EUROPEAN CENTRAL BANK

EUROSYSTEM

Working Paper Series

Elena Carletti, Agnese Leonello, Robert Marquez

Market power in banking

Revised September 2024

No 2886

Abstract

Bank market power, both in the loan and deposit market, has important implications for credit provision and for financial stability. This article discusses these issues through the lens of a simple theoretical framework. On the asset side, banks choose the quality and quantity of loans. On the liability side, they may be subject to depositor runs whenever they offer demandable contracts. This structure allows us to review the literature on the role of market power for credit provision and stability and also highlight the interactions between the two sides of banks' balance sheets. Our approach identifies relevant channels that deserve further analysis, especially given the rising importance of bank market power for monetary policy transmission and the rise of the digital economy.

Keywords: credit provision, bank runs, balance sheet interactions, monetary policy transmission, digital economy

JEL: G01, G21, G28

Non-technical Summary

Market power -- the ability of firms to influence market outcomes by exerting control over prices, output, and other competitive factors -- is a central concept in understanding the dynamics of various industries. In the banking industry, market power, both in the funding and credit market, has important implications for credit provision and financial stability. It plays crucial role in shaping credit supply (Carlson et al., 2022; Wang et al., 2022), affecting financial stability (Carlson et al., 2022) and influencing monetary policy transmission (Drechsler et al., 2017, Wang et al., 2022, Drechsler et al., 2023). Furthermore, in the digital economy, bank market power emerges as a central topic, given the rise of new competitors such as FinTech and BigTech (Berg et al., 2022; Gambacorta et al., 2022; Vives, 2019).

This article provides a brief overview of the literature on bank market power and highlights avenues for future research. We focus primarily on the role that market power has for credit provision and financial stability. We refer to market power both in the credit and funding market and consider market power that individual banks have within the banking sector and vis-á-vis external competitors. Our discussion is structured around a simple theoretical framework, which serves two main purposes. First, it provides an illustration of how market power could be incorporated in canonical banking models. Second, it allows to clarify how the various modelling assumptions in existing papers drive the different results in the literature.

Our framework builds on Carletti, Leonello, and Marquez (2023), providing a framework where banks choose to exert effort when extending lending and are subject to the possibility that depositors withdraw their deposits prematurely. On the asset side, banks choose the riskiness of the loans, while on the liability side, they choose the deposit rate. Market power, in the credit and deposit market, affects both decisions, with direct implications for credit decisions and bank exposure to runs. The structure of the model allows to analyze the spillovers between the asset and liability sides of the balance sheet and so to highlight the implications of bank market power for their overall risk exposure, which we identify as a promising area for future research.

In recent years, bank market power has gained attention in both the academic and policy fora. This increased interest is associated to the role that it plays in the transmission of monetary policy, as well as to the rise of new competitors for banks in the context of the digital economy. Concerning the former, in recent years, both in a low interest rate environment and, more recently following the monetary tightening, market power has been shown to influence bank risk behavior, credit allocation and stability (Drechsler et al., 2017; Drechsler et al., 2023). Concerning the latter, banks now face competition by FinTech companies in the lending market, as well as by digital platforms and means of payments in the provision of payment services. Related to that, the recent discussion in the academic

literature concerning central bank digital currencies (CBDC) also been partly framed around the erosion of bank market power triggered by their introduction and its implications for credit provision and stability. Given these developments, the paper concludes with an overview of the recent literature on the transmission of monetary policy and CBDC.

1 Introduction

Market power – the ability of firms to influence market outcomes by exerting control over prices, output, and other competitive factors – is a central concept in understanding the dynamics of various industries. In the banking sector, market power plays a crucial role in shaping credit supply (Carlson et al., 2022; Wang et al., 2022), affecting financial stability (Carlson et al., 2022;), influencing monetary policy transmission (Drechsler et al., 2017, Wang et al., 2022), and navigating the challenges posed by emerging competitors such as FinTech and BigTech (Gambacorta et al., 2022). Moreover, market power in banking is highly relevant given the crucial role that banks play as intermediaries between firms and depositors and the effect such dynamics can have on the welfare of the economy (Igan et al., 2021; Claessens and Laeven, 2004).

In contrast to other industries, the standard competitive paradigm is not straightforward in the banking sector (Carletti, 2007; Igan et al., 2021; Boyd and De Nicolò, 2005, Allen, Carletti and Marquez, 2011), which is why analyses that aim at understanding the trade-offs of market power in banking are essential for policymakers, regulators, and researchers seeking to promote efficient and stable financial systems. This article provides a brief overview of the literature on bank market power and highlights avenues for future research. We focus primarily on the role that market power has for credit provision and financial stability. We refer to market power both in the credit and funding market and consider market power that individual banks have *within* the banking sector and *outside*, vis-á-vis external competitors.

