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Abstract

By adjusting their lending, banks can smooth or amplify the macroeconomic impact of deposit fluctuations. This may however lead to extended periods of disproportionately high lending relative to deposit intake, resulting in the accumulation of risk in the banking system. Using bank-level data for 8,477 banks in 129 countries for the 24-year period from 1992 to 2015, we examine how individual banks' market power and other characteristics may contribute to smoothing or amplification of shocks and to the accumulation of risk. We find that the higher their market power the lower is the growth rate of lending relative to deposits. As a result, in periods of falling deposits, higher market power for the average bank would be associated with a greater fall in lending resulting in amplification of adverse effects as deposits fall during relatively bad times. Strikingly, at very high levels of market power there is a threshold past which the effect of market power on the growth rate of lending relative to deposits turns positive so that "superpower" banks contribute to smoothing of adverse effects when deposits are falling. In periods of rising deposits, however, such banks lead to amplification and accumulation of risk in the economy.

Keywords: smoothing, amplification, risk accumulation, market power, competition, crisis.

JEL Classification: E44, E51, F3, F4, G21.

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1 Introduction

By adjusting their lending, banks can smooth or amplify the macroeconomic impact of fluctuations in deposit inflows. This may however lead to extended periods of disproportionately high lending relative to deposit intake, resulting in the accumulation of risk in the banking system. Indeed, previous work and recent experience have shown that banks can amplify shocks or even create the preconditions for financial instability by accumulating risks. For example, as noted by Jordà et al. (2013) and Jordà et al. (2011), excessive and sustained credit expansions can build up risk in the economy over time and bring about financial crises.[1] In the current paper, we ask which banks are less likely to amplify shocks or accumulate risk via their prudence in lending during periods of rising deposits, and which banks are more likely to smooth shocks during periods of falling deposits. It turns out that smoothing during booms, when deposits grow, comes at the cost of amplification of adverse effects during periods of falling deposits, while the ability to maintain lending during economic downturns is associated with risk accumulation and amplification of positive shocks during periods of rising deposits.

These questions are arguably intriguing, not only because of the potentially destructive consequences of risk accumulation within the banking system, but also because of the potential importance of banks' smoothing ability for economic outcomes. Smoothing by banks would enable inter-temporally optimizing agents to bring consumption and investment forward, reflected in households' flatter consumption profiles directly increasing current welfare and in the growth-enhancing avoidance of temporary declines in firms' investment during relative bad times associated with falling deposits.

To answer the above questions, we will be using bank-level data for 8,477 banks in 129

[1] More specifically, Jordà et al. (2013), show that credit expansions have been a driver of the depth of subsequent recessions in advanced economies. Using the same 140-years long database from 1870 to 2008 for 14 advanced economies, Jordà et al. (2011) showed that credit growth has been the single best predictor of financial instability.

countries, available at an annual frequency over the period from 1992 to 2015. The large available variation in our data allows us to consider a vast array of economic conditions faced by individual banks across different countries over time. In particular, variation across the degree of competition faced by individual banks in different environments over time enables us to investigate banks' smoothing ability and risk accumulation during periods of falling or rising deposits in relation to the degree of competition they face. We construct the Lernex index as a measure of the degree of market power estimated using a flexible semi-parametric functional form that allows variation across space and time.[2] As the impact of market power on smoothing, amplification and risk accumulation has not previously been jointly investigated in the literature, this will constitute the main focal point of our analysis.

As we will see in section 2, there are a number of theoretical reasons suggesting an inverse relationship between the degree of competition and banks' smoothing ability. Sette and Gobbi (2015) review previous results for the impact of competition on relationship lending implying that higher competition as measured by lower concentration dampens the smoothing effect of relationship lending. We will focus on overall lending, not just on relationship lending, and in doing so will also employ data on loan loss provisions relating our study more closely to the intergenerational transfers literature.[3] The impact of competition in relation to the shock-smoothing ability of banks has not been emphasized in this literature.[4] We attempt to close this gap in what follows.

We find that the higher the market power for the average bank the lower is the

[2]The global index of market power has 118,278 observations in total and a coverage of 11,957 banks in 131 countries annually for 1988-2015.

[3]There are two main foci in the literature: (1) relationship lending and (2) intergenerational transfers. The first one is on the selection of borrowers where if the bank has to cut down lending, long-term established relationship clients suffer last. The second one is on the facilities enabling smoothing by banks. These are either accumulated reserves, or the transfer of "deficits" of the current period into future periods where current period losses are covered by short-term borrowing.

[4]There has been some work on LLP dynamics, e.g. Bouvatier and Lepetit (2008), focusing on the amplification of cycles.

growth rate of lending relative to deposits. As a result, higher market power for the average bank may act to amplify adverse effects during periods of deposit decline, while smoothing positive shocks and, over time, reducing the build-up of risk when deposits are growing. Interestingly, we also find that at very high levels of market power, there is a threshold past which the effect of market power on the growth rate of lending relative to deposits turns positive. Thus, market power acts to improve the smoothing-ability of super power banks during periods of deposit decline in relatively bad times, while leading to amplification and, over time, to risk accumulation when deposits are growing. Strikingly, amplification and risk accumulation during such periods, also characterize banks facing high competition.

The paper is organized as follows. In Section 2, we offer some theoretical motivation in the form of prior theory and evidence along with the basic theoretical framework we pursue in the current paper. Section 3 describes the estimation procedure and the construction of the final sample used in our analysis. The key empirical results are presented and discussed in Section 4. Section 5 concludes the paper.

2 Theoretical motivation

We begin this section with a brief review of the related literature, discussing the smoothing function of banks, how it works and what the main findings have been in the literature so far. We further present our measure of smoothing/amplification, the *lending-funding growth gap*, and discuss potential effects of market power on it. Auxiliary discussions and intermediate derivations are in Appendix A.

2.1 Prior theory and evidence on banks' smoothing function

The ability of financial systems to smooth economic shocks was originally discussed by Allen and Gale (1997), who distinguish between intertemporal (intergenerational) and cross-sectional (intragenerational) risk-smoothing. Banks possess the capacity to smooth shocks intertemporally by spreading their impact across generations of agents. This is the main mechanism in Allen and Gale (1997), where smoothing is achieved by accumulating liquid reserves, and in Gersbach and Wenzelburger (2001, 2011) and Vinogradov (2011), where banks exploit their ability to transfer "deficits" from period to period, i.e. effectively they use the inflow of deposits from each new generation of depositors to repay the previous one. In all these models, co-existence with and competition against financial markets suppresses the shock-smoothing ability of banks. In Allen and Gale (1997), banks do not perform any better than markets if they face competition from the latter. In Gersbach and Wenzelburger (2001, 2011) and Vinogradov (2011) banks recover after large shocks only if they are able to derive strictly positive and sufficiently high profits, e.g., through imperfect competition or appropriate regulation, otherwise they may amplify the impact of shocks rather than help smooth them.

The underlying theory stresses the ability of banks to "smooth" the impact of economic fluctuations on lending: in theory, given that banks base lending decisions on a horizon longer than typical stock market participants, lending in bank-based economies would be reduced to a lesser degree than in stock market-based ones during economic downturns, and conversely, during booms bank lending would grow at a rate lower than market-based financing. One of our hypotheses is that this role of banks depends on the degree of competition between banks. Even if we do not observe the hypothetical market-based economy to see whether banks indeed smooth better than markets, we can still investigate the impact of competition on the response of bank lending behaviour to shocks. Allen and Gale (1997) demonstrate that when competition between markets and banks is high, the behaviour of the bank is very close to that of the market. With this in mind, high competition itself can proxy for the "market-based" counterfactual.[5]

[5]Levine et al. (2016) provide empirical evidence of the substitution of bank finance by market finance

While Allen and Gale (1997), Gersbach and Wenzelburger (2001, 2011) and Vinogradov (2011) discuss the sources of funds that determine banks' ability to smooth shocks, another strand of literature focuses on the allocation of these funds. Their focus is usually on relationship lending (Bolton et al., 2013; Sette and Gobbi, 2015; Beck et al., 2014): during economic downturns banks keep (and prefer) lending to borrowers with whom they had already developed long-term relationships[6], which might help smooth business cycle fluctuations. Berlin and Mester (1999) show that in order to provide loan rate smoothing to long-term customers, banks need to possess high market power in the deposit market. However, in general, the literature offers opposing views on the role of market power in relationship lending. The pioneering model of relationship lending by Petersen and Rajan (1995) presumes that in competitive loan markets, bankers have incentives to build longer term relationships with borrowers. In Boot and Thakor (2000), although competition between banks leads to more relationship lending, it brings less benefits for borrowers; moreover, if banks compete with financial markets, relationship lending shrinks. Similarly, Boot and Ratnovski (2016) show that in well developed financial systems banks are more likely to switch from relationship lending to short-term speculative trading, suggesting a negative impact of market competition on lending. Kysucky and Norden (2015) find that informational benefits of relationship lending, reflected in higher credit volumes and lower rates, are more pronounced when banking competition is high. Carbó-Valverde et al. (2009) contrast the information hypothesis and the market power hypothesis, and empirically provide support for the negative effect of market power on relationship lending: in more concentrated banking markets firms tend to be more credit constrained. Importantly, they emphasize the role of the Lerner

during banking crises. As we show later, our findings suggest that the effect of market power on the smoothing ability of superpower banks differs for business cycle recessions as compared to financial Crises

[6]Sette and Gobbi (2015), in particular, show that relationship lending has helped businesses in Italy to secure better financing conditions with their banks after the Lehman Brothers collapse.

index, also used in the current paper, as a measure of banks' market power.

Our study also relates to the literature on the transmission of monetary shocks, in particular those that directly affect deposits. In a recent study by Drechsler et al. (2017) deposits are seen as a "unique stable source of banks' funding", which is directly affected by changes in the Fed rate: an increase in the interest rate triggers deposit outflow. Among other issues, their paper studies the role of competition in the transmission mechanism. When rates are low, deposits are a substitute to cash, hence banks "compete" against cash and have to adjust the deposit rate in order to keep deposits in house (low spread between Fed rate and deposit rate). When rates are higher, deposits are less of a substitute to cash, hence competition between banks comes into play: in concentrated markets, banks have an opportunity to keep the spread high, thus provoking an outflow of deposits. In a sense, this result is about banks' smoothing ability through pricing (deposit interest rate). The authors find an interesting relationship between bank size and the effect deposit outflows have on lending: (a) large banks with higher spread betas have greater deposit outflows and lower asset growth following Fed funds rate increases; (b) they also sell more securities and contract loan growth by more. (c) the effect on lending is larger for big banks than in the full sample: banks at the 90th percentile of the spread beta distribution reduce loan growth by 225 bps relative to banks at the 10th percentile per 100 bps increase in the Fed funds rate. Another notable finding is that "when the Fed funds rate rises, banks that raise deposits in more concentrated markets reduce lending relative to banks that raise deposits in less concentrated markets: a one-standard deviation increase in Bank-HHI reduces lending by 230 bps per 100 bps increase in the Fed funds rate."

To sum up: in the existing literature, banks' mechanism to provide shock smoothing consists of two main elements: (1) availability of funds, either through accumulated reserves or via borrowing from alternative sources, and (2) incentives to allocate these funds to existing borrowers. Relationship lending contributes to the latter incentives, yet it is just one of many possible channels. Although the literature suggests market power can affect relationship lending, no evidence exists for the role of market structure on the smoothing mechanism as a whole, which is what we explore here.

2.2 The lending-funding growth gap

As financial intermediaries, banks accept deposits and provide loans. As there is a large number of customers on both sides of this process, idiosyncratic shocks to deposits can typically be diversified out (Diamond and Dybvig, 1983; Bencivenga and Smith, 1991), rendering the overall deposit intake mostly dependent on systemic shocks. Our question is therefore, which banks possess a better capacity to protect their lending function from these shocks to their funding arm, to which we refer as the "smoothing"capacity. An opposite situation, when a funding shock translates into an even greater shock to lending, may be referred to as "amplification". We discus the two effects in more detail below.

Differences between the *levels* of long-term assets and short-term liabilities have been used in the literature to describe the maturity transformation function of banks (*maturity mismatch*, see e.g. Flannery and James (1984), or Brewer et al. (1996)); differences between the levels of liquid and illiquid assets and liabilities are used to measure liquidity creation by banks (Berger and Bouwman, 2009). Our primary concern is about the impact a *change* in deposits may have on the bank's lending, for which reason we will focus on the growth rates of the two variables.[7] One possible way to address the sensitivity of lending to deposit shocks would be to use the elasticity of lending to

[7] Drechsler et al. (2017) also study the impact of a change in deposits on the lending function, yet they only focus on lending growth and test the impact of a change in the Federal Funds rate on lending through deposits.

deposit inflow, as done, for example, in Jayaratne and Morgan (2000) with an emphasis on this parameter's relationship to bank capitalization. However this measure is not well behaved for near-zero deposit growth rates. [8] An alternative approach to measure this sensitivity, is to use a linear difference between the growth rates. This is the approach we adopt in this paper.

To assess the smoothing capacity of a bank, we therefore focus on the mismatch between loan and deposit growth rates,

$$l_t - d_t = \frac{L_{t+1} - L_t}{L_t} - \frac{D_{t+1} - D_t}{D_t},$$

where L_t and D_t are, respectively, the observed values of total loans and total deposits a bank has in period t. This difference between loan growth and deposit growth provides us with a measure of the *growth gap* we will be using to assess our main hypotheses. We interpret it as the sensitivity of loan growth to a change in deposit growth. If the latter is driven by an exogenous shock, the change in bank's lending can be seen as a response to this shock. More precisely, if $\frac{L_t}{D_t}$ is the previous period's loans-to-deposits ratio, then condition $l_t - d_t = 0$ is equivalent to dedicating to new loans $\Delta L_{t+1} = L_{t+1} - L_t$ exactly the same proportion of the new intake of deposits, $\Delta D_{t+1} = D_{t+1} - D_t$, as in period t:

$$l - d = 0 \Leftrightarrow \Delta L_{t+1} = \frac{L_t}{D_t} \cdot \Delta D_{t+1},$$

Deviations from this, as given by $l - d < 0$ and $l - d > 0$, correspond to a sub-proportional or a more-than-proportional increase in lending in response to a change in deposits:

$$l - d \lesseqgtr 0 \Leftrightarrow \Delta L_{t+1} \lesseqgtr \frac{L_t}{D_t} \cdot \Delta D_{t+1},$$

The variable $l_t - d_t$ therefore already takes into account that not every dollar of new deposits needs to be converted in a new dollar of loans. Instead it gives us a picture of

[8] The average rate of deposit growth in our sample is 8.22% per annum, with a standard deviation of 19.93.

