after the bank intervention. Size is measured as the total amount of the injection. Duration is the number of years from the initial injection to divestment. M&A is an indicator for whether there was an M&A in the same year of the intervention. Lerner is constructed as in Section 3.1. Country and time fixed effects are included. Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 13
Heterogeneity by bank characteristics.

Dependent Variable:	Lerner (1)	Lerner (2)	Lerner (3)	Lerner (4)	Lerner (5)
Intervention x Post x Market Share	0.096 (0.159)				
Intervention x Post x Assets		0.000 (0.001)			
Intervention x Post x ROA			−0.001 (0.003)		
Intervention x Post x Leverage Ratio				0.0004 (0.001)	
Intervention x Post x NPLs/Loans					−0.0003 (0.000)
Country FE	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes
Window	4	4	4	4	4
# of Matches	2	2	2	2	2
# of Treatment Obs.	730	730	730	730	730
Adjusted R ²	0.212	0.214	0.309	0.220	0.224

Notes: This table presents OLS estimates of a regression at the bank-year level on the matched sample as explained in Section 3. Intervention indicates that the bank is a recipient of a government intervention. Post indicates the year is after the bank intervention. % change in GDP per capita during GFC is measured as the change between 2008 and 2009. Lerner is constructed as in Section 3.1. All interaction variables are from FitchConnect. Country and time fixed effects are included. Standard errors, clustered by bank, in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 14
Heterogeneity by country characteristics.

Dependent Variable:	Lerner (1)	Lerner (2)
Intervention x Post x % change in GDP per capita during GFC	0.850** (0.300)	
Intervention x Post x pre-GFC Leverage Ratio		−0.038 (0.129)
Country FE	Yes	Yes
Time FE	Yes	Yes
Window	4	4
# of Matches	2	2
# of Treatment Obs.	730	730
Adjusted R ²	0.212	0.213

Notes: This table presents OLS estimates of a regression at the bank-year level on the matched sample as explained in Section 3. Intervention indicates that the bank is a recipient of a government intervention. Post indicates the year is after the bank intervention. Percent (%) change in GDP per capita during GFC is measured as the change between 2008 and 2009. Pre-GFC Leverage Ratio is the average leverage ratio in the 4 pre-intervention periods. Lerner is constructed as in Section 3.1. Country and time fixed effects are included. Standard errors, clustered by bank, in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 15
Evidence from loan-level data to US corporates.

Dependent Variable:	Lerner (1)	Lerner (2)	Avg. Maturity (3)	% Secured Loans (4)	All-in-drawn (5)
Intervention x Post	−0.018* (0.011)	−0.018* (0.011)	0.277 (2.899)	0.036 (0.038)	0.176 (0.183)
Country FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Window	4	4	4	4	4
# of Matches	2	2	2	2	2
# of Banks	199	199	199	199	130
Adjusted R ²	0.319	0.320	0.192	0.034	0.291
Additional controls	No	Yes	No	No	Yes

Notes: This table presents OLS estimates of Eq. (7) at the bank-year level on the matched sample as explained in Section 4.4. Intervention indicates that the bank is a recipient of a government intervention. Post indicates the year is after the bank intervention. Lerner is constructed as in Section 3.1. The average maturity, the share (%) of secured loans and the all-in drawn are aggregated at the bank level from syndicated loan level data, as discussed in Section 4.4. Country and time fixed effects are included. Additional controls include the average maturity and the share of secured loans (in columns 3 and 5). Standard errors, clustered by bank, in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

4.4. Loan characteristics

To better understand the impact of government interventions, it is important to consider margin of adjustments other than price and costs and take into account the potential effect that loan characteristics may have on loan pricing and markups. As our main dataset does not allow us to control for these factors, we run a set of additional tests using data on syndicated US corporate loans around the GFC (Ivashina and Scharfstein, 2010; Kapan and Minoiu 2018; Hale et al., 2020). These data allow us to investigate whether banks that received a direct government intervention changed the maturity of the loans or collateral requirements and whether the change in the Lerner index could be driven by changes in the composition of the loan portfolio or pricing.

We retain information on loan price, maturity and the presence of collateral (measured by a dummy for secured loans) from Reuters' DealScan database. Loan price is measured by the "all-in-spread-drawn," which refers to the sum of the spread over LIBOR, plus the facility fee associated with the granting of the loan (Berg et al., 2016). We aggregate deal-level information on syndicated loans granted to US corporates at the bank-year level splitting each loan amount equally among lenders (as in Hale, 2012 and Hale et al., 2020, among others) and computing the average maturity and price and the share of secured loans. We then match these bank lending characteristics with Fitch Connect applying a fuzzy

matching on bank names. We are able to match 199 banks, covering about 68 percent of total syndicated lending in Dealscan over our sample period. Out of the matched banks, 71 received government support.