In Section 2, we review the sources of bank market power and highlight that bank market power is either rooted in the asymmetric information between borrowers and lenders, which justifies the existence of banks (Diamond, 1984), or is the result of frictions limiting the ability and willingness of investors to move to alternative investment opportunities and intermediaries. Entry barriers, which make the market highly concentrated, as well as high switching costs due to, for example, limited financial sophistication (Drechsler et al., 2017), are key sources of market power. Similarly, the existence of network externalities also contributes to increased concentration in the payment industry and reduces the incentives to switch to alternative solutions.

In Section 3, we develop a simple theoretical framework. This allows us to highlight the mechanisms through which market power operates and it identifies relevant new forces for the effects of market power on credit and financial stability. We focus on credit provision in Section 4 and on financial stability in Section 5. In both sections, we review the existing literature through the lens of our simple framework, relating the existing literature to different modelling assumptions. The model builds on Carletti, Leonello, and Marquez (2023), providing a framework where banks choose to exert effort when extending lending and are subject to the possibility that depositors withdraw their deposits prematurely. Hence, it allows to analyze not only credit decisions and bank exposure to runs, but also highlights the existence of significant spillovers between the asset and liability sides of the balance sheet and the implications for banks' overall risk exposure (see Section 6).

Finally, in Section 7 we focus on two areas in which bank market power plays a crucial role. First, we discuss the implications that the introduction of central bank digital currencies (CBDC) may have for bank maker power. All major central banks are currently investigating the desirability and design of CBDC. While there are clear benefits, concerns have also been raised that CBDC, if not adequately designed, could reduce the attractiveness of bank deposits, leading to disintermediation, especially in crises times. We review the recent literature on the implication that CBDC, which can be seen as eroding bank market power in the funding market, has for both credit provision and stability. Second, we review the recent literature on the role that the degree of bank market power has in the transmission of monetary policy. In recent years, both in a low interest rate environment and, more recently following the monetary tightening, market power, manifested in the extent to which banks pass on changes in benchmark interest rates to their customers – either depositors or borrowers – has been shown to influence bank behavior and credit allocation decisions (Drechsler et al., 2017).

2 Sources and measures of market power

The degree of market power in the banking sector has been analyzed in depth in the literature. Numerous empirical studies have focused on measuring market power using both traditional structural measures or others linked to market contestability, for example. One key insight from these studies is that concentration is not always a good measure of competition. Therefore, different measures can have different implications for the efficiency and stability of the banking industry. By contrast, in the theoretical literature the focus is rather on the market failures that affect the nature of competition and its outcome in terms of credit provision and financial stability. Asymmetric information, switching costs, and network externalities create entry barriers and allow banks to retain some market power in the form of informational rents or enhanced differentiation. We discuss these elements briefly below.

2.1 Market power and asymmetric information

Banks act as intermediaries between savers and borrowers. In this role, they raise funds in the form of deposits and extend loans to borrowers (households, corporates and governments) in need of funds. While doing this, they specialize in screening and monitoring investment projects, acting as delegated monitors on behalf of depositors (Diamond, 1984). This information acquisition process creates informational asymmetries between banks and borrowers and across banks themselves, which may affect the competitive mechanism as well as the structure of the industry in several ways (Marquez, 2002).

Banks perform independent screening tests to discern borrowers' creditworthiness and then compete in setting loan rates. However, given that the screening tests are imperfect, the competitive market mechanism does not work perfectly. Setting the loan rate above that offered by competitors has two opposite effects. On the one hand, it increases the bank's revenues through the usual price effect. On the other hand, it worsens the quality of the borrowers accepting the loan, as a firm will accept the least favorable loan rate only if it is rejected by all other banks. Because of this "winner's curse" problem, increasing the number of banks performing screening tests decreases the average firm creditworthiness and increases the probability that a bank does not grant any loan (Broecker, 1990). It follows that the number of active banks is finite and the equilibrium may feature some degree of oligopolistic competition as asymmetric information creates an endogenous fixed costs which limits entry (Dell'Ariccia, 2001). In the limit, there may even be equilibria with blockaded entry, where only two banks are active and make positive profits even under pure Bertrand price competition (Dell'Ariccia et al., 1999).

Similar results on the limits of competition are obtained when considering the monitoring activity banks perform in the course of the relationship. As incumbent banks have an information advantage on their borrowers relative to outside banks, they can hold borrowers up and extract monopoly rents at the time their borrowers need to renew their loans (Rajan, 1992). This mechanism worsens borrowers' incentives to exert effort, leading to an inefficient allocation of capital toward lower quality firms (Sharpe, 1990).