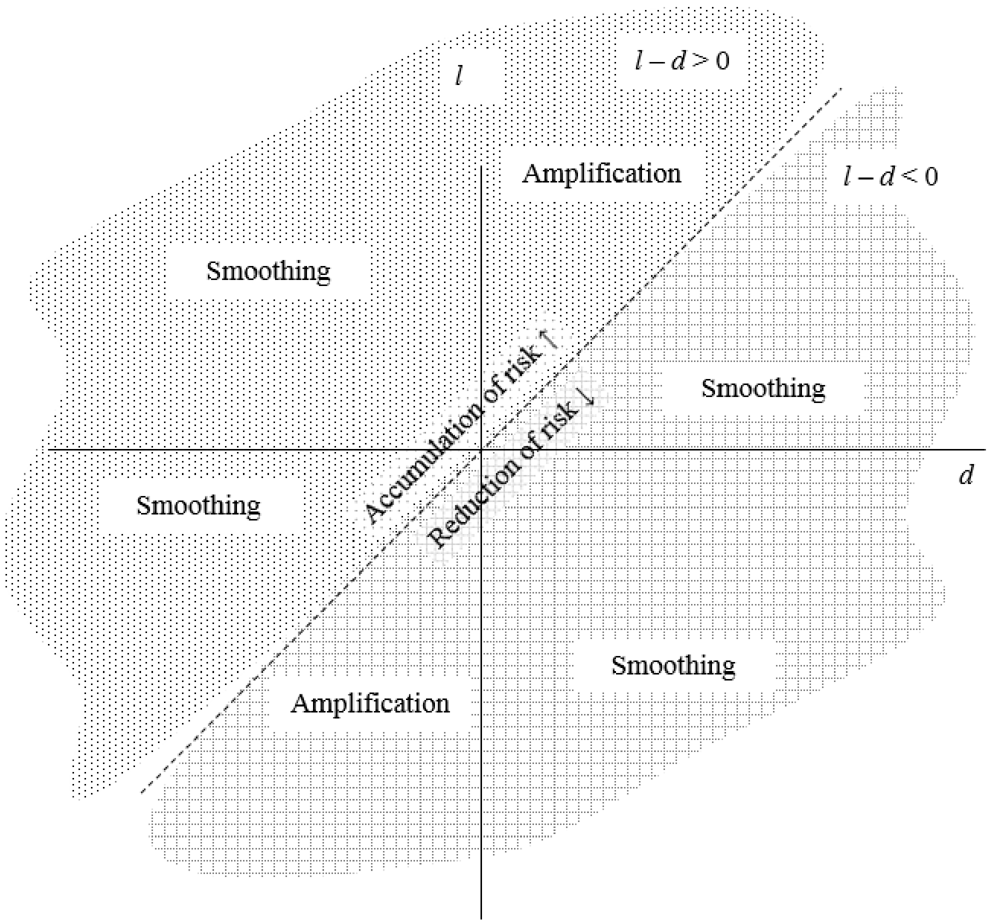
whether more or less dollars from each new deposit are used for lending in period $t+1$ as compared to period t.

Implications of having a positive or a negative $l_t - d_t$ are different in situations of falling or growing deposits. A positive growth gap, $l_t - d_t > 0$, means a lesser decline (or even an increase) in lending than a given decline in deposits, $d_t < 0$, and hence represents smoothing provided by banks to an economy experiencing a shock that leads to a decline in deposits. A negative growth gap under the same circumstances would instead imply amplification of this shock, as lending would be declining faster than deposits. Similarly, when deposits go up, a positive $l_t - d_t$ amplifies the economic effect of this, while a negative $l_t - d_t$ dampens any impact of deposit growth on the economy (which is also a form of smoothing). [9]

Figure 1 reflects this asymmetric interpretation of $l_t - d_t$ in times of growing deposits and in times of declining deposits. Figure 2 plots loan growth versus deposit growth in the worldwide sample of banks we use later for the analysis, separately for banks with low (below median) and high (above median) market power (see Section 3.2 for details). For both types of banks observations align around the $l = d$ line, as introduced in Figure 1. Still, variations around this line are pronounced in both subsamples, and include a number of implications with regards to the smoothing/amplification capacity of banks. These implications are highlighted in Figure 1. In particular, an increase in $(l - d)$ in times of declining deposits either improves the smoothing capacity of banks or reduces their contribution to the amplification of the business cycle; the opposite applies in times of rising deposits. Our main objective is to understand whether and how competition contributes to a bank's smoothing ability. This can be done by estimating the impact of

[9] If we were to associate the sensitivity of lending to the deposit intake with the elasticity measure $\frac{l_t}{d_t}$, then $\frac{l_t}{d_t} > 1$ would refer to amplification and $\frac{l_t}{d_t} < 1$ to smoothing, including the case when l_t and d_t are of opposite signs, $\frac{l_t}{d_t} < 0 < 1$.

Figure 1: Loan growth (l) versus deposit growth (d).



Notes: Dashed line corresponds to $l = d$. The ability to generate more loans than acquired deposits, $l - d > 0$, is interpreted as accumulation of liquidity risk and at the same time as smoothing for negative deposit shocks ($d < 0$) and as amplification for positive shocks ($d > 0$). Negative growth mismatch, $l - d < 0$, corresponds to a reduction in the liquidity risk, with an opposite interpretation for smoothing and amplification.

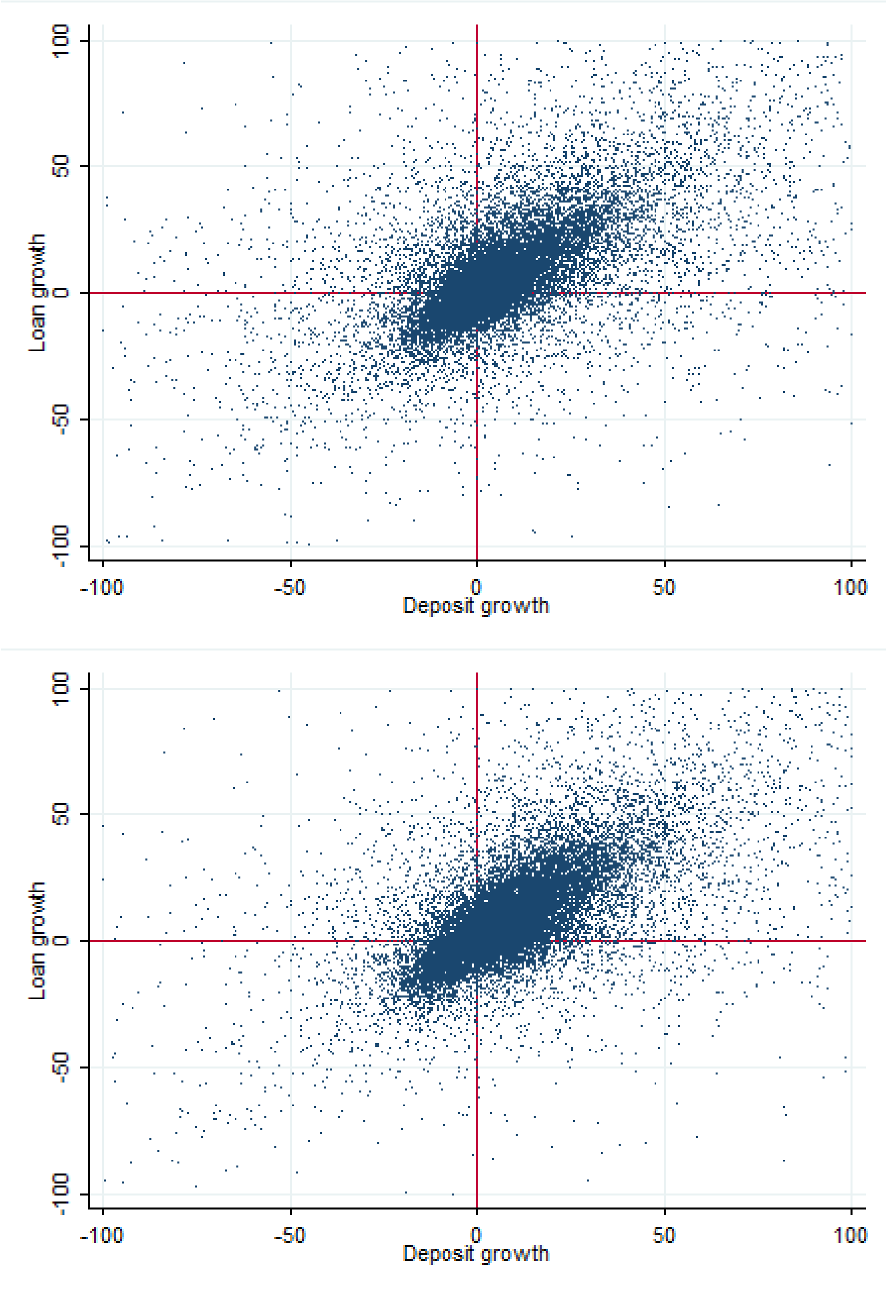
market power on the difference $l - d$, controlling for the directional change in deposits.

2.3 The build-up of liquidity risk

The above considerations refer to the role banks play in driving the business cycle in the short run, having in mind an instantaneous response of lending to a change in deposits. In the long run, however, having persistently positive or persistently negative $l_t - d_t$ has implications for the difference in the *levels* of lending and deposits. As mentioned above, a body of literature focuses on the latter difference in levels to assess the maturity and liquidity transformation function of banks. A related yet distinct growing line in research operates with the so-called "customer funding gap", i.e. the difference between customer loans and deposits to and from all non-bank borrowers and depositors, often taken as a relative measure to the total amount of loans $\frac{L_t - D_t}{L_t}$. This measure reflects banks' liquidity risk (Pagratis et al., 2009; Albertazzi et al., 2014) and is used by central bankers as an indicator of risks to financial stability (BoE, 2009, 2011). In particular, in BoE (2010) an emphasis is made on the build-up of the relative funding gap in the major UK banks just prior to the global financial crisis of 2008-10. In Figure 3, the same period of 2003-2007 is marked with a persistently positive, especially for banks with high market power, lending-funding growth gap, $l - d$. Similarly, in Figure 3 the persistently positive $(l - d)$-gap is observed in the nineties, after the early 1990s recession and preceding the early 2000s recession.

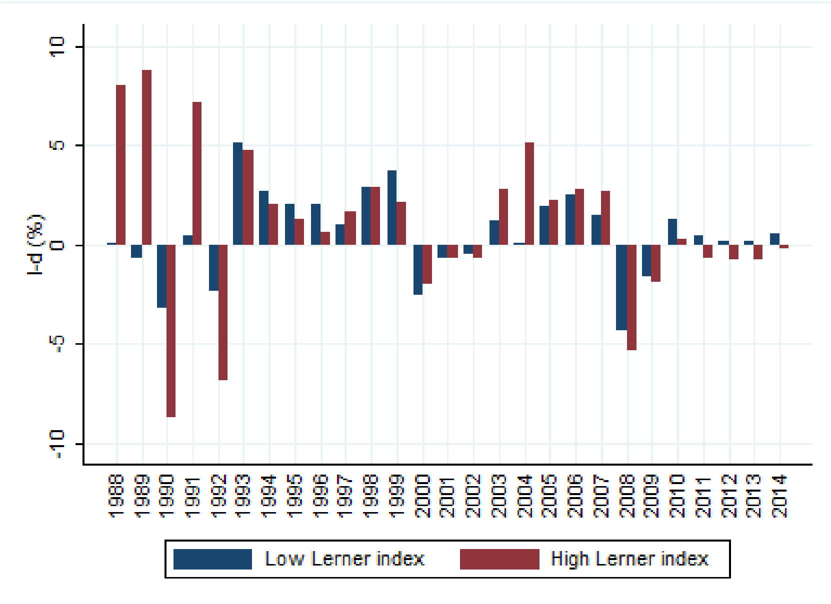
The growing or large customer funding gap is of concern as it requires resorting to market sources of liquidity, which may be scarce especially if long-term funding is required, thus raising the risk of systemic bank failures (Allen et al., 2012). In particular, applying the concept to the local market (local funding gap accounting only for local deposits and loans), Albertazzi and Bottero (2014) show that in the aftermath of the Lehman Brothers bankruptcy, Italian banks with higher local funding gap restricted

Figure 2: Loan growth versus deposit growth worldwide.



Notes: The figure plots loan growth versus deposit growth for individual bank/year observations with below (top panel) and above (bottom panel) median market power, as measured by the Lerner index. Sources of data and variables are defined in Section 3.2

Figure 3: The dynamics of the $(l-d)$-gap.



Source: Authors' calculations, see details in Section 3.2

their lending by more than those with a lower gap. It is therefore of policy relevance to relate our lending-funding growth gap to the customer funding gap and through it to the potential build-up of liquidity risks.

A change in the relative customer funding gap, $\Delta_t\left(\frac{L-D}{L}\right)$, can be written as:[10]

$$\Delta_t\left(\frac{L-D}{L}\right) = \frac{1}{1+l_t} \cdot (l_t - d_t) \cdot \frac{D_t}{L_t}. \tag{1}$$

It follows that a positive growth gap $l_t - d_t$ implies a growing relative customer funding gap, as $\Delta_t\left(\frac{L-D}{L}\right) > 0$, while a negative $l_t - d_t$ reduces the funding gap. Persistence in the positive sign of $l_t - d_t$ leads to a build-up of the customer funding gap in the long run.

Knowing the determinants of $l_t - d_t$ thus helps predict the change in the funding gap

[10] See Appendix A.

for banks with known loan-to-deposit ratio: banks who are likely to have a larger $l_t - d_t$, are also likely to experience a higher funding gap than their counterparts with the same $\frac{D_t}{L_t}$ but lower $l_t - d_t$. Here $\frac{D_t}{L_t}$ measures a bank's reliance on deposits as the source of funds. Large banks can therefore end up with large funding gaps, like in Albertazzi et al. (2014), if they have a larger $l_t - d_t$ (which may occur if they are reluctant to reduce lending in response to a reduction in deposit intake), especially if they initially have a large portion of deposits in their funding portfolio.

2.4 The lending-funding growth gap and market power

We now link the smoothing function of banks to their market power. Consider a bank funded at time t by deposits D_t and other sources of finance K_t, such as interbank borrowing, debt finance and capital accumulation. Deposits are subject to exogenous shocks. As they represent a significant portion of the bank's liabilities, these shocks may be transmitted to the bank's investment decisions through the balance-sheet constraint. The bank performs qualitative asset transformation and in doing so invests fraction α_t of its funds in risky loans L_t, with the remainder invested in market securities, including but not limited to safe assets:

$$L_t = \alpha_t \cdot (D_t + K_t) \,. \tag{2}$$

The bank thus chooses its portfolio composition α_t, and hence L_t, subject to this balance sheet constraint, so as to maximize its profit. Our interest is in measuring the ability of the bank to smooth the impact of a given change in deposits on the lending function. The main focus is therefore on constraints the bank faces in performing this smoothing role, for which reason the optimization problem is not explicitly presented here, although factors affecting optimal portfolio choice and borrowing decisions will be discussed below.