We first re-estimate the main Eq. (7) in the restricted sample of matched banks and find that the estimated impact of government interventions on the Lerner index is negative, statistically different than zero, and similar in size to the baseline (Table 15, column 1). This result holds when controlling also for the average loan maturity and the share of secured loans (column 2). We then take as dependent variable either the share of loans that are collateralized or the average loan maturity and we detect no impact of government interventions (columns 3–4). This result is consistent with the fact that intervened banks do not start requesting more collateral or providing shorter-term loans, possibly in response to a weaker credit demand. Then, we look directly at the average loan price and find again no significant effect of the government interventions, even when controlling for loan characteristics—loan maturity and collateral (column 5). This additional evidence, while limited in scope because of data availability and by the impossible task of fully controlling for all changes in credit demand, further supports our main results and suggests that the decline in the Lerner index is not driven by demand factors and variation in loan pricing, but by change in costs following government interventions,

which are not due to changes in loans characteristics, but reflect the cost of risk through provisioning.

5. Conclusions

The COVID-19 pandemic could lead to significant bank losses, due to household and firm insolvencies. Governments might have to resort to various forms of interventions to support banks and to avoid that a financial crisis further exacerbates the severe economic downturn brought about by the pandemic.

As previous literature has argued that an increase in markups could be a side-effect of such government intervention, this paper studies GFC-era government interventions in the banking industry to gain insights on what might be the impact on banks' markups going forward. In particular, we contribute to the existing literature by analyzing government interventions using bank level data for 800 banks in 27 countries between 2007 and 2017 and taking into account that interventions are non-random through a multivariate matching procedure.

Our analysis shows that banks that received direct equity injections (but not other types of interventions) experienced a significant decline in markups. Specifically, intervened banks exhibited a significant increase in costs, due to greater recognition of loan losses, which was not matched by higher prices, nor by any

change in market shares. This effect was more pronounced for larger and longer interventions and in countries that experienced sharper output losses. The results are invariant to various robustness checks.

Overall, our findings mitigate, though not fully eliminate, the concern that future interventions may lead to substantial consumer welfare losses due to an increase in lenders' markups, as could occur if intervened banks were perceived to be safer and were able to charge higher prices or pay lower funding costs as a result.

Author statement

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Appendix A

Figs. A1,A2.

Fig. A1. Differences in covariates between non-matched (missing) and matched banks.

Notes: This figure plots the coefficients from a regression of an indicator for being an unmatched (or missing) bank in Fitch Connect on return on assets (ROA), capital ratio, and log assets. The sample is all intervened banks from Igan et al. (2019).

Fig. A2. Differences in intervention types between non-matched and matched banks.

Notes: This figure plots the coefficients from a regression of an indicator for being an unmatched (or missing) bank in Fitch Connect on the size of the intervention by intervention type. The sample is all intervened banks from Igan et al. (2019).

Tables A1–A8.

Table A1

Interventions by instrument in Igan et al. (2019).

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Equity											
Number of banks	0	231	500	20	21	23	17	6	9	2	8
o/w US banks	0	211	446	0	0	0	0	0	0	0	0
% of system assets	0.0	17.2	13.7	1.2	0.8	1.3	0.5	0.1	0.2	0.0	0.2
o/w US banks	0.0	7.7	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hybrid securities											
Number of banks	0	8	63	5	4	8	2	0	2	0	1
o/w US banks	0	3	51	0	0	0	0	0	0	0	0
% of system assets	0.0	2.1	0.8	0.4	0.1	0.5	0.0	0.0	0.2	0.0	0.1
o/w US banks	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Debt											
Number of banks	2	11	12	4	5	3	2	1	1	0	0
o/w US banks	0	0	0	0	0	0	0	0	0	0	0
% of system assets	0.1	0.3	0.1	0.0	0.2	0.3	0.5	0.0	0.0	0.0	0.0
o/w US banks	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Sources: National authorities; European Commission; bank reports.

Note: This table shows the banks that were subject to asset purchases by year in absolute numbers ("number of banks") and in terms of their assets as a percent of total system assets ("percent of system assets") by type of instrument (equity, hybrid instruments, and debt). System assets are the total assets of the financial sector in the sample. Data reflect the available information as of April 2019 for EU countries and as of end-2018 for the United States.

Table A2
Common support.