In sum, the information acquisition process on borrowers' creditworthiness banks perform via either screening or monitoring allows them to exercise market power over borrowers. Information and technology are key determinants of bank market power. Banks that possess superior information about borrowers, markets, and risk management techniques can leverage this knowledge to gain a competitive edge (Hauswald and Marquez, 2003, 2006). In this light, advances in technology enable banks to develop sophisticated systems for risk assessment, customer analytics, and operational efficiency, enhancing their market power but also reducing the costs to acquire information for outside competitors. In recent years, technological development has fostered the rise of FinTech lenders (Berg et al., 2022) and BigTech companies providing financial services as new entrants in businesses that have been traditionally dominated by banks (Vives, 2019).

2.2 Market power and switching costs

Switching costs are an important source of market power in retail banking (e.g., Diamond, 1971). In moving from one bank to another, consumers may incur costs associated with the physical change of accounts, bill payments, or lack of information (Vives, 2001, Drechsler et al., 2017). The presence of switching costs produces in general two opposing effects on the degree of competition. On the one hand, they may lead to collusive behavior once banks have established a customer base which remains locked in. On the other hand, they induce fierce competition to enlarge the customer base. Thus, switching costs may lead banks to offer high rates initially to attract customers and to reduce them subsequently, when consumers are locked in (see also Bouckaert and Degryse, 2004, for an analysis that focuses on switching costs for borrowers and its effects for credit market competition). Allen and Gale (2000b, 2004) show that a small fixed cost of switching banks may imply higher rates in a system with many small independent banks (unitary system) than in a system with two large banks having extensive nationwide branching networks (branching system).

2.3 Market power and networks

Network effects occur when the value of a bank's services increases as more customers use its products, creating a barrier for customers to switch to other banks, thus affecting the pricing of banking products and the structure of the industry. The analysis of these issues dates back to the literature on two- or multi-sided platforms (e.g., Rochet and Tirole, 2003, 2006; Amstrong, 2006). In the context of banks, network effects have been studied in earlier literature in the context of the Automatic Teller Machine (ATM) networks as summarized in Carletti (2008), and have become again very prominent recently in the context of the digital economy as presented in Vives (2019).

Strong network effects are associated with higher market power and, in extreme cases, may lead to a winner-takes-all outcome (Rysman, 2009). In the context of digital platforms, the extensive data they collect on customers allows to strengthen the network externalities through the offer of more targeted products and services. The resulting increased attractiveness of services and products, in turn, translates into higher market power. This is the case in many markets, including the provision of payment solutions alternatives to bank deposits.

By having an established pool of consumers (including merchants and customers), platforms have competitive advantage in offering payment solutions, from which they can derive large benefits from direct access to payment data. This is a key rationale behind the rise of (private) digital currencies and also an argument for the introduction of public digital money- central bank digital currency (CBDC)- as a way to limit concerns about privacy and anti-competitive behavior, which are spurred by the dominance of digital platforms in the provision of payment services (Ahnert et al., 2022).

Both private and public digital currency represent a potential competitive threat to banks, and, in particular, on their ability to raise and maintain a stable funding base, thus having consequences for both credit provision and stability.

3 A simple conceptual framework

In this section, we develop a simple conceptual framework to serve two main purposes. First, the model provides an illustration of how market power could be incorporated into otherwise canonical banking models to show how it affects banks' decisions on both the asset and liability side of their balance sheets. Second, it allows to structure the discussion of the existing literature on the implications of bank market power for credit, stability, and the transmission of monetary policy.

The stylized two-period model sees banks using external funds D and own funds E to provide loans L^s to firms, so that

$$L^s = E + D.$$

Loans to firms entail a return $\ell \leq 1$ if liquidated in the first period, while they provide a risky return $\widetilde{R}$ at maturity. There are two sources of risk. First, loans are exposed to aggregate risk, whereby their return depends on the fundamental of the economy θ, whose realization is uncertain at the initial date. Second, there is a bank-specific risk, whereby the bank can exert effort q to improve the likelihood that firms repay their loans (Dell'Ariccia and Marquez, 2006; Martinez-Miera and Repullo, 2017). Effort can be interpreted as ex-ante screening or ex-post monitoring and is costly. Formally, the expected return of a loan for a bank is

$$\widetilde{R} = \begin{cases} R\theta & \text{w.p. } q \\ 0 & \text{w.p. } 1-q \end{cases},$$

where R is the loan rate and θ is a random variable representing the fundamentals of the economy.