As before, denote $l_t = \frac{L_{t+1} - L_t}{L_t}$ the growth rate of loans; similarly let d_t, k_t and g_t denote the growth rates of deposits, funding from other sources, and the overall size of the bank $(D_t + K_t)$, respectively; finally, let $a_t = \frac{\alpha_{t+1} - \alpha_t}{\alpha_t}$ be the percentage change in the fraction of loans in the bank's portfolio from t to $t+1$. Re-writing (2) in growth rates and subtracting d_t from both sides yields

$$l_t - d_t = a_t \left(1 + g_t\right) + \phi_t \cdot \left(k_t - d_t\right), \tag{3}$$

where $\phi_t = \frac{K_t}{D_t + K_t}$ is the leverage parameter, referring to the bank's current reliance on deposits or "alternative funding" as a source of finance.[11] At the beginning of period t, parameter ϕ_t is fixed by the existing levels of K_t and D_t, and is independent of their growth, i.e., this is not a forward-looking decision variable.

The right-hand side in (3) highlights that smoothing can be achieved via two main channels: either by portfolio reallocation (via changes in a_t), or by resorting to alternative funds or its buffer, or both simultaneously. The term $k_t - d_t$ describes the ability of the bank to offset the outflow of deposits with funding from alternative sources. As discussed above, parameter ϕ_t is exogenous for decisions made at time t about actions at $t+1$, in contrast to k_t, which is the growth rate of alternative funding and hence may be part of the bank's decision in period t about the composition of its assets and liabilities at $t+1$.

Equation (3) relates our variable of interest to the main parameters of the bank: portfolio adjustment a_t, overall balance sheet growth g_t, leverage parameter ϕ_t, and "access to alternative (non-deposit) sources of funding" k_t; the latter comprises banks' capital as well as funds banks obtain by borrowing from other financial institutions (e.g. interbank borrowing or refinancing from the central bank) and the wider market (such as issuing bonds and other securities). As the bank's lending portfolio depends on the

[11]Parameter ϕ_t is, in general, distinct from the capital ratio; the two will coincide only if K_t consists solely of the bank's capital.

quality of loans, we would also expect $l_t - d_t$ to positively depend on loans quality. To account for this, in the subsequent analysis we will control for the quality of loans as proxied by the share of non-performing loans, NPL_t, at the beginning of each period t. Our main interest is however in the impact of market power on $l_t - d_t$. The remainder of this section thus focuses on this.

A major difference between the two mechanisms of smoothing, portfolio re-balancing and external funding, is in their feasibility and costs. Portfolio reallocation (sales of liquid assets) is a relatively cheap and reversible option due to the liquid nature of assets involved; a bank can potentially resort to this source of liquid funds at any point as long as regulatory liquidity constraints are not binding. In contrast, a quick arrangement of an inflow of funds from other (non-deposit) sources is not always possible especially if these require issuing financial instruments like bonds or equity. Once financing arrangements are made, these are irreversible until the maturity of debt instruments involved, or until a buyout is arranged. A bank would have different strategic considerations and incentives to seek alternative funding if it faces or expects an outflow of deposits, or if deposits are projected to grow. With this potentially asymmetric effect of declining and growing deposits on our main variable of interest, we thus deem it necessary to consider the two cases separately.

2.4.1 Declining deposits

Ability of banks to smooth shocks implies that lending declines by less than proportional to the decline in deposits (or not at all). If the bank instead reduces loans by more than proportionally or proportionally to the decline in deposits, this could amplify the downturn via its effects on the real economy.

With regards to the usage of "alternative funds", we can distinguish between three scenarios:

1. The bank has no access to "alternative sources", $\phi_t = 0$, hence $l_t - d_t = a_t\,(g_t + 1)$, and smoothing can only be achieved through portfolio reallocation as represented by changes in a_t: the bank sells safe assets in order to grant more loans.

2. The bank has limited access to "alternative sources": these represent a non-negligible fraction of funding, $\phi_t > 0$, but cannot be *endogenously* changed in the short term, $k_t = 0$. To smooth the impact of a decline in deposits, this bank needs to sell less safe assets than if it had no access to alternative sources: $l_t - d_t = a_t\,(g_t + 1) - d_t \cdot \phi_t$. Alternative funding here provides a cushion against shocks through diversification of liabilities, as it lessens their impact on lending, unless *exogenous* changes in d_t and k_t are correlated.[12] Banks with lower reputation (related to past record, market power or size) would be more likely to have only limited access to alternative funding.

3. The bank has unconstrained access to "alternative sources", and can freely choose the amount obtained from them at any point in time, $\phi_t > 0$, $k_t \neq 0$. This bank can resort to alternative funds to compensate for the shortage of deposits. Reputable banks (for example "superpower" banks in terms of market power or size) would have this advantage. Barclays' or Credit Suisse's quick recapitalization during the recent global financial crisis are examples of such banks.[13]

[12]To stress this point, one may wish to distinguish between changes in alternative funding due to the bank's decision, k_t^B, and those beyond the bank's control (exogenous to the bank), k_t^E, i.e. $k_t = k_t^B + k_t^E$. In this case, limited access of the bank to the alternative market is given by $k_t^B = 0$, and exogenous shocks to this market are represented by $k_t^E \neq 0$. The latter can be correlated with shocks to the deposit market, and if $d_t = k_t^E$ then the bank cannot diversify on the liabilities side.

[13]In the UK most big banks had to accept the UK Government bailout sceheme, Barclays were able to raise over £6.5bn without government help. (see, e.g., "UK banks receive 37bn bail-out", BBC, 13 October 2008, http://news.bbc.co.uk/1/hi/business/7666570.stm). In Switzerland, the only two banks affected by the crisis were differently recapitalized. UBS obtained 6 billion Swiss francs ($ 5.3 billion) from the government in return for a 9.3 percent stake, while Credit Suisse raised 10 billion francs from investors ("Swiss banks raise emergency funds to fight crisis", Reuters, 16 October 2008, http://www.reuters.com/article/us-financial-swiss-banks-idUSTRE49F1J320081016).

One of our central hypotheses to be tested, is whether market power can help banks reduce the impact of deposit outflows on lending. The three scenarios above demonstrate this may be due to the differences in banks' ability to obtain funding from "alternative sources". For example, Fonseca and González (2010) provide evidence of a positive relationship between bank market power and their capital buffers. The main reasons for market power to affect this ability of banks to raise funds are: reputation (banks with higher market power may invoke less reliability concerns on the side of lenders), higher net present value of banks with higher market power (usually associated with better ability of these banks to screen and monitor borrowers) and competitive pressure (the need to create precautionary arrangements "just in case"). The first two would effectively reduce the cost of access to and employment of alternative sources of funds while the third may have a qualitatively different effect depending on the market situation. While it may be true that banks with very high market power ("superpower" banks) can manipulate the market and in particular use ties and connections to enable inflow of funds when necessary, this would be less likely for banks that have some influence on prices (and thus market power) but not enough to have a strategic influence on other market participants. Banking sectors across the globe usually are not perfectly competitive, yet only few banks enjoy superpower. For the remainder of them, we expect that competition (rather than market power) would force them to set up long-lasting arrangements (such as bank safety networks and agreements with other potential funders) enabling access to funds when necessary.

Hypothesis 1 *The impact of market power on smoothing ability is non-linear: more market power reduces the ability to smooth for lower values of market power, and improves it for superpower banks (e.g. non-linear association between the market power index - positive quadratic term - and* $l_t - d_t$*), ceteris paribus.*

We could also expect that larger banks have better access to alternative funds. For example, because of economies of scale that reduce the relative cost of relevant arrangements on them.

Hypothesis 2 *Larger banks are more likely to provide effective smoothing.*

We note that size is endogenous to past profit growth which is in turn related to market power. To the extent that we include a direct measure of the evolution of market power over time, size will then largely capture aspects driving lending relative to deposit growth that are unrelated to market power. Thus, in this case, we do not expect to find the above-mentioned non-linearities nor asymmetries (discussed in the next section) in the size effect.[14]

Martinez-Miera and Repullo (2010) discuss the "margin effect": banks with higher market power charge higher rates on loans and use these increased revenues to add capital that provides a buffer against losses. However, this effect comes at interplay with more risk taken on through investments as monopolistic banks charge higher rates and thus invoke riskier investment. Similarly, in equation 3 the access-to-funds effect is at interplay with the portfolio composition effect. We should therefore consider Hypothesis 1 jointly with the portfolio allocation decision. The latter is effectively about the fraction of risky and safe assets, hence we draw on the literature regarding the impact of market power on banks' risk-taking decisions and riskiness. Several authors, e.g., Boyd and De Nicolo (2005), Martinez-Miera and Repullo (2010), Jiménez et al. (2013), have addressed the non-linear relationship between competition and risk-taking by banks. The main line of argument in Boyd and De Nicolo (2005) is that, on the one hand, when banks can earn

[14]The main role of size would be expected to act via its cost-reducing effect on banks' access to funding. However, based on our findings, this potential cost reduction plays little role in enabling access to emergency borrowing in times of declining deposits. In contrast, when deposits expand, larger banks are able to extend more loans than smaller banks, indicating that economies of scale mainly affect the assets side of the balance sheet: large banks have better opportunities in attracting borrowers.

monopoly rents they become relatively conservative and invest more in safe assets but, on the other hand, banks with more market power can charge higher interest rates on loans which imposes higher risk of borrowers' bankruptcy (amplified by moral hazard). Martinez-Miera and Repullo (2010) suggest this "risk-shifting" effect is offset by the "margin effect" discussed above. They obtain that "the risk-shifting effect tends to dominate in monopolistic markets whereas the margin effect dominates in competitive markets."

Thus, for most banks, higher market power can be associated with riskier investment and less safe and other marketable assets that could be sold to provide liquidity to offset declining deposits without major effect on loans. However, not only can "superpower" banks charge higher interest rates but they also have a better choice of borrowers, thus the risk-shifting argument is less applicable to them. The portfolio composition effect thus produces a similar implication as the access-to-funds argument above, already formulated as Hypothesis 1.

On top of that, the portfolio choice of the bank also depends on the quality of loans; the higher the latter, the more likely the bank is to substitute the dropping out deposits with funds obtained through sales of the safe asset in order to reduce the impact on the total quantity of loans provided. Assuming the quality of loans can be captured by the percentage of non-performing loans, we form the following hypothesis:

Hypothesis 3 *Banks with low NPL are more likely to provide effective smoothing (negative association between NPL_{t-1} and $l_t - d_t$).*

2.4.2 Growing deposits

When deposits fall, banks may experience shortage of funds and have to trigger arrangements that would reduce the risk of illiquidity. In times of deposit growth there is no need of such a fight for survival. In this case, banks' concern is instead just about getting a bigger chunk of the market. Our variable of interest, $l_t - d_t$, reflects here the willingness of banks to generate loans in excess of deposits intake. This may be due to prospects during an economic boom, for example. If an increase in deposits leads to a more than proportional (or proportional) increase in loans we face amplification of a positive shock to deposits. Alternatively, if banks are cautious and do not transmit the growth in deposits fully into the provision of loans, this can have a smoothing effect cooling the economy down and avoiding overheating or bubbles.

Again, banks have two possibilities for extra growth in lending - either to raise funds through alternative sources beyond deposits, or to replace safe assets in their portfolios with loans. As discussed in relation to Hypothesis 1, there are two channels of the effect of market structure on the "smoothing" variable: refinancing versus portfolio re-balancing. When deposits fall, banks seek to activate both channels and market power comes into play: superpower banks can easily arrange refinancing and have reserves to re-balance. When deposits grow, banks are not credit constrained thus they are not as keen on refinancing. Raising funds would exhaust sources of funding that cautious banks would perhaps like to keep available for "bad times" when deposits fall. Portfolio reallocation remains however a feasible option. Competitive banks could reduce safe assets to fund more loans as in the literature on competition-fragility. In boom times, however, we do not have the risk concern that banks with higher market power engage in riskier investment by setting rates too high. By contrast, as they do not need to sharply expand their loans given such banks already enjoy higher than competitive revenue, they have less of a need to use the momentum to generate extra profits. Superpower banks on the other hand, are unconstrained in alternative sources of funds so that they could use these to exploit the momentum and raise their market share. Thus, we expect a non-linear relationship, as in Hypothesis 1, albeit for different strategic considerations.

Although differences between banks with different market power may still exist, they would be less pronounced during periods of deposit growth as compared to periods of falling deposits due to the reasons analyzed above. This asymmetry can be informative about the roles of the two channels, i.e., access-to-funds versus portfolio reallocation. Authors like Drechsler et al. (2016) consider deposits as the most important source of funds. If other sources were negligible only the portfolio channel would matter, and we would then expect a more symmetric response to deposit growth/decline than we actually observe in the data. The asymmetry we observe would then be consistent with the access-to-funds channel being non-negligible.

Hypothesis 4 *In times of deposit growth the relationship between market power and net loan growth,* $(l - d)$*, is similar to that in Hypothesis 1 but weaker (lower coefficients).*

Other hypotheses from the previous section also remain in place. However, as above, relations during periods of growing deposits may differ from those during periods of deposit outflow. If the benefits banks derive from economies of scale and scope are asymmetric between the lending and funding arms, and the channels (re-balancing versus refinancing) are differently activated when deposits go up or down, we ought to observe a differential impact of the banks' size on our main variable of interest. We expect economies of scale to be more pronounced in lending activities (large banks have advantages in attracting new borrowers) than in funding (reputation aside, large banks may save on costs of searching for potential funders, yet securing a large amount of funding may be more complicated).[15] With this in mind, if the refinancing channel is of

[15]Studies of economies of scale and scope in banking follow either the intermediation approach (deposits are treated as inputs and loans as outputs) or the production approach (both deposits and loans are treated as products, i.e. outputs), with a focus on deposits as the main source of funds. In the review of the pre-1990-s literature on this topic by Clark (1988), an overwhelming majority of studies estimate the overall - as contrasted to product-specific - economies of scale. Clark (1988) writes (p. 17-18): "Product-specific economies of scale are present if a decline in the per-unit cost of producing a specific product occurs as the output of that product increases. [...] in practice such a measure is not meaningful

lower importance when deposits grow, and the portfolio re-balancing is the major mechanism that governs net loan growth, $l-d$, then we should expect economies of scale, and hence the size of financial institutions, to matter more in periods of growing deposits than in periods of their decline. A similar argument, with an opposite sign, applies when economies of scale are more pronounced for funding than for lending activities. The empirical literature leaves us largely agnostic with regards to activity-specific scale economies, however we can expect an asymmetric role of size, depending on whether deposits grow or decline.