	5th	25th	Median	75th	95th
Intervened Banks					
Lerner	0.0000	0.0682	0.1428	0.2066	0.3069
Price	0.0386	0.0572	0.0647	0.0715	0.0849
Marginal Cost	0.0337	0.0480	0.0561	0.0633	0.0810
Loan Impairment Charges / Assets	0.0000	0.0717	0.1695	0.3491	1.0850
Net Interest Margin	1.6000	3.2000	3.8000	4.4000	5.5270
ROE	-7.6691	4.1160	8.2485	12.2388	19.1215
Log Assets	3.4464	4.6877	5.6627	7.0472	11.3860
NPL / Gross Loans	0.0000	0.1000	0.5000	1.3000	4.7000
Liquidity Ratio	0.0000	0.0682	0.1428	0.2066	0.3069
Non-Intervened Banks					
Lerner	0.0000	0.0630	0.1377	0.2045	0.3137
Price	0.0381	0.0572	0.0651	0.0729	0.0875
Marginal Cost	0.0321	0.0485	0.0566	0.0648	0.0831
Loan Impairment Charges / Assets	0.0000	0.0816	0.1885	0.3555	1.0616
Net Interest Margin	1.4400	3.1800	3.7000	4.3400	5.4000
ROE	-7.6905	4.8705	9.5380	13.3782	20.9571
Log Assets	4.0693	5.9917	6.9131	8.4166	11.6444
NPL / Gross Loans	0.0000	0.2000	0.5000	1.1000	4.2190
Liquidity Ratio	0.0000	0.0630	0.1377	0.2045	0.3137

Notes: This table presents summary statistics for variables measured at the bank-year level on the matched sample by intervention and non-intervention groups. Only pre-intervention data is included.

Table A3
Extending the post-intervention period to 6 years.

Dependent Variable:	Lerner (1)	Lerner (2)	Lerner (3)	Lerner (4)	Lerner (5)	Lerner (6)
Intervention x Post	-0.014*** (0.004)	-0.019*** (0.004)	-0.022*** (0.003)	-0.020*** (0.003)	-0.017*** (0.004)	-0.014*** (0.004)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Years post-intervention	1	2	3	4	5	6
# of Matches	2	2	2	2	2	2
# of Treatment Obs.	1002	862	792	730	678	630
Adjusted R ²	0.308	0.291	0.256	0.215	0.203	0.207

Notes: This table presents OLS estimates of Eq. (7) at the bank-year level on the matched sample as explained in Section 3. Years post-intervention indicates the number of years after the bank-specific intervention. We require the bank to exist 4 periods before the intervention as in the main specification. Intervention indicates that the bank is a recipient of a government intervention. Post indicates the years after the bank intervention. Lerner is constructed as in Section 3.1. Country and time fixed effects are included. Standard errors, clustered by bank, in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A4
Robustness for number of matches.

Dependent Variable:	Lerner (1)	Lerner (2)	Lerner (3)	Lerner (4)
Intervention x Post	-0.019*** (0.002)	-0.020*** (0.003)	-0.020*** (0.003)	-0.019*** (0.003)
Country FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Window	4	4	4	4
# of Matches	4	3	2	1
Adjusted R ²	0.210	0.207	0.215	0.220

Notes: This table presents OLS estimates of Eq. (7) at the bank-year level on the matched sample as explained in Section 3. # of Matches indicates the number of matches for each treatment observation following Diamond and Sekhon (2013). Intervention indicates that the bank is a recipient of a government intervention. Post indicates the year is after the bank intervention. Lerner is constructed as in Section 3.1. Country and time fixed effects are included. Standard errors, clustered by bank, in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A5
Robustness to bank fixed effects.

Dependent Variable:	Lerner (1)	Lerner (2)
Intervention x Post	0.020*** (0.003)	0.018*** (0.002)
Country FE	Yes	No
Bank FE	No	Yes
Time FE	Yes	Yes
Window	4	4
# of Matches	2	2
Adjusted R ²	0.215	0.620

Notes: This table presents OLS estimates of Eq. (7) at the bank-year level on the matched sample as explained in Section 3. Intervention indicates that the bank is a recipient of a government intervention. Post indicates the year is after the bank intervention. Lerner is constructed as in Section 3.1. Time fixed effects are included. Country fixed effects are included in Column 1 and bank fixed effects are included in Column 2. Standard errors, clustered by bank, in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A6
Robustness to the set of bank-level matching variables.