In the loan market, banks face a downward-sloping demand for loans

$$L^d = \alpha - \beta R.$$

Since in equilibrium loan demand equals loan supply, the loan rate R depends on the equilibrium loan volume L and the degree of credit market competition, which is captured by β, the sensitivity of loan demand to changes in the loan rate: the lower β, the higher is a bank's market power. The variable β could also capture the competitive pressure exerted by alternative financing opportunities for firms. For example, firms can also raise funds by issuing bonds (Bolton and Freixas, 2006) or through other non-bank intermediaries (e.g., FinTech) as alternative or in addition to bank loans. In this respect, a lower β would reflect that the access of firms to non-bank financing is more limited.

External funds are raised in the form of deposit contracts offering a repayment $r_1 \geq 0$ if withdrawn in the first period and a repayment $r_2 \geq r_1$ if held until the maturity of the bank's investment. If $r_1 > 0$, then investors have the possibility to withdraw funds at the interim date, while if $r_1 = 0$ they will have to wait to the final period to be repaid.

Investors deposit their funds into a bank as long as the contractually agreed contract $\{r_1, r_2\}$ compensates them for the risk of bank failure and pays more than alternative investment opportunities. The value of outside investment opportunities, which we denote as $u \geq 1$, can be interpreted as a measure of the market power a bank has within the banking sector, as well as vis-á-vis other assets and investments available to depositors, such as cash, bonds, or digital currencies.

In our framework, a bank failure can occur for different reasons and at either date. In all cases, for simplicity, our specification reflects the presence of full bankruptcy costs (James, 1991) at either date, so that whenever the bank fails, investors do not receive anything.

When $r_1 = 0$, depositors leave the money at the bank until the final date so that the bank can only fail at the final period. Such failure is either due to the fact that its effort does not pay off, i.e., with probability $1-q$, or when the realized loan returns $R\theta\,(E + D)$ are not enough to repay depositors' promised repayments, $r_2 D$. By contrast, when $r_1 > 0$, the bank can also fail at the interim date due to a run. The bank satisfies early withdrawals by liquidating units of the long term project and, thus, depleting the resources available to repay depositors at the final date. Hence, when $r_1 > 0$, the bank's failure probability is determined by it's risk-taking decisions, as captured by q, depositors' early withdrawals, and low realization of the fundamental θ.

As we discuss in detail in Section 5, crucial in the determination of the source of runs is the underlying assumption about the nature of θ, whether it is deterministic or stochastic, and the information that depositors have on its realization.

4 Market power and credit

In this section we discuss some of the existing literature on the link between bank market power and the allocation of credit. This encompasses, among others, the effect of market power on banks' screening decisions, on the availability of credit, on the efficiency of credit allocation decisions, and on the pricing of credit terms. We also highlight emerging issues exploring how bank market power affects borrowers as well as its implications for financial sector stability.

Many of these aspects are, of course, intertwined. One dimension the literature has identified as an important driver of competition is the presence of information asymmetries, which has been shown to affect the relationship between competition and loan rates. As banks reduce their individual screening efforts when there is entry, increasing the number of banks implies that more low-quality borrowers obtain financing. To compensate for the higher portfolio risk, banks may have to increase their rates, thus leading to an inverse relationship between competition and loan rates (Marquez, 2002).

To this, a new, and possibly offsetting, aspect is introduced when one allows information acquisition to be endogenous. For instance, Hauswald and Marquez (2006) study how competition affects banks' investments in borrower creditworthiness information, establishing a clear link between increases in competition and reduced investments. Such investments have two important roles. First, by providing a bank with private and often proprietary information about borrowers, they endow the lender with an information monopoly over their customers, leading to information-based rents for the bank. This dimension creates a strategic reason for banks' information acquisition decisions since information is useful for keeping bank profits high and also for keeping other competitors at bay by generating larger adverse selection problems for competing lenders (see also Dell'Ariccia, Friedman, and Marquez, 1999, for an alternative framework that generates reduced entry as a result of information asymmetries across lenders).

Second, changes in the degree to which banks acquire information on which they can base their lending decisions have implications for the interest rates they may charge, as well as for the decisions they may make in terms of when and to whom they should grant credit (Dell'Ariccia and Marquez, 2004). Consider, for instance, a setting where borrower quality is on average high, even if there are some borrowers whose credit risk is sufficiently high that it would be inefficient to grant them credit. In the absence of any information, a lender would find it reasonable to extend a loan even at the risk of sometimes mistakenly making a "bad" loan given the high average quality. Obtaining information, however, allows the lender to better sort borrowers and improves the efficiency of lending decisions since the bank can now do a better job of avoiding lending to some borrowers that are not creditworthy. However, the volume of credit decreases as a result. The opposite, of course, is true if for a given market the average quality of borrowers is sufficiently low that, in the absence of any additional information, banks would find it unprofitable to lend at all. In this case, acquiring information, similar to before, allows the bank to more efficiently grant credit, and in fact expands credit since it allows borrowers with good opportunities and higher repayment probabilities to obtain credit. In both of these cases, one immediately sees that, if changes in bank competition affect their incentives to acquire information, this will have implications for the volume of credit and for the efficiency of credit allocation decisions.