Hypothesis 5 *The impact of bank size on smoothing in periods of deposit growth is different from that in episodes of deposit outflow.*

Equally, we can expect a weakened effect of the quality of loans on lending decisions in periods when deposits grow, if the latter is associated with an improvement in economic conditions and a general reduction in economic risks.

Hypothesis 6 *The impact of $NPLs$ on the lending-funding gap is different in periods of deposit decline and deposit growth; GDP growth positively contributes to net loan growth.*

An important take-away from this section is that a positive impact on the smoothing variable during periods of deposit booms can be seen as amplification of shocks. However, based on the preceding analysis, this may be less of a concern in terms of industrial organization effects as the impact of competition (market power) is expected to be smaller when deposits grow.

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since, under joint production, it is generally impossible to change the output of one product while holding constant the output of the other products."Theoretically, however, different banking activities are differently susceptible to economies of scale. For example, Walter (2003) and Boot and Ratnovski (2016) emphasize scalability of transaction banking in general and trading in particular. Even though differences in activity-specific economies of scale are hard to directly observe empirically, they indirectly manifest in the differential impact of size in our hypotheses.

3 Estimation and Data

3.1 Estimation

To assess the smoothing/amplification capacity of banks, we consider the sensitivity of the lending-funding growth gap to a bank's market power and other bank and market characteristics. We thus estimate the following regression equation[16] as our baseline:

$$[GL_{i,j,t+1} - GD_{i,j,t+1}] = \alpha_f + MP_{i,j,t} + MP^2_{i,j,t} + GY_{j,t} + NPL_{i,j,t-1} + X_{i,j,t} + \varepsilon_{i,j,t} \quad (4)$$

In equation (4) the difference in the growth rates between loans ($GL_{i,j,t+1}$) and deposits ($GD_{i,j,t+1}$) for bank i in country j between periods t and $t+1$ is regressed on market power ($MP_{i,j,t}$), market power squared ($MP^2_{i,j,t}$) to capture potential non-linear effects of market power, the GDP growth rate ($GY_{j,t}$) to capture the business cycle effect on net loan growth, non-performing loans ($NPL_{i,j,t-1}$), and a vector of bank characteristics $X_{i,j,t}$. The rationale for including $NPL_{i,j,t-1}$, apart from it being the focus of Hypotheses 3 and 6, is that when the prevalence of non-performing loans in the economy is low, banks would need to make less provisions which would enable them to increase loan growth for any given rate of deposit growth. As a robustness check, we will also consider $PROV_{i,j,t-1}$, loan loss provisions made by bank i in country j at time $t-1$, as an alternative to non-performing loans. Finally, for identification purposes, α_f denotes a vector of fixed effects, while ε it is an bank-country-level shock, which captures stochastic disturbances.[17]

As our theoretical predictions are different for episodes of declining and growing

[16]We change notation at this point to emphasize the distinction between equation (3) that provides a theoretical justification of the two main channels via which market power can affect net loan growth, and the empirical approach chosen to test the relationship as given in regression (4). Market power enters the latter explicitly while it only implicitly affects the components on the right-hand side of the former.

[17]We note that the error term obtained from the estimation of equation (4) is likely to be serially correlated due to the fact that the dependent variable is observed at the bank-country-year level and some of the explanatory variables are observed at different level. This problem is comprehensively analyzed by Moulton (1990). Thus, estimation is carried out using standard errors clustered by country.

deposits, we will also estimate the above equation for two subsamples, where bank-year observations will be split according to the sign of the deposit growth variable. Thus, we consider the behavior of $GL_{i,j,t+1} - GD_{i,j,t+1}$ during episodes of falling and rising deposits separately. This can uncover important asymmetries in line with our theoretical exposition in the previous section.

In equation (4) endogeneity can arise both from reverse causality and an omitted variable bias. Reverse causality could emerge from the preferences of banks with higher market power to impede competition and offer monopolistic products with high markups. To alleviate concerns of reverse causality, all the right-hand side variables except the non-performing loans are lagged once. From a statistical viewpoint, the literature commonly employs lagged explanatory variables to mitigate endogeneity issues that emerge due to reverse causality (e.g.,Beck et al. (2013)). On the theoretical side, the banks are aware of their main balance-sheet characteristics when deciding on their cost structure and pricing policy for the next period (i.e., the components of the Lerner index).

In turn, the omitted variable bias could arise because there are some unobserved bank-country-year reasons affecting banks' market power (e.g., specific unobserved elements of the tax system, ability to carry out profit shifting and/or portfolio diversification). On this front, the structure of our sample allows the inclusion of bank, country, year, specialization and country×year high dimensional fixed effects. These fixed effects saturate our analysis from other within bank (time invariant), year (common shocks) and country-year (time varying country characteristics).[18]

3.2 Data

For the construction of the dataset, we rely on Bankscope as our primary source of bank-level data. Our data set includes data for 8,477 banks in 129 countries, available

[18]Including bank×year is not feasible because these effects completely identify equation (4).

annually for the period 1992-2015. We exclude earlier years because of concerns associated with coverage and accounting issues. Our focus is on commercial, savings and cooperative banks. We exclude real-estate and mortgage banks, investment banks, other non-banking credit institutions, specialized governmental credit institutions and bank-holding companies.[19] The excluded institutions are less dependent on the traditional intermediation function and have a different financing structure compared to our focus group. In short, our focus in this study is on banks carrying out traditional banking activities.[20] We have included in our sample only countries that had at least three banks in each year of our panel.

We apply three further selection rules to avoid including duplicates in our sample. This is an essential part of the sample-selection process that is absent from most empirical studies using the Bankscope database (for a similar strategy with ours, see Delis et al. (2016)). First, even though we do not include bank-holding companies, we still need to exclude double entries between parent banks and subsidiaries. Bankscope's consolidation code system allows downloading either consolidated or unconsolidated statements, but in some cases information on either unconsolidated or consolidated statements of certain banks is not available. We use either the consolidated or the unconsolidated statement depending on which one is available. This is a non-trivial process that requires the re-examination of all banks on an individual basis to avoid double-counting. Notably, there are cases of banks with subsidiaries in domestic or in foreign countries and one should be very careful to avoid double-counting of subsidiaries that are established, for example, in a foreign country.[21]

[19]The main activities of excluded financial institutions relate to the following: provide mortgages; assist corporations and governments in a range of services (e.g., M&As, raising capital, etc.); provide credit to public sectors; provide funding for public or municipal projects.

[20]Inclusion of bank-holding companies could lead to double counting, as these are corporations controlling one or more banks. We always check that we have the subsidiaries of these companies in the sample to avoid false exclusion of some banks.

[21]Let us provide some examples to clarify this point. Assume that bank A_1 is the parent bank with a

Second, we account for mergers and acquisitions (M&As). We went through all the M&As one-by-one and made sure that both banks appear separately in the sample before the M&A and only the merged entity or the acquiring bank is included in the sample after the event. For example, if bank A and bank B merged in 2005, we create a new entity AB after 2005 and exclude the separate financial accounts of A and B that might still be reported for some time after the merger. We identify M&As and their timing using Bankscope and the websites of the merging parties.

Third, in the US there are many distinct banks that have the same name but are active in a different state. To solve this issue, we relate the value of total assets of, say, bank i in the last year this bank appears in our sample with Bankscope's identification number for bank i. This also allows avoiding problems with our procedure concerning M&As described above.

Sources of the variables used in the empirical analysis and their definitions are summarised in Table 1 and Table 2 presents summary statistics. In Appendix B1, we additionally present the total number of banks in our sample by year, and the correlations of the main variables.

[Please insert Table 1 about here]

[Please insert Table 2 about here]

consolidated (C) statement and banks A_1^1, A_1^2 and A_1^3 are subsidiaries and unconsolidated (U) statement. If we include all banks in our sample we will have 3 duplicates. Hence, we need to subtract either the percentage of the subsidiaries or to exclude the subsidiaries from the sample. The former solution is not feasible because we do not have enough information for the percentage and the time duration of the ownership of the subsidiaries, thus we resort to the latter solution. Two other examples for the case of banks with foreign subsidiaries that we account for using the same strategy are (i) B_1 is a parent bank with a C statement, B_1^1 is a subsidiary bank operating in the domestic market with a C or a U statement and $B_1^{1,1}$ is a sub-subsidiary bank operating in the domestic market and (ii) B_1 is a parent bank with C statement, B_1^2 is a subsidiary bank operating abroad with a C or a U statement and $B_1^{2,1}$ is a sub-subsidiary bank operating in the domestic market with a U statement.

3.3 Measures of market power

The measurement of market power has received much attention in the literature. The Lerner index (Lerner (1934)) remains a popular measure of market power due to its simplicity and transparency. It is defined as

$$L_{ijt} = \frac{P_{ijt} - MC_{ijt}}{P_{ijt}} \tag{5}$$

where P_{ijt} and MC_{ijt} are the price of bank output i in country j at time t and the marginal cost of the production of this output, respectively. The Lerner index ranges between zero and one, with zero corresponding to perfect competition and larger values reflecting more market power (and less competition). The index can also be negative if $P_{ijt} < MCijt$, which is of course not sustainable in the long run.

The Lerner index has a number of characteristics that make it an appealing measure of market power. First, the Lerner index measures departures from the competitive benchmark of marginal cost pricing. This makes it a simple and intuitively appealing index of market power (competition). Second, the Lerner index is perhaps the only structural indicator of market power that can be estimated at the bank-year level. This is quite important for the purposes of our study, as the unit of our analysis is at the bank-country-year level. Third, as Beck et al. (2013) argue, the Lerner index is a good proxy for current and future prots stemming from pricing power, while it is not constrained by the extent of the market. Moreover, the Lerner index captures both the impact of pricing power on the asset side of the banks balance sheet and the elements associated with the cost efficiency on their liability side.

Computation of the Lerner index requires knowledge of the marginal cost. When such information is unavailable, the marginal cost can be estimated using econometric methods. A popular approach has been to estimate a translog cost function and take its derivative to obtain the marginal cost. Some recent work has shown that it is possible to improve on this methodology with semiparametric or nonparametric methods that allow for more flexibility in the functional form (Delis et al. (2014, 2016)). As we follow the exact same approach as in Delis et al. (2016), we only provide salient details in Appendix C.[22]

Most importantly, the semiparametric nature of the method implies that no assumption regarding the functional form of the cost equation is made globally. An assumption is just made in local neighborhoods of observations. This is important as it is usually quite difficult for the researcher to be certain about the validity of the chosen functional form. The flexibility of the semiparametric technique also allows using large international samples of banks from different countries, without being concerned that certain banking markets in different countries or banks within the same country face or adopt different production technologies. Hence, this approach takes into account the heterogeneity in the production technology across banks, countries, and time. We also examine the sensitivity of our results to the use of different variants of the traditional Lerner index and other alternatives measures of market power like the Boone indicator. In Table (C4) of the Appendix C, we report the annual averages of the Lerner index.

4 Results

4.1 Market power and smoothing

Our baseline regression equation (4) serves to assess the potential non-linear effect of market power stated in Hypotheses 1 and 4. However, in order to emphasize the importance of considering the non-linear affect of market power, we begin by considering a shorter specification omitting non-linearities and other theory-implied variables next. This will then serve for comparison with the more complete specification described by

[22] In unreported results we also consider the sensitivity of our results using and the translog cost (parametric method) function to estimate marginal cost (Beck et al. (2013)).

equation (4) above.

The first specification we estimate, shown in column 1 of Table 3, considers the effect of the Lerner index on $l_t - d_t$ controlling only for loans quality and time effects, omitting non-linearities and other theory-implied variables. Subsequently, we allow for country, specialization, and bank fixed effects (column 2) and the interaction of the first two with time effects (column 3).

Our first result, shown in the second row of Table 3, is that higher market power (higher value of the bank's Lerner index) reduces the lending-funding growth gap. This can occur either via a greater fall in lending relative to falling deposits (amplifying adverse effects during episodes of falling deposits), or via a lower increase in lending relative to increasing deposits (smoothing the cycle and reducing the build up of risk during episodes of deposit growth). This is consistent with hypothesis 1. We note here that these estimates do not capture the case of "superpower" banks, considered in the next subsection where we include potential non-linearities for market power. The separate estimation for periods of declining and growing deposits ("Deposits DOWN" and "Deposits UP" in the table) confirms this relationship, yet this linear estimate lends little support to our Hypothesis 4, which predicted a difference in the role market power plays in episodes of deposit inflows versus periods of deposit outflows. As we show next, this is due to the omission of the non-linear term, suggesting non-linearity is crucial for this type of analysis.[23]

We also find that an increase in non-performing loans limits a bank's ability to extend loans relative to its deposit inflows, in line with Hypothesis 3. Our results are robust to controlling for a number of fixed effects, including country×year×specialization

[23] We show that there is an asymmetric impact of market power on $l_t - d_t$, with impact always greater during periods of deposit decline as compared to periods of deposit growth, once we control for the non-linear effect of market power. This is not present in the 4th and 6th columns relative to the 7th and 9th columns of Table 3 where we omit non-linearities.

effects. This is evident in columns (1)-(3) of Table 3, as well as in columns (4)-(6) and (7)-(9) where we consider periods of declining and rising deposits respectively. In all specifications, the coefficients for the NPL variable have larger absolute values when deposits decline, consistent with Hypothesis 6: the impact of the quality of loans on banks' smoothing ability appear stronger in periods of deposit decline.

[Please insert Table 3 about here]

Figure 4 presents a fitted line summarizing the empirical bivariate relationship of loan growth and deposits growth (%) in each case, against the Lerner index. The regression line for loan growth exhibits a statistically significant U-shape relationship, while for deposits growth it has a negative statistically significant slope. Similarly, the lending-funding growth gap (%) plotted against the Lerner index (figure 5) exhibits a U-shape relationship. It remains to be examined whether this continues to hold when controlling for unobserved heterogeneity in a multivariate setting and whether it can be interpreted as causal. For one, the U-shape suggests it's useful to explore potential non-linearities in the relation between the lending-funding gap and market power further. We pursue this next within a multivariate setting in our baseline regression specification.

Our baseline specification is given by regression equation (4) that extends the specification estimated in Table 3 by including a number of variables implied by theory, as motivated in our theoretical exposition previously. This involves the inclusion of bank-specific size and the country-specific business cycle over time and, importantly, of the squared term of the Lerner index that helps us allow for non-linear dependence of the shock-smoothing ability of banks on market structure.