Dependent Variable:	Lerner (1)	Lerner (2)	Lerner (3)	Lerner (4)
Intervention x Post	−0.019*** (0.003)	−0.019*** (0.003)	−0.018*** (0.003)	−0.016*** (0.003)
Country FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Sample	All	All	All	All
Window	4	4	4	4
# of Matches	2	2	2	2
# of Treatment Obs.	730	730	730	657
Adjusted R ²	0.213	0.197	0.215	0.212
Match on pre-intervention variable:				
Lerner	Yes	Yes	Yes	Yes
Assets	Yes	Yes	Yes	Yes
Costs	Yes	Yes	Yes	Yes
Non-performing Loans	Yes	Yes	Yes	Yes
Revenue	Yes	Yes	Yes	Yes
Provisions/Loans	No	No	Yes	Yes
Market Share	No	No	Yes	Yes
Capitalization	No	No	Yes	Yes
Loans/Assets	No	No	No	Yes
Corporate and commercial loans/Gross loans	No	No	No	Yes
Non-interest income / Net interest income	No	No	No	Yes
Wholesale funding / Liabilities	No	No	No	Yes
Propensity Score	No	Yes	No	No

Notes: This table presents OLS estimates of Eq. (7) at the bank-year level on the matched sample as explained in Section 3. Intervention indicates that the bank is a recipient of a government intervention. Post indicates the year is after the bank intervention. The outcome variable, Lerner, is constructed as in Section 3.1. In Columns 1, we present the baseline. In Columns 2 we add propensity score as a matching variable. In columns 3 and 4 we add additional matching variables. Standard errors, clustered by bank, in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A7
Robustness to including country x year fixed effects.

Dependent Variable:	Lerner (1)	MC (2)	Price (3)	Loan Impairment (4)
Intervention x Post	−0.019*** (0.003)	−0.003*** (0.001)	0.000 (0.001)	−0.214*** (0.028)
Country x Time FE	Yes	Yes	Yes	Yes
Sample	All	All	All	All
Window	4	4	4	4
# of Matches	2	2	2	2
# of Treatment Obs.	730	730	730	730
Adjusted R ²	0.228	0.459	0.584	0.261

Notes: This table presents OLS estimates of Eq. (7) at the bank-year level on the matched sample as explained in Section 3. Intervention indicates that the bank is a recipient of a government intervention. Post indicates the year is after the bank intervention. Lerner, Price and Marginal Cost (MC) are constructed as in Section 3.1. Country x year fixed effects are included in all columns. Standard errors, clustered by bank, in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A8
Robustness to timing of intervention within year.

Dependent Variable:	Lerner (1)	Lerner (2)
Intervention x Post x Month	−0.001 (0.004)	
Intervention x Post x 1{Month ≤ 6}		0.003 (0.005)
Country FE	Yes	Yes
Time FE	Yes	Yes
Window	4	4
# of Matches	2	2
# of Treatment Obs.	730	730
Adjusted R ²	0.214	0.213

Notes: This table presents OLS estimates at the bank-year level on the matched sample as explained in Section 3. Intervention indicates that the bank is a recipient of a government intervention. Post indicates the year is after the bank intervention. Lerner is constructed as in Section 3.1. Month corresponds to the month number of the intervention from 1 to 12 (January is 1). 1{Month ≤ 6} is an indicator for the first half of the year. Country and time fixed effects are included. Standard errors, clustered by bank, in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Appendix B. Provisioning and marginal costs estimation

An explanation for the impact of government intervention on costs (and markups) is that some banks were forced to recognize, through more appropriate provisioning (or accounting of impairment charges), the full extent of the credit risk and losses associated with lending. Therefore, it is possible that the provisions/impairment charges on pre-intervention income statements (and hence the estimated marginal costs) are a poor proxy for the true cost of lending. Would this invalidate our interpretation of the results? In other words, would the potential mismeasurement of costs bias the estimates of the Lerner index? We argue that it would not.

A firm facing a downward-sloping residual demand curve (thus, having some market power), would pick the price that equates marginal revenues to marginal costs. What matters for the market equilibrium is thus the cost measure that is used by firms to set its pricing. A static oligopolistic model implies that, *ceteris paribus*, the higher the costs, the higher the prices charged to consumers (e.g. Bresnahan 1989). Thus, the validity of a cost estimate as a tool to study market power hinges on how close this estimate is to the cost measure used by firms in their pricing decisions.

Therefore, to evaluate empirically the validity of the cost estimates used to compute the pre-intervention Lerner index, we study their relevance for pricing decisions. First, we focus on banks which experienced a government intervention and regress the (log of the) price, as defined in Section 3.1, before the GFC on either (a) provisioning normalized by assets or (b) the (log of the) estimated marginal costs. The first column of Table B1 shows a significant and positive correlation between prices and the two measures of costs, indicating that these measures, at least qualitatively, behave as we would expect if they were fully capturing the cost of lending.