Many of the important forces at work can best be illustrated through the simple model introduced in Section 3. For the moment, we shut down the feedback between financial instability stemming from the liability side of the bank's balance sheet and the bank's credit allocation decisions by setting $r_1 = 0$. This eliminates the possibility of a bank run at the interim date, and effectively transforms the model into a single period setting. With this, we can now solve for the equilibrium loan rate by equating loan demand with loan supply,

$$\alpha - \beta R = E + D \Leftrightarrow R(\beta) = \frac{\alpha - (E+D)}{\beta}. \tag{1}$$

Equation (1) illustrates that the interest rate on bank loans, R, is decreasing in the total supply of bank funds, $E + D$, as well as in the interest rate sensitivity of loan demand, β. As argued above, β represents a measure of the degree of competition or, alternatively, an inverse measure of bank market power, so that increases in β lead to lower market interest rates. Note as well that, all things equal, an increase in bank market power (i.e., a reduction in β) is tantamount to an increase in loan demand for a given interest rate offered by the bank.

To see how changes in the degree of market power for the bank affects loan allocation decisions, consider the bank's objective, which is to maximize profits with respect to its effort decision q, which can be viewed as representing the amount of monitoring of its loans undertaken by the bank, or as the extent to which the bank screens loan applications ex-ante. In the latter case, q would represent the overall quality of the bank's portfolio, with return $R(E + D) - C(q)$, where $C(.)$ is the cost of the bank's screening/monitoring effort. For simplicity, we normalize the size of the bank, as measured by $E + D$, to 1. The bank therefore maximizes

$$\max_q E\left[q\left(R(\beta) - Dr_2\right) | R(\beta) - Dr_2 > 0\right] - C(q).$$

For concreteness, let the cost of the bank's effort be quadratic, so that $C(q) = \frac{c}{2}q^2$. Also, suppose that, for simplicity, aggregate uncertainty θ is uniformly distributed between 0 and 1. The bank's objective function can now be rewritten as

$$\max_q q \int_{\frac{Dr_2}{R(\beta)}}^{1} \left(R(\beta)\theta - Dr_2\right) d\theta - \frac{c}{2}q^2 = q\frac{1}{2R(\beta)}\left(R(\beta) - Dr_2\right)^2 - \frac{c}{2}q^2.$$

The first order condition for q is

$$\frac{1}{2R(\beta)}\left(R(\beta) - Dr_2\right)^2 - cq = 0,$$

which yields

$$q^* = \frac{1}{2R(\beta)c}\left(R(\beta) - Dr_2\right)^2. \tag{2}$$

The bank's optimal choice of effort q^* can readily be seen to be increasing in the loan return R. Since R is decreasing in β, however, this means that the degree of monitoring or screening undertaken by the bank will be decreasing in the degree of competition β or, equivalently, as bank market power erodes. The reduction in q then implies a riskier portfolio for the bank and a lower probability of full repayment to depositors. In other words, reduced market power in lending markets for the bank translates into greater risk of bank failure.

A counterpoint to this result can be found in Boyd and De Nicoló (2005), who incorporate a role for borrowers to also exert effort in improving the success probability of their projects. They show that a bank with too much market power and who, as a consequence, charges too high an interest rate R, will deter a borrower from exerting sufficient effort on its own project. As result, a reduction in bank market power should lead to an increase in the borrower's own effort, and may actually increase the overall probability of success of the bank's project, improving financial stability and reducing the likelihood of default.

The mechanism from Boyd and De Nicoló (2005) can be illustrated in the context of the model presented above with a simple extension. Suppose that, in addition to the bank's effort decision q, the borrower also has the ability to put in effort w at cost $\frac{c_w}{2}w^2$. The total probability of project success is $Q = q + w$. When successful, the project returns a total amount $P \geq R(0)$ to the borrower. With this, the bank's maximization problem becomes

$$\max_q (q+w) \int_{\frac{Dr_2}{R(\beta)}}^{1} (R(\beta)\theta - Dr_2)\, d\theta - \frac{c}{2}q^2 = (q+w)\frac{1}{2R(\beta)}(R(\beta) - Dr_2)^2 - \frac{c}{2}q^2,$$

while the borrower's objective is

$$\max_w (q+w) \int_0^1 (P - R(\beta))\,\theta d\theta - \frac{c_w}{2}w^2. \tag{3}$$

From (3) it can readily be seen that, if the bank's market power decreases, so that β increases, the consequent reduction in the loan's interest rate $R(\beta)$ will lead to an improvement in the borrower's incentives to exert effort.[1] Whether the overall risk $1 - Q$ increases or decreases then depends on the relative magnitudes of the changes in q and w, so that overall risk may actually decrease even as banks' market power is reduced and their own incentives to either screen or monitor go down.