As shown in Table 4, the square of the Lerner index enters positively implying that at high levels of bank market power, the negative impact of market power on net loan growth can be reversed. That is, at very high levels of market power, there is a threshold

Figure 4: Loan growth and deposits growth

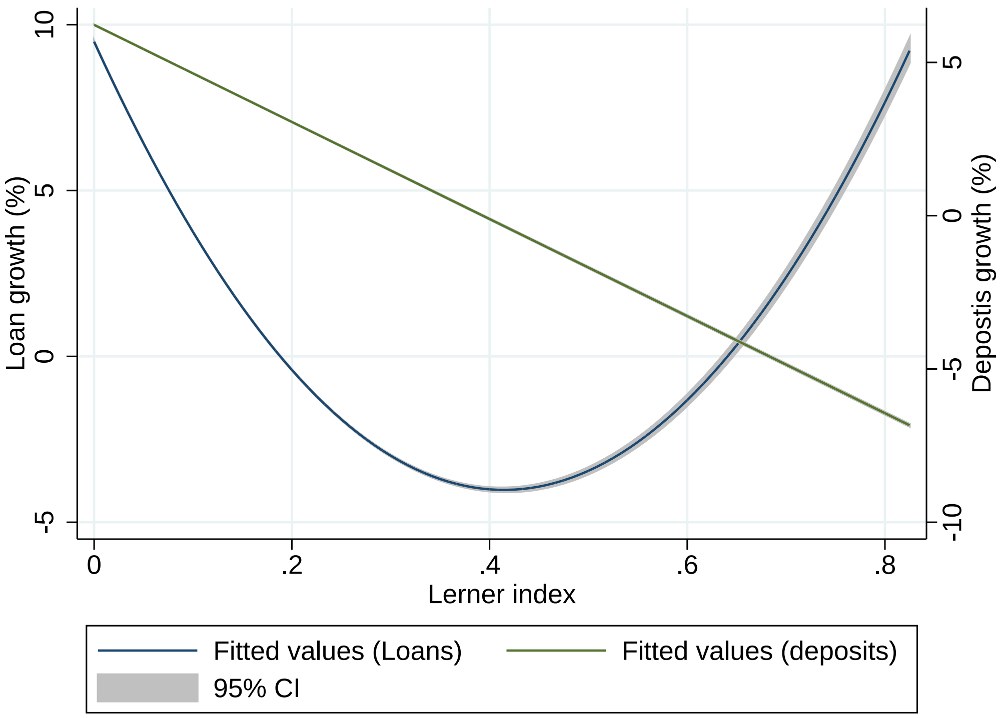
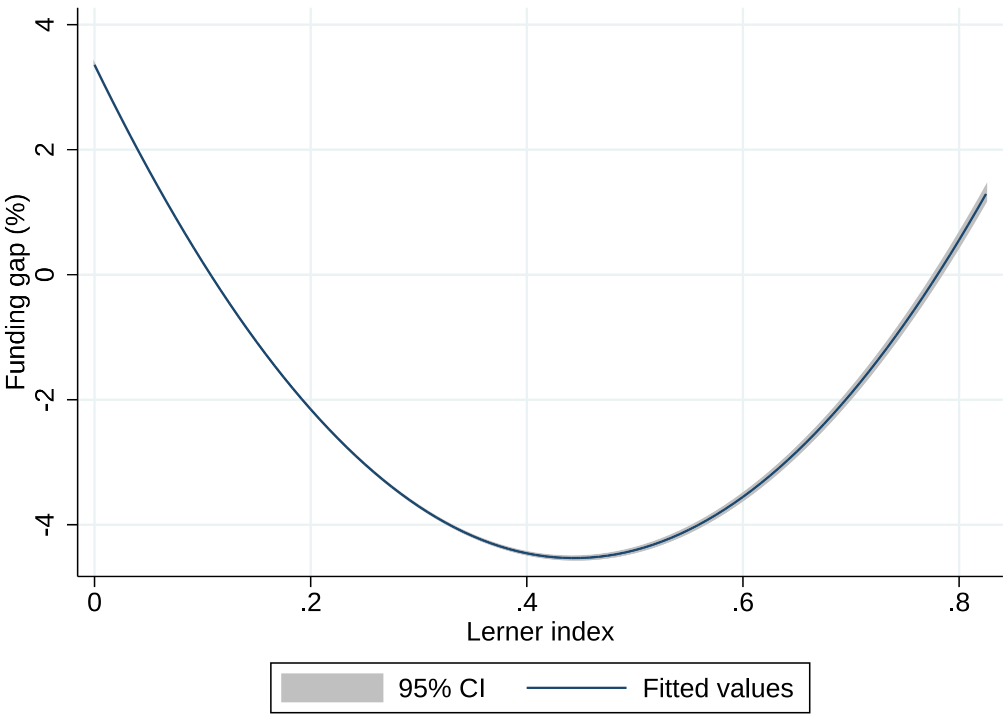


Figure 5: Lending-funding growth gap and market power



past which the effect of market power on loan growth relative to deposits growth, turns positive. This threshold is, for example, estimated at 0.37 in periods of deposit decline as shown in column 6 of Table 4. The latter value is approximately one standard deviation above the mean value of the Lerner index for the banks in our dataset, with just 5 percent of banks above this market power value. This non-linear dependence is exactly what is predicted by our Hypothesis 1.

The above effect of market (super) power on $l_t - d_t$ is related to smoothing (in the presence of falling deposits) or amplification and risk accumulation over time (in the case of rising deposits). For the great majority of banks however, with levels of market power below the above-mentioned threshold value, the effect of market power on $l_t - d_t$ is consistent with amplification in the presence of falling deposits and with smoothing and a reduction in the build-up of risk during periods of rising deposits. To distinguish between the impact of market power on smoothing versus amplification that applies to the average bank or to superpower banks, we need to consider separately episodes of decreasing and increasing deposits. We pursue this next.

When we do so, we see that the impact of market power appears stronger during episodes of deposit outflows as compared to periods of increasing deposits. This is evident in Table 4 comparing columns (4)-(6) with the respective columns (7)-(9) in each case, supporting our Hypothesis 4.

The asymmetric effect of market power for periods of deposit decline versus periods of deposit growth apparent in the second row of Table 4 suggests that the adverse role of market power for the average bank on smoothing when deposits are falling (more reduction in lending in periods of deposit decline), matters more than the positive role of market power for the average bank on smoothing when deposits are growing (i.e., the negative impact of market power on amplification associated with our measure $l_t - d_t$

during episodes of deposit growth).

However, since in episodes of deposit outflow there is also a starker contrast between the majority of banks and "superpower" banks, as indicated by a larger positive quadratic term in row (3) of Table 4 comparing columns (4)-(6) to the respective columns (7)-(9), the presence and prevalence of "superpower" banks in an economy's system will matter more for smoothing (less reduction in lending when deposits fall) than for amplification during periods of rising deposits (when $l_t - d_t$ is associated with amplification of positive shocks so that the positive impact of more market power for superpower banks on $l_t - d_t$ amplifies these.)

We note that as the Lerner index is included in the regressions in addition to bank size, its coefficient captures market power aspects that affect loans relative to deposit growth but are not associated with the present size of the bank. Bank size itself typically affects $l_t - d_t$ positively, but insignificantly so during periods of falling deposits. The differential effect of bank size in periods of deposit growth and deposit decline shown in Table 4 is in line with our hypothesis 5. Similarly, $l_t - d_t$ exhibits positive comovement with the country's business cycle. The positive contribution of GDP growth both when deposits decline and when they grow supports the argument behind Hypothesis 6: medium-term economic growth reduces overall risks and thus contributes to lending via portfolio re-balancing. Finally, an increase in non-performing loans reduces the bank's ability to extend loans relative to its deposit inflows, and apparently more so during periods of falling deposits. We note that the latter is more evident in specifications without GDP growth in columns (5-6) and (8-9) in Table 4, where the quality of loans evidently affects the $l - d$-gap differently depending on whether deposits grow or fall.

[Please insert Table 4 about here]

Overall, Tables 3 and 4 support our key Hypothesis 1: more market power on average reduces the ability of banks to smooth deposit outflows, yet for superpower banks the opposite holds. This effect of market power is highly robust in all specifications.

4.1.1 Components

By definition, the variation in $l_t - d_t$ over time is due to changes in either of its two components. Our argument refers to the degree to which banks adjust lending in response to a given change in deposits. Market power then affects the ability and willingness of banks to grant loans when the flow of deposits changes. It is, however, possible that market power also affects the inflow of deposits itself. Our main variable does not differentiate between banks that sharply reduce lending due to a minor deposit outflow, and those that keep lending unchanged when deposits grow. To this effect, we have considered periods of declining deposits and rising deposits separately in the previous sub-section and Tables 3 and 4. To better identify the role of market power, we now consider its effect on each of its two components, l_t and d_t, separately. This is done in Table 5.

The component analysis presented in Table 5 demonstrates that market power affects lending much more strongly than it affects deposit-taking: in all specifications, the coefficient of the Lerner index for loan growth is at least twice as high as that for deposit growth. Moreover, the significance of this coefficient for loan growth remains significant at the 1% level throughout, while for deposits growth this is only 10% in the model controlling for country × year × specialization fixed effects shown in column 6 of Table 5. Our findings here show that the adverse impact of market power for the average bank on loan growth is substantially bigger than its impact on the rate of growth of deposits. It follows that the impact of market power for the average bank on $l_t - d_t$ is primarily via its impact on the rate of growth of loans rather than deposits. Evidently, market power has its primary effect on smoothing via the lending channel.

[Please insert Table 5 about here]

4.2 Banking Crises

Next, we include a banking crisis variable that serves to proxy for the presence of credit constraints and episodes of low confidence from depositors. Acknowledging what is now widely accepted among macroeconomists and policy-makers alike, i.e., that banking crises are endogenous to prior excessive credit expansion in the banking system, we still find it useful to examine the relation between banking crises and lending for two main reasons. First, while a banking Crisis can be endogenous to the past (prior-to-Crisis) lending behavior of banks, it is unlikely that the occurrence of banking crises is endogenous to the future (or even the contemporaneous) lending behavior of any one bank. In our application, we take two annual lags of the banking Crisis variable in order to alleviate potential endogeneity of our Crisis measure arising due to the effect of past lending on it. Second, the potentially shock-smoothing behavior of banks is especially critical for current and future welfare during extreme adverse events such us banking crises.

In addition to the direct effect of banking crises on $l_t - d_t$, we include here the interaction of the banking crises proxy with the Lerner index to see how the impact of market power on $l_t - d_t$ differs between normal and crisis periods. We present results from this estimation exercise in Table 6. As we can see in Table 6, banking crises have an adverse impact on net loan growth in periods of declining deposits.

Our main hypothesis is that individual banks respond differently to deposit shocks, depending on their degree of market power. If crises are viewed as shocks to an individual bank's lending ability, we should obtain a similar effect. Indeed, this appears to be the case, yet in a manner that differs from normal periods. In all specifications in Table 6, interaction of both the linear and the quadratic Lerner index terms with the crisis dummy counteracts and inverts the respective average effect (see terms without interaction, for which the size and sign of coefficients is consistent with the baseline estimates in Table 4). The resulting non-linear relationship in crises thus differs from that in non-crisis times. The overall effect of market power on net lending is negative for most banks during crisis times and "superpower" banks are no exception in this case as the negative coefficient for the resulting quadratic terms in crisis times implies a downward sloping parabolic relationship for high values of the Lerner index. This is in drastic contrast to non-crisis periods, when market power works differently for superpower banks than for the rest of the sample, enabling them to outperform banks in the mid-range of the Lerner index in smoothing the impact of deposit outflows on lending.[24]

We also note that the impact of market power is again greater during periods of deposit decline as compared to periods of increasing deposits, as can be seen in rows (2) to (5) of Table 6 by comparing columns (4)-(6) respectively to columns (7)-(9) in each case. Nevertheless, this difference becomes less pronounced in periods of banking crises, even though [some] banks may still enjoy an inflow of deposits then. This underscores that while in normal economic conditions market power matters for banks' ability (and willingness) to suppress the impact of deposit outflows on lending, crises hit them all equally, apart from, perhaps, the least powerful banks.

[Please insert Table 6 about here]

[24] Arguably, crises may serve to remove any advantages of superpower as they are systemic events affecting the whole market. More specifically, the advantages of superpower discussed previously were access to funding and ability to find good quality borrowers. The first advantage is most probably there - superpower banks can find extra capital when needed. However, on the lending side, they face the same problem as other banks in the country: the economy in downturn, high risks and interest rates reflecting this high systemic risk, and no credit-worthy lenders willing to borrow at these high rates. At the same time, superpower banks are not willing to reduce rates as risks are high, hence no advantage of superpower, while in normal times they were able to offer better rates and attract more borrowers.

4.2.1 Robustness

Table 7 presents a number of sensitivity tests. All specifications shown in Table 7 utilize the same basic set of control variables as used in our baseline specifications in Table 4, considering now either alternative explanatory variables (loan loss provisions are added to the baseline specification replacings NPLs in column 1) or alternative measures of market power: in columns 2 and 3 we use the subcomponents of market power (average price of bank activities and marginal cost respectively) in place of the Lerner index, in columns 4 to 7 we use alternative versions of the Lerner index and in column 8 replace it with the Boone indicator. In all cases, the impact of market power for the average bank is estimated to be negative and significant. Furthermore, the non-linear term of market power is estimated to be positive and significant except in the last column where it comes in as marginally insignificant.

[Please insert Table 7 about here]

5 Conclusions

The large variation in our data has allowed us to consider a vast array of economic conditions faced by individual banks across different countries over time. In particular, variation across the degree of competition faced by individual banks in different environments over time has enabled us to investigate banks' smoothing ability and accumulation of risk during periods of falling or rising deposits in relation to their market power. We have shown that for the average bank, market power has a negative impact on the lending-funding growth gap, implying that more competition for such banks may help smooth adverse shocks to deposit intake, and will tend to amplify positive shocks during which deposits are growing. Since more competitive banks are more likely to have a positive lending-funding growth gap, they will also contribute to the build-up of risk in the banking system during periods of rising deposits.

Our answer to the questions posed in the introduction as to which banks tend to smooth/amplify shocks or reduce/accumulate risk and when, is contingent on the overall economic conditions and their persistence. Banks with higher market power (but not "superpower") are more likely than other banks to smooth shocks and reduce the build-up of risk during booms associated with rising deposits, but at the cost of amplification of adverse effects during periods of falling deposits. By contrast, more competitive along with "superpower" banks are more likely to smooth shocks during economic downturns associated with falling deposits, but at the cost of amplification and risk accumulation during periods of rising deposits.

However, the asymmetric effect of market power we find for periods of deposit decline versus periods of deposit growth implies that the helpful role of competition for the average bank on smoothing when deposits are falling, matters more than the problematic positive impact of competition for the average bank on amplification and risk accumulation when deposits are growing. Similarly, since in episodes of deposit outflow there is also a starker contrast between the impact of market power for "superpower" banks versus the average bank, the prevalence of "superpower" banks in the economy will matter more for smoothing in periods of falling deposits than for amplification and the build-up of risk in periods of rising deposits.