However, a positive correlation between costs and prices does not exclude the possibility that banks purposely take on more

credit risk or ultimately experience more losses than what is indicated by provisions or impairment charges. Importantly for our analysis, the cost measures based on balance-sheet data may only be partially informative of the true costs for pre-intervention banks while they are more informative for banks that do not need an intervention. We thus perform a further test asking whether the correlation between prices and costs is the same for banks that will receive an intervention and banks that will not, estimating the following linear model:

$$\text{price}_{b,t,c} = \alpha + \gamma * \text{cost}_{b,t,c} * \text{Intervention}_b + \beta * \text{cost}_{b,t,c} + \delta * \text{Intervention}_b + \varepsilon_{b,t,c} \quad (8)$$

where $\text{price}_{b,t,c}$ is the log of the price charged by bank b in country c in a (pre-GFC) year t , and cost is either the (log of the) estimated marginal cost or provisioning scaled by assets. Intervention_b is a dummy variable indicating whether bank b received a government intervention during the GFC. The results confirm that banks charge higher prices when costs are higher. Importantly, the relationship between costs and prices for banks that subsequently receive a government intervention is not different from that for banks that do not (i.e. the coefficient γ is not different from zero), suggesting the extent to which estimated costs impact pricing is the same for both groups (Table B1, columns 2–5). This implies that, for a given estimated marginal cost, both bank groups charge the same price. It is not the case that banks which will receive a government intervention charge higher prices than what is implied by the estimated costs: we would expect this to happen if the banks acted as if their real cost were higher than what is reported in their balance sheets. Results are unaffected by inclusion of controls.

We conclude that potential mismeasurement of marginal costs with respect to the costs used by banks in pricing decisions is not different between treatment and control groups. To the extent that intervened banks were underestimating credit risk in their pre-GFC provisioning, they were likely not reflecting this hidden (from the balance-sheet) costs in pricing. Therefore, it is reasonable to con-

Table B1
Price, provisioning and marginal costs.

Dependent Variable:	Log(Price) (1)	(2)	(3)	(4)	(5)
Panel A: Price and provisions					
Loan Impairment Charges/ Assets	0.085*** (0.009)	0.085*** (0.008)	0.077*** (0.008)	0.065*** (0.008)	0.092*** (0.007)
Loan Impairment Charges/ Assets x Intervention		–0.002 (0.011)	0.003 (0.011)	0.007 (0.011)	0.007 (0.011)
Adjusted R ²	0.339	0.372	0.395	0.466	0.572
Panel B: Price and marginal costs					
Log(MC)	0.730*** (0.009)	0.708*** (0.008)	0.702*** (0.008)	0.645*** (0.008)	0.608*** (0.007)
Log(MC) x Intervention		0.021 (0.016)	0.023 (0.015)	0.024 (0.015)	0.019 (0.013)
Adjusted R ²	0.531	0.566	0.588	0.597	0.701
Country FE	Yes	Yes	Yes	Yes	No
Year FE	Yes	Yes	Yes	Yes	No
Intervention Control	Yes	Yes	Yes	Yes	Yes
Pre-intervention Only	Yes	Yes	Yes	Yes	Yes
Treatment vs Control	Treatment	Both	Both	Both	Both
# of Treatment Obs.	730	730	730	730	730
Controls:					
Log Assets	No	No	Yes	Yes	Yes
Loans/Assets	No	No	No	Yes	Yes
Leverage Ratio	No	No	No	No	Yes

Notes: This table presents OLS estimates at the bank-year level on the matched sample as explained in Section 3. Intervention indicates that the bank is a recipient of a government intervention. The outcome variable, Log Price, is constructed as in Section 3.1. The main explanatory variable is loan impairment charges over assets (panel A) or (the log of) marginal costs (MC) (panel B). Country and time fixed effects, and a control for the intervention group is included in all columns. Column 1 restricts the sample to only the treatment group. Columns 2–4 includes the full matched sample. Column 5 adds additional controls. Standard errors, clustered by bank, in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

sider the increase in provisioning caused by government intervention as an actual increase in costs when analyzing pricing and market power. The decline in the Lerner index is not driven by a mechanical measurement error.

Furthermore, the main policy implications of the paper would be similar even if we did not find an impact on marginal costs. In that case, as we do not find any meaningful impact on prices, we would infer that government interventions have no impact on markups and we would still conclude that should governments need to intervene banking institutions, the possibility that such interventions could lead to a rise in market power is unlikely to be a major concern.

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