As a final point, it is worth noting that much of the existing empirical and theoretical work has focused on how changing bank market power, stemming from greater competition from other banks as a result of foreign entry or deregulation, for instance, affects bank borrowers and banking sector stability. More recently, there is a growing literature on the role of FinTech lenders, and the possibility of disruption of the traditional roles for banks in the allocation of credit. One salient aspect of such lenders is their use of information, with specialized ability to gather information from customer transaction data, mobile device usage, or online search history, to name a few. This feature of FinTech firms is reducing the barrier to competition with traditional lenders, and will likely erode bank market power along many dimensions. A careful discussion of recent developments of FinTech firms and their impacts on credit markets can be found in Vives (2019) and

[1] This setup is, of course, overly simplistic in that it assumes the project's total return P is always at least as large as what is promised to the bank, R, at least when the project is succesful. This implies that borrower default never occurs unless the project fails entirely, which occurs with probability $1 - q - w$. More generally, the borrower may need to first repay its loan, which would give rise to a cutoff value $\widehat{\theta}(R)$ below which the borrower receives nothing, and above which he receives $P - R$. Similar insights hold in such a setting.

Berg et al. (2022). In the context of the simple guiding framework we present here, greater competition by FinTech should translate into greater β or, in other words, reduced bank market power, with concomitant implications for bank portfolio risk.

4.1 Deposit market competition

The focus of our review so far has been on market power on the lending side, with loan interest rates being determined by borrower's demand sensitivity. Here, we briefly discuss issues related to market power on the deposit side. Bank deposits are notoriously sticky (Drechsler et al., 2017), which gives rise to market power for banks when setting deposit rates – as funding conditions change, such as if benchmark interest rates (e.g., the Fed funds rate) increase, the bank need not pass on much of the rate increase onto depositors. In essence, the low elasticity of deposits to changes in market interest rates allows banks to set rates so as to maximize their profits, keeping margins relatively high. This deposit-side market power has implications for banking sector stability, as we illustrate next.

One simple way to incorporate market power on the deposit side is to consider the participation decision of depositors – what does it take for a bank to be able to attract investors to deposit their funds, thus becoming a source of financing for the bank? Specifically, suppose that depositors have an outside option of $u \geq 1$, where $u = r + z$. Here, $r \geq 1$ represents a benchmark (gross) interest rate such as the federal funds rate, while $z \geq 0$ is whatever markup above the benchmark rate demanded by depositors. In general, greater competition for deposits should lead to increases in z. However, bank market power can also be seen in the extent to which banks pass on changes in benchmark interest rates, r, to depositors. If z is constant for all r, that is equivalent to saying that bank's pass on rate increases one-for-one to depositors, and thus have no market power over these investors. Conversely, if $\frac{du}{dr} < 1$, this implies that banks use their market power to (at least partly) offset changes in funding costs when trying to attract deposits.

Consider now an investor's participation condition for depositing at a bank. For simplicity, let $w = 0$ so that the borrower's effort decision plays no role, as in our baseline. In this case, the participation condition is

$$q \int_0^{\frac{Dr_2}{R(\beta)}} R(\beta)\,\theta d\theta + \int_{\frac{Dr_2}{R(\beta)}}^1 Dr_2 d\theta \geq u = r + z.$$

For any given q, an increase in u, whether stemming from an increase in the benchmark rate r, or from depositors' ability to demand a markup z, leads to an increase in the deposit rate r_2. This increase in r_2 then has two implications for the bank. First, it reduces the likelihood of being profitable since it increases the threshold $\frac{Dr_2}{R(\beta)}$ above which the bank is able to fully repay depositors. Second, even if deposits are fully repaid (i.e., for $\theta > \frac{Dr_2}{R(\beta)}$), the bank's residual return $R(\beta)\,\theta - Dr_2$ is lower. Both of these effects reduce bank profits. Moreover, they also reduce the bank's marginal incentive to put in effort, as can be seen from

(2). Hence, changes in bank market power have a direct effect on the bank's effort decision q, and thus on the likelihood of bank failure.

5 Market power and financial fragility

Instability on the liability side of the bank balance sheet relates to runs and systemic crises. Both phenomena are rooted in the role that banks perform in the economy as liquidity and credit providers and so, ultimately, in the liquidity and maturity mismatch that characterize banks' balance sheets. On the liability side, banks finance themselves mostly with liquid liabilities, like demandable deposits or short-term debt.[2] On the asset side, instead, they hold a large fraction of illiquid and long-term assets, like commercial loans and long-term government debt (Saunders et al., 2021).