Our findings provide useful insights to different strands of the literature. First, they provide a challenge to the theoretical literature that suggested an inverse relationship between the degree of competition and banks' smoothing ability (e.g. Allen and Gale (1997)). Our results imply a more complex non-linear and asymmetric (over the cycle) relationship between smoothing ability and the degree of competition, with more competitive banks possessing higher smoothing ability than banks with higher market power during periods of falling deposits while, at the same time, a few super-power banks are characterized by higher smoothing ability than banks with some market power during such downturns. During periods of rising deposits, however, higher market power for the average bank enhances smoothing and thus serves to limit amplification and the accumulation of risk in the economy, consistent with Allen and Gale (1997) and the theoretical point that banks further away from the competitive market hypothetical, base lending decisions on a longer horizon than typical market participants so that their lending during upturns grows at a lower rate than market-based financing.

Second, our results complement the empirical literature on relationship lending reviewed in Sette and Gobbi (2015), where higher competition dampens the smoothing effect of relationship lending. Our findings suggest that when considering overall lending rather than just relationship lending, more competition may actually enhance smoothing ability in the banking sector. Third, in relation to the literature emphasizing the role banks may play in accumulating risk in the economic system, our results imply that certain bank characteristics, such us higher market power, may serve to induce more prudent lending practices that help limit the build-up of risk in the banking system during periods of rising deposits.

Based on the above-described results, future research would be well advised to focus on building macroeconomic models that incorporate a heterogeneous financial sector in order to provide a more complete understanding of the link that exists between individual banks' characteristics, smoothing or amplification of shocks, and the accumulation of risk in the economy. In particular, such models should be able to match the asymmetric effects uncovered here and the potentially enhancing role of competition for banks' smoothing ability during downturns.

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Tables

Table 1: Definitions and sources of main variables

Name	Description	Data source
	Panel A: Variables used in the derivation of market power	
Earning assets	Natural logarithm of deflated total earning assets (measure of a bank's output).	Bankscope
Price of output	Total income divided by total earning assets.	Bankscope
Expenses	Natural logarithm of deflated total interest expenses and total non-interest expenses (measure of a bank's total cost).	Bankscope
Price of deposits	Natural logarithm of total interest expenses divided by total customer deposits.	Bankscope
Price of borrowed funds	Natural logarithm of total interest expenses divided by short-term funding.	Bankscope
Price of labor	Natural logarithm of personnel expenses divided by total assets.	Bankscope
Price of physical capital	Natural logarithm of overheads minus personnel expenses divided by fixed assets.	Bankscope
Price of financial capital	Natural logarithm of equity divided by total assets	Bankscope
	Panel B: Variables used in the analysis of market power	
Lending-funding growth gap	The difference between Loan growth and Deposits growth.	Bankscope
Loan growth	The annual forward change in the volume of total bank loans between *t+1* to *t*.	Bankscope
Deposits growth	The annual forward change in the volume of total bank deposits between *t+1* to *t*.	Bankscope
Liquidity	Liquid assets divided by total assets.	Bankscope
Non-performing loans	The ratio of non-performing loans to total loans per bank and year.	Bankscope
Loan-loss provisions	Loan-loss provisions divided by total loans.	Bankscope
Lerner index	The ability of an individual bank to charge a price above marginal cost.	Own calculations
Dual-output Lerner	Variant of the Lerner index that adopts a dual-output cost function.	Own calculations
Boone indicator	The elasticity of profits to marginal costs.	Own calculations
CR5	The five-bank concentration ratio.	Own calculation
ROA	The ratio of net income to total assets.	Own calculation
Equity	Natural logarithm of bank?s equity.	Bankscope
Bank size	Natural logarithm of total assets.	Bankscope
OBSI size	Natural logarithm of the off-balance sheet items.	Bankscope
Big bank	A dummy variable equal to one when a bank belong to top-10 pc per country year	Own calculation
GDP growth	Real GDP growth (annual %).	World Development Indicators
Banking crisis	A dummy variable equal to one when a country suffers from a banking crisis with a two years clear window (t,t+1).	Laeven and Valencia (2014)

Table 2: Summary statistics

Variables	Level	Obs.	Mean	Std. Dev.	Min.	Max.
Panel A: Variables used in the derivation of market power						
Earning assets	Bank	59,397	12.276	2.158	6.839	21.38
Price of output	Bank	59,397	0.085	0.08	0.005	4.257
Expenses	Bank	59,397	9.311	2.058	4.561	18.414
Price of deposits	Bank	59,397	-3.715	1.213	-8.835	3.833
Price of borrowed funds	Bank	59,397	-3.875	1.094	-8.835	0.741
Price of labour	Bank	59,397	-4.343	0.552	-7.541	-1.28
Price of physical capital	Bank	59,397	-0.083	0.928	-2.063	8.934
Price of financial capital	Bank	59,397	-2.396	0.507	-8.396	-0.047
Panel B: Variables used in the analysis of market power						
Lending-funding growth gap	Bank	59,397	0.474	18.925	-99.892	99.99
Loan growth	Bank	58,801	8.651	19.757	-99.764	100
Deposits growth	Bank	58,792	8.22	19.927	-100	100
Liquidity	Bank	59,396	14.993	13.381	0	98.387
Non-performing loans (%)	Bank	59,397	4.187	6.65	0	100
Loan-loss provision (%)	Bank	54,081	0.518	0.986	0	47.38
Lerner index	Bank	59,397	0.25	0.114	-0.199	0.924
Lerner index with deposits	Bank	59,397	0.25	0.114	-0.2	0.924
Lerner index with financial capital	Bank	59,393	0.252	0.114	-0.199	0.926
Lerner index with country FE	Bank	59,391	0.236	0.115	-0.229	0.915
Dual-output Lerner index	Bank	56,048	0.25	0.112	-0.2	0.92
Boone Indicator	Bank	59,397	-0.251	0.188	-0.901	0.039
CR5	Country	49,889	0.477	0.273	0.032	1
ROA	Bank	59,397	0.012	0.015	-0.46	0.326
Equity	Bank	59,397	10.689	1.763	5.075	19.148
Bank size	Bank	59,397	13.084	1.833	7.786	21.744
OBSI size	Bank	54,463	9.746	2.689	-1.583	21.466
Big Bank	Bank	59,397	0.501	0.219	0	1
GDP growth	Country	59,392	2.391	3.117	-14.814	34.5
Banking crisis	Country	59,397	0.091	0.288	0	1

The table reports summary statistics for the variables used in the empirical analysis. The variables are defined in Table 1.

Table 3: The impact of non-performing loans and market power on the lending-funding growth gap

	Full sample			Deposits DOWN			Deposits UP		
	I	II	III	IV	V	VI	VII	VII	IX
Non-performing loans (%)	-0.166***	-0.300***	-0.155***	-0.211***	-0.307***	-0.178***	-0.130***	-0.261***	-0.129***
	[-11.560]	[-11.186]	[-4.906]	[-9.252]	[-5.863]	[-3.253]	[-6.982]	[-7.868]	[-3.068]
Lerner index	-2.408***	-3.691***	-8.280***	-2.243*	-6.075***	-6.765***	-3.138***	-4.276**	-8.856***
	[-2.848]	[-2.613]	[-5.609]	[-1.708]	[-2.579]	[-2.820]	[-2.841]	[-2.236]	[-4.395]
Observations	59,398	58,654	57,505	23,622	22,042	21,157	35,776	34,416	33,283
R-squared	0.027	0.171	0.255	0.036	0.258	0.323	0.027	0.244	0.348
Chow test (P-value) $H_0 : \widehat{\beta}^{Deposit\ Down} = \widehat{\beta}^{Deposit\ UP}$							0.000	0.000	0.000
Year FE	Y	Y	N	Y	Y	N	Y	Y	N
Country FE	N	Y	N	N	Y	N	N	Y	N
Specialization FE	N	Y	N	N	Y	N	N	Y	N
Bank FE	N	Y	Y	N	Y	Y	N	Y	Y
Country*Year FE	N	N	N	N	N	N	N	N	N
Country*Year*Specialization FE	N	N	Y	N	N	Y	N	N	Y
Clustered standard errors	Country	Country	Country	Country	Country	Country	Country	Country	Country

The table reports coefficients and t-statistics (in brackets) of regressions investigating the impact of non-performing loans and market power on the lending-funding growth gap. We estimate the regression $[GL_{i,j,t+1} - GD_{i,j,t+1}] = \alpha_f + MP_{i,j,t} + NPL_{i,j,t-1} + \varepsilon_{i,j,t}$, where i is an index specific to the bank; j is an index specific to country; and t is an index for years. $MP_{i,j,t}$, measures the Lerner index and $NPL_{i,j,t-1}$, measures the non-performing loans. All variables are defined in Table 1. All regressions are estimated with High Dimensional Fixed Effects (HDFE) and include fixed effects as noted in the lower part of the table to control for different levels of unobserved heterogeneity. Standard errors are robust and clustered at country. In columns IV-VI and VII-IX we restrict our analysis only to periods with deposits declined (< 0) and deposits growth (> 0), respectively. To test for differences in coefficients across subgroups we use the Chow test. The *,**,*** marks denote the statistical significance at the 10, 5, and % level, respectively.

Table 4: Baseline results

	Full sample			Deposits DOWN			Deposits UP		
	I	II	III	IV	V	VI	VII	VII	IX
Non-performing loans (%)	-0.236***	-0.140**	-0.146**	-0.234***	-0.214**	-0.174*	-0.213***	-0.092**	-0.077
	[-5.616]	[-2.597]	[-2.523]	[-3.026]	[-2.307]	[-1.679]	[-4.999]	[-2.038]	[-1.468]
Lerner index	-14.932***	-12.941***	-14.119***	-25.248***	-19.402***	-18.445***	-11.041**	-10.021**	-12.009***
	[-3.115]	[-2.904]	[-3.573]	[-4.079]	[-3.875]	[-3.649]	[-2.189]	[-2.129]	[-2.962]
Lerner index squared	16.133**	15.540***	16.741***	34.063***	26.680***	24.812***	15.277**	15.067**	17.629***
	[2.578]	[2.804]	[3.195]	[2.918]	[3.144]	[3.068]	[2.330]	[2.580]	[2.712]
CR5	-4.248			-4.264			-3.330		
	[-1.166]			[-0.697]			[-0.998]		
ROA	45.007***	6.169	6.572	50.569**	-2.246	5.392	11.376	-19.210	-14.812
	[2.998]	[0.299]	[0.318]	[2.257]	[-0.102]	[0.257]	[0.490]	[-0.613]	[-0.451]
Equity	-4.573***	-5.032***	-5.286***	-3.046**	-2.316*	-2.515**	-5.115***	-5.650***	-5.721***
	[-5.113]	[-5.593]	[-5.360]	[-1.988]	[-1.915]	[-2.081]	[-5.843]	[-5.985]	[-5.509]
Bank size	4.681***	5.360***	5.443***	2.084	1.838	1.922	5.389***	6.054***	5.979***
	[3.836]	[4.748]	[4.877]	[1.141]	[1.406]	[1.512]	[4.825]	[5.505]	[5.651]
OBSI	-0.023	-0.166	-0.145	0.034	-0.302*	-0.243	-0.054	-0.135	-0.150
	[-0.179]	[-1.607]	[-1.248]	[0.171]	[-1.905]	[-1.464]	[-0.313]	[-0.900]	[-1.000]
GDP growth	0.523***			0.487**			0.424***		
	[5.258]			[2.025]			[3.968]		
Observations	44,710	44,351	43,626	16,235	15,734	15,383	26,496	26,058	25,418
R-squared	0.181	0.261	0.273	0.298	0.356	0.357	0.244	0.350	0.366
Turning point (Lerner index)	0.463	0.416	0.422	0.371	0.364	0.372	0.361	0.332	0.341
Joint significance (Lerner index)	0.001	0.010	0.001	0.000	0.001	0.002	0.050	0.029	0.003
Marginal effect at mean ($\frac{\partial y}{\partial(Lerner\ index)}$)	-2.029	-2.016	-2.221	-3.287	-2.913	-2.739	-1.484	-1.620	-1.875
Chow test (P-value) $H_0 : \widehat{\beta}^{Deposit\ Down} = \widehat{\beta}^{Deposit\ UP}$							0.000	0.000	0.000
Year FE	Y	N	N	Y	N	N	Y	N	N
Country FE	Y	N	N	Y	N	N	Y	N	N
Specialization FE	Y	Y	N	Y	Y	N	Y	Y	N
Bank FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Country*Year FE	N	Y	N	N	Y	N	N	Y	N
Country*Year*Specialization FE	N	N	Y	N	N	Y	N	N	Y
Clustered standard errors	Country	Country	Country	Country	Country	Country	Country	Country	Country

The table reports coefficients and t-statistics (in brackets) of regressions investigating the impact of non-performing loans and market power on the lending-funding growth gap. We estimate the regression $[GL_{i,j,t+1} - GD_{i,j,t+1}] = \alpha_f + MP_{i,j,t} + MP^2_{i,j,t} + GY_{j,t} + NPL_{i,j,t-1} + X_{i,j,t} + \varepsilon_{i,j,t}$, where i is an index specific to the bank; j is an index specific to country; and t is an index for years. $MP_{i,j,t}$, measures the Lerner index, $MP^2_{i,j,t}$, measures the Lerner index squared and $NPL_{i,j,t-1}$, measures the non-performing loans. All variables are defined in Table 1. All regressions are estimated with High Dimensional Fixed Effects (HDFE) and include fixed effects as noted in the lower part of the table to control for different levels of unobserved heterogeneity. Standard errors are robust and clustered at country. In columns IV-VI and VII-IX we restrict our analysis only to periods with deposits declined (< 0) and deposits growth (> 0), respectively. To test for differences in coefficients across subgroups we use the Chow test. The *,**,*** marks denote the statistical significance at the 10, 5, and % level, respectively.

Table 5: Effects of market structure on deposit growth and loan growth separately

Dependent variable:	Loan growth			Deposits growth		
	I	II	III	IV	V	VI
Non-performing loans (%)	-0.510***	-0.387***	-0.419***	-0.292***	-0.239***	-0.257***
	[-14.381]	[-11.874]	[-12.250]	[-9.248]	[-7.904]	[-8.156]
Lerner index	-25.440***	-19.950***	-19.815***	-9.349***	-7.558**	-6.640*
	[-7.019]	[-6.057]	[-5.916]	[-2.647]	[-2.215]	[-1.897]
Lerner index squared	38.861***	23.638***	23.275***	24.545***	14.075**	12.356*
	[5.945]	[3.806]	[3.685]	[3.682]	[2.097]	[1.785]
Observations	44,303	43,944	43,228	44,319	43,959	43,237
R-squared	0.457	0.637	0.645	0.434	0.609	0.617
Turning point (Lerner index)	0.327	0.422	0.426	0.190	0.268	0.268
Join significance (Lerner index)	0.000	0.000	0.000	0.000	0.081	0.160
Marginal effect at mean ($\frac{\partial y}{\partial (Lerner\ index)}$)	-2.125	-1.895	-1.886	0.088	0.030	0.142
Control Variables (Bank-Country)	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Country FE	Y	Y	Y	Y	Y	Y
Specialization FE	Y	Y	N	Y	Y	N
Bank FE	Y	Y	Y	Y	Y	Y
Country*Year FE	N	Y	N	N	Y	N
Country*Year*Specialization FE	N	N	Y	N	N	N
Clustered standard errors	Country	Country	Country	Country	Country	Country

The table reports coefficients and t-statistics (in brackets). We estimate the regression $Y_{i,j,t+1} = \alpha_f + MP_{i,j,t} + MP^2_{i,j,t} + GY_{j,t} + NPL_{i,j,t-1} + X_{i,j,t} + \varepsilon_{i,j,t}$, where i is an index specific to the bank; j is an index specific to country; and t is an index for years. $MP_{i,j,t}$, measures the Lerner index, $MP^2_{i,j,t}$, measures the Lerner index squared and $NPL_{i,j,t-1}$, measures the non-performing loans. All variables are defined in Table 1. All regressions are estimated with High Dimensional Fixed Effects (HDFE), include the control variables that are reported in Table (4 and include fixed effects as noted in the lower part of the table to control for different levels of unobserved heterogeneity. Standard errors are robust and clustered at country. In columns I-III and IV-VI the dependent variable is the loan growth and deposits growth, respectively. The *,**,*** marks denote the statistical significance at the 10, 5, and % level, respectively.

Table 6: Effects of market structure and banking crises on the lending-funding growth gap

	Full sample			Deposits DOWN			Deposits UP		
	I	II	III	IV	V	VI	VII	VIII	IX
Non-performing loans (%)	-0.230***	-0.226***	-0.147***	-0.227***	-0.212***	-0.227***	-0.209***	-0.163***	-0.168***
	[-7.162]	[-7.001]	[-4.021]	[-3.213]	[-2.973]	[-3.100]	[-5.577]	[-4.161]	[-4.128]
Lerner index	-16.898***	-17.282***	-15.866***	-29.126***	-29.757***	-30.652***	-12.704**	-11.296**	-12.428**
	[-4.333]	[-4.426]	[-3.989]	[-4.400]	[-4.488]	[-4.583]	[-2.357]	[-2.065]	[-2.255]
Lerner index*Crisis	22.739***	23.030***	15.717*	33.434**	36.301**	34.843**	20.275*	19.591*	20.659*
	[2.774]	[2.789]	[1.851]	[2.145]	[2.321]	[2.209]	[1.735]	[1.699]	[1.787]
Lerner index squared	21.072***	20.653***	20.184***	43.086***	43.044***	44.200***	19.342**	24.801**	26.853***
	[2.903]	[2.839]	[2.642]	[3.376]	[3.380]	[3.439]	[2.043]	[2.535]	[2.721]
Lerner index squared*Crisis	-54.569***	-56.927***	-41.088*	-68.378*	-74.913*	-72.806*	-52.533*	-46.181	-46.844*
	[-2.650]	[-2.751]	[-1.922]	[-1.754]	[-1.932]	[-1.862]	[-1.789]	[-1.642]	[-1.662]
Observations	44,710	44,710	43,626	16,235	16,235	16,231	26,496	26,496	26,496
R-squared	0.181	0.184	0.273	0.299	0.303	0.312	0.244	0.245	0.252
Turning point (Lerner index, Crisis=0)	0.400	0.418	0.393	0.338	0.345	0.347	0.328	0.228	0.231
Turning point (Lerner index, Crisis=1)	0.087	0.079	0.003	0.085	0.102	0.073	0.114	0.193	0.205
Join significance (Lerner index)	0.000	0.000	0.000	0.000	0.000	0.000	0.060	0.037	0.023
Marginal effect at mean ($\frac{\partial y}{\partial (Lerner\ index)}$)	-2.062	-2.066	-8.846	-3.559	-3.638	-3.642	-1.485	-1.343	-1.505
Chow test (P-value) $H_0: \widehat{\beta}^{Deposit\ Down} = \widehat{\beta}^{Deposit\ UP}$							0.000	0.000	0.000
Control Variables (Bank-Country)	Y	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	N	N	Y	N	N	Y	N	N
Country FE	Y	N	N	Y	N	N	Y	N	N
Specialization FE	Y	Y	N	Y	Y	N	Y	Y	N
Bank FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Country*Year FE	N	Y	N	N	Y	N	N	Y	N
Country*Year*Specialization FE	N	N	Y	N	N	Y	N	N	Y
Clustered standard errors	Country	Country	Country	Country	Country	Country	Country	Country	Country

The table reports coefficients and t-statistics (in brackets). We estimate the regression $[GL_{i,j,t+1} - GD_{i,j,t+1}] = \alpha_f + MP_{i,j,t} + MP^2_{i,j,t} + GY_{j,t} + NPL_{i,j,t-1} + X_{i,j,t} + \varepsilon_{i,j,t}$, where i is an index specific to the bank; j is an index specific to country; and t is an index for years. $MP_{i,j,t}$, measures the Lerner index, $MP^2_{i,j,t}$, measures the Lerner index squared and $NPL_{i,j,t-1}$, measures the non-performing loans. All variables are defined in Table 1. All regressions are estimated with High Dimensional Fixed Effects (HDFE), include the control variables that are reported in Table (4 and include fixed effects as noted in the lower part of the table to control for different levels of unobserved heterogeneity. Standard errors are robust and clustered at country. In columns IV-VI and VII-IX we restrict our analysis only to periods with deposits declined (< 0) and deposits growth (> 0), respectively. To test for differences in coefficients across subgroups we use the Chow test. The *,**,*** marks denote the statistical significance at the 10, 5, and % level, respectively.

Table 7: Sensitivity tests

	I	II	III	IV	V	VI	VII	VIII
Variables:	LLP	P	MC	Lerner with DSTF	Lerner with financial capital	Lerner with country FE	Dual-output Lerner	1-Boone indicator
Loan-loss provision	-1.759***							
	[-14.295]							
Non-performing loans		-0.231***	-0.238***	-0.235***	-0.227***	-0.226***	-0.234***	-0.243***
		[-7.183]	[-7.440]	[-7.310]	[-7.098]	[-7.068]	[-7.290]	[-7.629]
Subcomponents		-25.166***	-19.651***					
		[-3.780]	[-2.955]					
Market power	-11.771***			-15.065***	-14.581***	-15.232***	-15.328***	-32.044***
	[-3.043]			[-4.172]	[-4.004]	[-4.457]	[-4.254]	[-3.524]
Market power squared	19.873***			17.062**	13.074*	13.600**	16.914**	4.657
	[2.775]			[2.517]	[1.923]	[1.995]	[2.439]	[1.558]
Observations	38,408	44,731	44,731	44,731	44,725	44,711	44,731	44,731
R-squared	0.194	0.181	0.181	0.181	0.179	0.179	0.181	0.184
Joint significance (Lerner index)	0.000			0.000	0.000	0.000	0.000	0.000
Turning point (Lerner index)	0.296			0.441	0.557	0.559	0.453	3.441
Marginal effect at mean ($\frac{\partial y}{\partial (Lerner\ index)}$)	-1.456			-2.003	-2.362	-2.326	-2.074	-32.373
Control Variables (Bank-Country)	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y	Y
Country FE	Y	Y	Y	Y	Y	Y	Y	Y
Bank Specialization FE	Y	Y	Y	Y	Y	Y	Y	Y
Bank FE	Y	Y	Y	Y	Y	Y	Y	Y
Clustered standard errors	Country	Country	Country	Country	Country	Country	Country	Country

The table reports coefficients and t-statistics (in brackets). We estimate the regression $[GL_{i,j,t+1} - GD_{i,j,t+1}] = \alpha_f + MP_{i,j,t} + MP^2_{i,j,t} + GY_{j,t} + NPL_{i,j,t-1} + X_{i,j,t} + \varepsilon_{i,j,t}$, where i is an index specific to the bank; j is an index specific to country; and t is an index for years. $MP_{i,j,t}$, measures the Lerner index, $MP^2_{i,j,t}$, measures the Lerner index squared and $NPL_{i,j,t-1}$, measures the non-performing loans. All variables are defined in Table 1.All regressions are estimated with High Dimensional Fixed Effects (HDFE), include the control variables that are reported in Table (4 and include fixed effects as noted in the lower part of the table to control for different levels of unobserved heterogeneity. Standard errors are robust and clustered at country. Column I shows the baseline results, where we use the loan-loss provisions. The following columns confirm the results of our baseline regression when using alternative measures of market power. In columns II and III we replace the market power with its two subcomponents, being the average price of bank activities and marginal cost, respectively. In column IV we use the Lerner index with deposits and short term funding, in column V we use the Lerner index with financial capital, in VI the Lerner index with financial capital when we include country fixed effects in the estimation of marginal cost, in VII the Lerner index obtained from the dual-output cost function, and in VIII the Boone indicator. The *, **, *** marks denote statistically significance at the 10, 5, and 1% level, respectively. The *,**,*** marks denote the statistical significance at the 10, 5, and % level, respectively.

Appendices

A Further details on the lending-funding growth gap

The lending-funding growth gap, $l_t - d_t$ is best understood as a measure of sensitivity, and is closely related to the elasticity of bank lending to a shift in the deposit intake:

$$\frac{\frac{\Delta L_t}{L_t}}{\frac{\Delta D_t}{D_t}} = \frac{l_t}{d_t} \tag{A.1}$$

For example, banks with low constant elasticity of lending to deposit inflow, $\frac{l}{d} = c < 1$ always smooth shocks as for them holds $l - d = (c - 1) \cdot d < 0$ for positive d and $l - d > 0$ for negative d (see Figure A.1), while banks with $\frac{l}{d} = c > 1$ always amplify these as for them holds $l - d > 0$ for positive d and $l - d < 0$ for negative d (see again Figure A.1). We note that even though the elasticity parameter $\frac{l}{d}$ is not well-defined for values of d close to zero, the linear difference $l - d$ provides a similar insight into the relationship between lending and deposit growth rates without ruling out small deposit growth rates.

To derive the link between the relative customer funding gap, $\frac{L_t - D_t}{L_t}$, and the lending-funding growth gap, note that a change in the former, $\Delta_t \left(\frac{L-D}{L}\right)$, is given by a change in the deposits-to-loans ratio:

$$\Delta_t \left(\frac{L - D}{L}\right) = \frac{L_{t+1} - D_{t+1}}{L_{t+1}} - \frac{L_t - D_t}{L_t} = \frac{D_t}{L_t} - \frac{D_{t+1}}{L_{t+1}} = -\Delta_t \left(\frac{D}{L}\right). \tag{A.2}$$

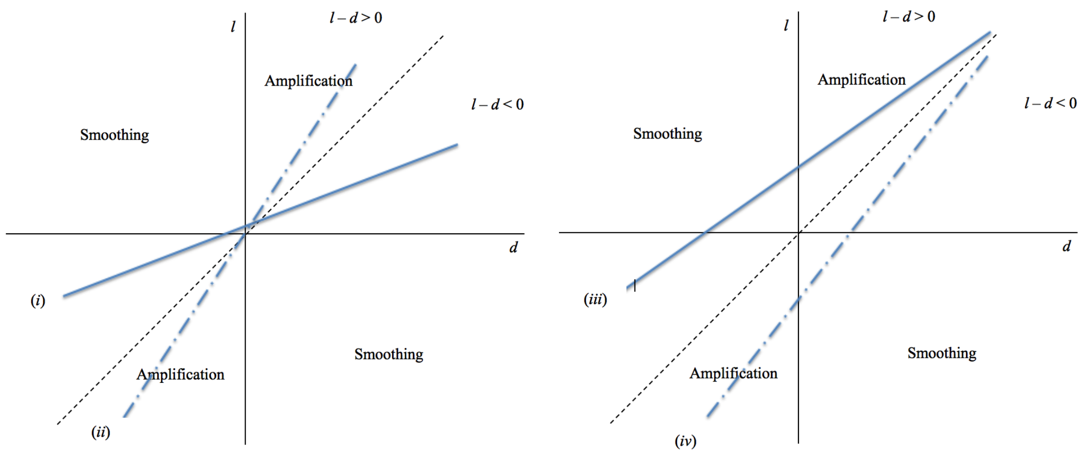
A percentage change in the latter is linked to the lending-funding growth gap:

$$-\frac{\Delta_t \left(\frac{D}{L}\right)}{\frac{D_t}{L_t}} = -\frac{L_t}{L_{t+1}} \cdot \frac{L_t D_{t+1} - D_t L_{t+1}}{L_t D_t} = -\frac{L_t}{L_{t+1}} \cdot (d_t - l_t) = \frac{1}{1 + l_t} \cdot (l_t - d_t). \tag{A.3}$$

We can therefore write

$$\Delta_t \left(\frac{L - D}{L}\right) = \frac{1}{1 + l_t} \cdot (l_t - d_t) \cdot \frac{D_t}{L_t}. \tag{A.4}$$

Figure A.1: Types of banks with regards to smoothing/amplification.



Notes: Type (*i*) banks almost always smooth shocks, type (*ii*) banks always amplify shocks, type (*iii*) banks are more likely to smooth negative shocks and amplify positive ones, while type (*iv*) banks are more likely to amplify negative shocks and smooth positive ones.

Note that $\frac{1}{1+l_t} \cdot (l_t - d_t)$ in the expression transforms to $1 - \frac{1+d_t}{1+l_t}$ where the latter ratio of *gross growth rates* cannot be converted to elasticity $\frac{l_t}{d_t}$, providing an additional argument in favor of using the lending-funding growth gap as a measure of sensitivity.

B Tables

Table B1 of this appendix presents the number of banks used, while Table B2 presents pairwise correlations of the main variables. Finally, Table B3 is similar to Table 6 in the main text with only one difference: we now interact the crisis dummy with the NPL variable, thus explicitly studying the difference in the impact of quality of loans on our main variable of interest during crises and crisis-free times. The interaction term is insignificant in the baseline specification, yet becomes significant once we control for fixed effects at country*year and country*year*specialisation levels, with a stronger impact of the interaction term is stronger when deposits decline.