Liquidity and maturity mismatch expose banks to the risk that their investors run, that is, that they withdraw their funds *en masse* before the maturity of the assets, thus forcing the bank to liquidate assets prematurely with the risk of reducing their values and putting pressure on market liquidity. Investors may decide to withdraw at the interim date for two reasons. They can either worry about a deterioration in economic conditions (Gorton, 1988) or they may panic and withdraw early out of the self-fulfilling belief that other depositors will do the same and the bank will fail (Diamond and Dybvig,1983).[3]

To illustrate this phenomenon, we consider our stylized model where we now assume $q = 1$ so that the loan return does not depend on the bank's effort, while, as in Section 4, it is a function of bank market power β as characterized in (1). Unlike Section 4, we assume $r_1 > 0$ so that the deposit contract is demandable. This is typically justified by the presence of early type consumers that need to withdraw and consume in the first period. In addition, in line with the literature on financial stability, we consider that banks are fully debt financed so that $E = 0$ and $L = D$.

In the fundamental view of bank runs, crises are linked to the business cycle (Jacklin and Battacharya, 1988) which, in the context of our stylized framework, refers to the realizations of the stochastic variable θ. During recessions, the value of assets deteriorates (i.e., θ is low), making it more difficult for banks to honor promised repayments. Anticipating this, bank debt holders find it optimal to withdraw their funds prematurely. This would force banks to sell assets, potentially at a lower value, thus affecting their solvency. This instance can be captured in our simple conceptual framework by the condition

[2] For example, three quarters of U.S. commercial bank funding is formed of deposits, half of which are uninsured (Egan et al., 2017).

[3] While we focus on models of a representative bank, runs may trigger a systemic crisis. The propagation of instability (i.e., contagion) can, for example, occur through the interbank deposit market (e.g., Allen and Gale, 2000) or through asset prices (Diamond and Rajan, 2011) in contexts in which markets are incomplete and prices are determined by available liquidity, the so-called "cash-in-the-market prices" (see e.g., Acharya and Yorulmazer, 2008; Allen and Carletti, 2008; Allen and Gale, 2005).

$$R(\beta)\,\theta < r_2. \tag{4}$$

Whenever (4) holds true, the resources available at maturity, as captured by the LHS, are not enough to meet depositors' promised repayment, as captured by the RHS, thus making it optimal for them to withdraw.

In the panic view, instead, bank runs emerge as multiple equilibria stemming from coordination problems among depositors. In Diamond and Dybvig (1983), banks invest in safe long-term assets (i.e., $\theta = 1$), which can be liquidated prematurely at no cost (i.e., $\ell = 1$) and offer depositors a liquidity premium: Investors withdrawing early are promised more than what they initially deposited (i.e., $r_1 > 1$).[4] Due to the positive wedge between liquidity demand, as measured by the resources promised to early withdrawers, and liquidity available, as captured by the proceeds from liquidation, a large enough fraction of depositors withdrawing prematurely will completely deplete the bank's resources, thus making it optimal for a depositor to run when he believes that such crisis will occur. Hence, this bad equilibrium coexists with a good one in which no one runs. The Diamond and Dybvig (1983) runs then emerge in the context of our model whenever the following condition holds:

$$\underbrace{r_1 D}_{\text{demand for liquidity}} > \underbrace{\ell D}_{\text{available liquidity}}. \tag{5}$$

Condition (5) implies that when the fraction of withdrawing depositors is large enough, the bank is forced to liquidate everything prematurely and there is nothing left for those depositors that wait to withdraw until maturity.

While the earlier literature on bank runs has contrasted the fundamental view of runs with the idea of panics, a more recent literature based on global games techniques (Goldstein and Pauzner, 2005) has allowed to consider them in a single framework. Going back to our stylized model, assume that $\theta \sim U[0,1]$ and investors decide whether to withdraw prematurely after receiving an imperfect signal on the realization of θ. The equilibrium outcome is that runs occur when the signal and, in turn, fundamentals are below a unique threshold, which we denote as θ^*. Within the range where runs occur, they can be classified into fundamental-based runs or panic runs. The former type occur when the signal on the fundamentals is low enough (i.e., $\theta \leq \theta^F < \theta^*$) to make running a dominant strategy for depositors. The latter type is generated by the self-fulfilling belief of depositors that other depositors will run in the range $\theta^F < \theta \leq \theta^*$.

The financial stability literature has largely ignored the role of bank market power and competition for the occurrence of runs for two reasons. First, the literature has been developed for the most part assuming a perfectly competitive environment where banks maximize depositors' expected utility, focusing instead on

[4] The liquidity premium derives from the assumption of risk averse consumers exposed to idiosyncratic liquidity shocks affecting the time of their consumption.

highlighting the efficiency properties of the equilibrium. Second, it has mostly analyzed runs in the form of panics, which are a sunspot phenomena emerging in settings where competition plays no role.