Table B1: Number of banks in the sample

Year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
All countries														
	91	100	114	152	399	973	1,262	1,411	1,488	4,072	3,929	6,197	6,100	6,030
Income groups														
LI					3	6	7	14	20	48	59	68	75	79
LMI	14	15	15	21	37	54	61	63	64	225	219	252	260	256
OECD	71	79	92	118	327	860	1,126	1,240	1,285	3,356	3,211	5,373	5,203	5,115
OHI	3	3	3	3	5	8	11	19	26	85	86	84	91	90
UMI	3	3	4	10	27	45	57	75	93	358	354	420	471	490
Regional groups														
EAP	4	5	4	6	13	18	25	26	27	117	90	91	86	91
ECA					1	1	2	5	11	84	76	136	156	174
LAC	4	4	5	10	17	40	50	64	69	264	288	311	352	337
MENA				1	12	20	19	21	23	48	42	47	48	41
SA	10	10	11	14	23	24	27	28	32	74	79	83	84	88
SSA					2	6	6	12	19	81	93	105	118	122

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
All countries														
	5,899	5,786	5,916	7,175	7,303	7,618	7,502	7,544	7,215	4,873	4,929	4,925	4,861	4,414
Income groups														
LI	89	100	107	121	123	139	168	186	179	139	151	157	164	139
LMI	270	287	329	373	383	403	408	444	424	279	300	309	291	277
OECD	4,942	4,758	4,801	5,709	5,631	5,707	5,479	5,542	5,354	3,677	3,668	3,652	3,648	3,304
OHI	92	87	92	100	101	101	93	96	90	73	77	75	74	66
UMI	506	554	587	872	1,065	1,268	1,354	1,276	1,168	705	733	732	684	628
Regional groups														
EAP	98	108	131	156	170	185	207	223	222	178	196	202	193	180
ECA	229	277	312	614	779	941	975	865	756	354	359	363	342	314
LAC	297	303	316	311	336	360	377	410	410	315	322	319	290	266
MENA	44	48	50	45	55	65	75	91	86	59	63	59	54	51
SA	94	103	109	115	110	112	117	133	135	90	113	114	116	113
SSA	133	138	143	168	168	193	220	230	210	169	172	180	183	152

LI refers to the low-income economies, LMI refers to the lower-middle-income economies, OECD refers to the OECD member countries, HI refers to high-income economies other than OECD countries, and UMI refers to upper-middle-income economies. EAP refers to East Asian and Pacific countries, ECA to the European and Central Asian countries, LAC refers to Latin American and Caribbean countries, MENA refers to Middle Eastern and North African countries, SA refers to Southern Asian countries and SSA refers to Sub-Saharan African countries.

Table B2: Correlation table

	Lending-funding growth gap	Non-performing loans	Lerner index	Lerner index squared	CR5	ROA	Equity	Bank size	OBSI size	GDP growth
Lending-funding growth gap	1									
Non-performing loans	-0.0645*	1								
Lerner index	0.00120*	-0.0570*	1							
Lerner index squared	-0.0001*	-0.0114*	0.9194*	1						
CR5	0.0060*	0.0534*	0.1704*	0.2192*	1					
ROA	0.0516*	-0.1955*	0.4474*	0.4392*	0.1552*	1				
Equity	-0.0226*	0.0473*	0.2325*	0.2197*	0.1376*	0.0515*	1			
Bank size	-0.0223*	0.0464*	0.1309*	0.1028*	0.0391*	-0.0615*	0.9409*	1		
OBSI size	-0.0076*	0.0301*	0.1921*	0.1853*	0.2158*	0.0415*	0.7477*	0.7346*	1	
GDP per growth	0.0914*	-0.1449*	-0.0928*	-0.0870*	-0.1410*	0.0632*	-0.0981*	-0.0782*	-0.4593*	1

The table reports the pair-wise correlations. The variables are defined in Table 1. The * marks denote statistically significance at the 5% level.

Table B3: Financial crisis and quality of loans

	Full sample			Deposits DOWN			Deposits UP		
	I	II	III	IV	V	VI	VII	VIII	IX
Non-performing loans (%)	-0.229***	-0.177***	-0.148***	-0.226***	-0.164**	-0.197***	-0.197***	-0.201***	-0.152***
	[-7.113]	[-5.331]	[-3.900]	[-3.198]	[-2.397]	[-2.840]	[-5.315]	[-6.824]	[-3.763]
Non-performing loans(%)*Crisis	0.004	-0.147**	-0.222**	0.008	-0.236*	-0.454***	-0.252	-0.188*	-0.335*
	[0.055]	[-2.299]	[-2.276]	[0.051]	[-1.865]	[-2.786]	[-1.356]	[-1.889]	[-1.824]
Lerner index	-14.510***	-10.049***	-13.109***	-24.662***	-19.908***	-19.525***	-10.752**	-11.630***	-9.973*
	[-3.976]	[-2.691]	[-3.533]	[-3.921]	[-3.051]	[-3.202]	[-2.130]	[-3.220]	[-1.937]
Lerner index squared	16.626**	19.623***	16.572**	35.005***	37.002***	27.653**	15.879*	15.536**	22.940**
	[2.410]	[2.755]	[2.316]	[2.871]	[2.886]	[2.265]	[1.755]	[2.412]	[2.443]
Observations	44,710	44,710	44,351	16,235	16,235	15,734	26,496	26,496	26,496
R-squared	0.181	0.174	0.256	0.299	0.294	0.355	0.244	0.247	0.252
Turning point (Lerner index)	0.436	0.256	0.395	0.352	0.269	0.353	0.338	0.374	0.217
Join significance (Lerner index)	0.000	0.019	0.000	0.000	0.008	0.003	0.100	0.004	0.047
Chow test (P-value) $H_0 : \widehat{\beta}^{Deposit\ Down} = \widehat{\beta}^{Deposit\ UP}$				0.000	0.000	0.000	0.000	0.000	0.000
Control Variables (Bank-Country)	Y	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	N	N	Y	N	N	Y	N	N
Country FE	Y	N	N	Y	N	N	Y	N	N
Specialization FE	Y	Y	N	Y	Y	N	Y	Y	N
Bank FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Country*Year FE	N	Y	N	N	Y	N	N	Y	N
Country*Year*Specialization FE	N	N	Y	N	N	Y	N	N	Y
Clustered standard errors	Country	Country	Country	Country	Country	Country	Country	Country	Country

The table reports coefficients and t-statistics (in brackets). We estimate the regression $[GL_{i,j,t+1} - GD_{i,j,t+1}] = \alpha_f + MP_{i,j,t} + MP^2_{i,j,t} + GY_{j,t} + NPL_{i,j,t-1} + X_{i,j,t} + \varepsilon_{i,j,t}$, where i is an index specific to the bank; j is an index specific to country; and t is an index for years. $MP_{i,j,t}$, measures the Lerner index, $MP^2_{i,j,t}$, measures the Lerner index squared and $NPL_{i,j,t-1}$, measures the non-performing loans. All variables are defined in Table 1.All regressions are estimated with High Dimensional Fixed Effects (HDFE), include the control variables that are reported in Table (4 and include fixed effects as noted in the lower part of the table to control for different levels of unobserved heterogeneity. Standard errors are robust and clustered at country. In columns IV-VI and VII-IX we restrict our analysis only to periods with deposits declined (< 0) and deposits growth (> 0), respectively. To test for differences in coefficients across subgroups we use the Chow test. The *,**,*** marks denote the statistical significance at the 10, 5, and % level, respectively.

C Estimation of marginal cost

We estimate marginal cost using both semiparametric. For the semiparametric method, we use the following log-linear cost function:

$$lnC_{it} = \alpha_1 + \alpha_2(z_i t)lnQ_{it} + \alpha_3 lnw^l_{it} + \alpha_4 lnw^k_{it} + \alpha_5 lnw^d_{it} + \epsilon_{it} \quad \text{(C.1)}$$

In equation (C.1) C is the total cost of the bank i at time t, measured by the deflated total interest expenses and total noninterest expenses; Q is the total output of each bank, measured by the deflated total earning assets (or simply total assets in robustness tests); w^l is the price of labor, measured by the ratio of personnel expenses to total assets; w^k is the price of physical capital, measured by the ratio of overheads minus personnel expenses to fixed assets; and w^d is the price of intermediation funds, measured by the ratio of total interest expenses to total customer deposits. In alternative specifications, we also include the price of financial capital, as measured by the ratio of equity capital to total assets, as well as measures of bank risk (ratio of non-performing loans or loan-loss provisions to total loans), the results being unaffected. Equation (C.1) has parametric parts (those related to the input prices) and a non-parametric part (that related to bank output). The variable z, which is the so-called smoothing parameter, is crucial for the identification of the model and must be a variable that is highly correlated with α_2 and considerably varies by bank-year. Delis et al. (2014, 2016) propose using $z = lnw^l_{it} + lnw^k_{it}$, which is intuitive given the high potential correlation of input prices with the output elasticity of costs. We use the same approach and we also verify that using each input price separately yields similar results. Further, we impose the linear homogeneity restriction in input prices by normalizing total cost and the input prices by the price of deposits before taking logs. From equation (C.1) we can obtain the marginal cost at the bank-year level as $\frac{\partial C_{it}}{\partial Q_{it}} = \alpha_2(\frac{C_{it}}{Q_{it}})$ to calculate the Lerner index. The actual estimation methodology of the semi-parametric model follows the paradigm of Fan and Zhang (1999). Specifically, and by dropping the t subscript for simplicity, we can write equation (C.1) in econometric form as follows:

$$Y_i = E(Y_i|W_i) + e_i = X_i\beta_1 + V_i\beta_2(Z_i) + e_i \tag{C.2}$$

In this equation, β_2 is a function of one or more variables with dimension k added to the vector Z. The linear part in equation (C.2) is in line with the idea of the semiparametric model as opposed to a nonparametric model (e.g., Zhang et al. (2002)). The coefficients of the linear part are estimated in the first step as averages of the polynomial fitting by using an initial bandwidth chosen by cross-validation Hoover et al. (1998). We then average these estimates β_{1i} and β_{2i} to receive β_1 and β_2 in equation (C.2). In the second step we use the average estimates and equation (C.2) to redefine the dependent variable as follows:

$$Y_i^* = Y_i - X_i\widehat{\beta}_i = V_i\beta_2(z) + e_i^* \tag{C.3}$$

where the asterisks denote the redefined dependent variable and error term. $\beta_2(z)$ is a vector of smooth but unknown functions of z_i, estimated using a local least squares of the form

$$\widehat{\beta}_2(z) = \left[\left(n\lambda^k\right)^{-1}\sum_{j=1}^{n} V_j^2 K\left(\frac{z_j - z}{\lambda}\right)\right]^{-1}\left[\left(n\lambda^k\right)^{-1}\sum_{j=1}^{n} V_j V_j^* K\left(\frac{z_j - z}{\lambda}\right)\right] = \left[B_n(z)\right]^{-1} C_n(z) \tag{C.4}$$

where

$$B_n(z) = \left(n\lambda^k\right)^{-1}\sum_{j=1}^{n} V_j^2 K\left(\frac{z_j - z}{\lambda}\right), Cn(z) = \left[\left(n\lambda^k\right)^{-1}\sum_{j=1}^{n} V_j V_j^* K\left(\frac{z_j - z}{\lambda}\right)\right] \tag{C.5}$$

Equation (C.4) represents a local constant estimator, where $K(z, \lambda)$ is a kernel function, $\lambda$is the smoothing parameter (chosen by generalized cross validation) for sample size n, and k is the dimension of z_i.

If we assume that z is a scalar and K is a uniform kernel, then equation (C.4) can be written as follows:

$$\widehat{\beta}_2(z) = \left[\sum_{|z_j - z \leqslant \lambda|} Vj^2\right]^{-1} \left[\sum_{|z_j - z \leqslant \lambda|} VjVj^*\right] \tag{C.6}$$

In equation (C.6), $\widehat{\beta}_2(z)$ is a least squares estimator obtained by regressing Y_j^*on V_j, using the observations of (V_j, Y_j^*) for which the corresponding z_j is close to z, that is, $|z_j - z| \leqslant \lambda$. Therefore, to estimate $\widehat{\beta}_2(z)$, we only use observations within this sliding window. Note that no assumptions are made about this estimator globally, but locally-within the sliding window-we assume that $\widehat{\beta}_2(z)$ can be well-approximated. Also, because $\beta_2(z)$ is a smooth function of z, $|\beta_2(z_j) - \beta_2(z)|$ is small when $|z_j - z|$ is small. The condition that $n\lambda$ is large ensures that we have sufficient observations within the interval $|z_j - z| \leqslant \lambda$ when $\beta_2(z_j)$ is close to $\beta_2(z)$. Therefore, under the conditions $\lambda \longrightarrow 0$ and $n\lambda^k \longrightarrow \infty$ (for $k \geqslant 1$), the local least squares regression of Y_j^*on V_j provides a consistent estimate of $\beta_2(z)$ (for a proof, see Li et al. (2002) . Therefore, the estimation method is usually referred to as a local regression. The main merit of this approach is that it is quite more flexible than the usual parametric functional forms (e.g., the translog) and this can lead to substantial improvement in the precision of the estimates. However, in unreported regressions we also use a translog specification and the same outputs and input prices and our results remain very similar.

Table C4: Average estimates of market power

		Percentile distribution				
		10	25	50	75	90
Year	Lerner index	Lerner index	Lerner index	Lerner index	Lerner index	Lerner index
1988	0.160	0.043	0.131	0.184	0.184	0.264
1989	0.135	0.039	0.104	0.161	0.161	0.219
1990	0.114	0.048	0.066	0.137	0.138	0.182
1991	0.129	0.059	0.104	0.129	0.150	0.150
1992	0.146	0.087	0.136	0.150	0.150	0.164
1993	0.187	0.143	0.173	0.173	0.173	0.263
1994	0.206	0.138	0.207	0.207	0.207	0.243
1995	0.198	0.160	0.195	0.195	0.195	0.227
1996	0.209	0.176	0.203	0.203	0.203	0.241
1997	0.200	0.126	0.184	0.197	0.228	0.255
1998	0.178	0.135	0.162	0.162	0.199	0.234
1999	0.210	0.142	0.173	0.222	0.254	0.254
2000	0.198	0.150	0.150	0.223	0.230	0.232
2001	0.211	0.143	0.143	0.217	0.267	0.267
2002	0.244	0.166	0.166	0.214	0.323	0.323
2003	0.263	0.180	0.182	0.251	0.341	0.341
2004	0.256	0.191	0.193	0.249	0.306	0.311
2005	0.249	0.187	0.187	0.245	0.296	0.314
2006	0.248	0.205	0.206	0.256	0.266	0.304
2007	0.225	0.171	0.171	0.229	0.246	0.287
2008	0.223	0.159	0.176	0.214	0.236	0.285
2009	0.279	0.212	0.212	0.259	0.362	0.362
2010	0.294	0.210	0.255	0.277	0.364	0.364
2011	0.293	0.206	0.264	0.267	0.367	0.388
2012	0.294	0.208	0.253	0.283	0.366	0.385
2013	0.306	0.218	0.269	0.282	0.380	0.406
2014	0.312	0.237	0.273	0.279	0.368	0.398
2015	0.321	0.218	0.290	0.301	0.404	0.417
Mean	0.249	0.159	0.191	0.244	0.296	0.362

This table reports average estimates of market power by year. Averages are obtained from the bank-year level estimates of market power using the Lerner index weighted by market shares. Higher values reflect higher market power (lower competition).