In the context of our stylized framework, conditions (4) and (5) highlight that there are several channels through which bank market power, in both the asset and the deposit market, could affect the occurrence of both panic- and fundamental-driven runs. First, focusing on the asset side, market power β affects banks' ability to withstand crises, as clearly shown in (4), through changes in the loan rate R. Second, focusing on the deposit market, bank market power**,** as measured by the value of depositors' outside opportunity u, directly affects the amount of funds that the bank is able to raise, i.e., D, as well as the terms of the deposit contract $\{r_1, r_2\}$, whereby a higher r_2 makes condition (4) more likely to hold, and condition (5) requires the deposit repayment r_1 to be sufficiently large.

A few papers have explored some of those channels, albeit in frameworks somewhat different from our stylized model. Carletti and Leonello (2019) develop a model in which banks are subject to exogenous liquidity shocks and the degree of credit market competition determines the returns that banks accrue on their investment, i.e., the variable R in the context of our model. In their framework, higher market power in the loan market increases the differential return between illiquid loans and liquid reserves. Hence, when loan competition is less intense, banks are less willing to hold reserves, which are liquid but less profitable than loans, and thus are more susceptible to liquidity shocks. As a result, they show the existence of a threshold value of credit market competition below which bank failures emerge in equilibrium and show that this threshold increases with the probability of a liquidity shock.

The analysis in Carletti and Leonello (2019) supports the view that competition is beneficial for bank stability, although it also suggests that it is important to account for the interaction of bank market power with other elements, such as the probability of aggregate liquidity risk. A similar approach focusing on the role that competition plays in shaping banks' portfolio decisions is also adopted by Gao and Reed (2021). Unlike Carletti and Leonello (2019), they focus on panic crises, but reach similar conclusions about the detrimental role of market power for bank stability.

The focus on panic crises is also central in Matutes and Vives (1996), which represents the first contribution exploring the role of bank market power for the occurrence of sunspot runs. Differently from the papers above, their focus is on market power in the deposit market. They develop a model with product differentiation and network externalities in which depositors hold self-fulfilling beliefs about the probability of a panic run. In their framework, a two-way feedback between competition and fragility emerges. First, the degree of rivalry between banks affects the probability of failure through a change in the deposit rate. Second, the probability of failure affects market power in that safer banks enjoy higher margins and larger market shares.

The analysis in Matutes and Vives (1996) highlights a beneficial role of market power for stability as it allows banks to economize on the costs of deposits. Our stylized framework shows that this prediction may not always be true. To see this, we first need to take a few more steps in characterizing the run thresholds θ^F and θ^*. In doing this, we treat q as a parameter. In addition, to also consider the role of capital structure, we consider again that banks finance themselves with both deposits and equity, so that their total funding is $E + D$, with $E > 0$. As explained above, in our simple setting, fundamental runs occur in the range of θ where a depositor finds it optimal to withdraw irrespective of what others do, i.e., for $\theta < \theta^F$ where running is a dominant action. This is the case as long as the depositor believes that the bank will fail at the final date even if no other depositors run. Hence, the run threshold θ^F can be pinned down directly as the solution to (4) holding with equality and augmented with equity E, and is equal to

$$\theta^F = \frac{r_2}{R(\beta)} \frac{D}{E + D}. \tag{6}$$

The expression above shows immediately that a higher deposit rate r_2, which is compatible with more intense competition in the deposit market, is associated with a higher run threshold θ^F and the more so the higher is bank leverage $\frac{D}{E+D}$. Hence, concerning fundamental runs, our framework supports the prediction in Matutes and Vives (1996). Moreover, a higher β, which reflects more intense competition in the loan market and implies a lower loan rate $R(\beta)$, is associated with a higher run threshold θ^F, thus also suggesting that more intense competition is detrimental for stability.

Consider now panic-driven runs. The probability of a panic run can be pinned down in our framework using global games and corresponds to the threshold θ^*,[5] which is equal to:

$$\theta^* = \frac{r_2 D}{R(\beta)(E + D)} \frac{\left(q r_2 - \ell \frac{(E+D)}{D}\right)}{q r_2 - r_1 (E + D)} = \theta^F \frac{\left(q r_2 - \ell \frac{(E+D)}{D}\right)}{q r_2 - r_1 (E + D)}. \tag{7}$$

The threshold θ^* identifies the level of the fundamental θ below which all depositors run and, so represents the probability of a panic run. It is easy to see that again more intense competition in the loan market, which implies a lower loan rate $R(\beta)$, is associated with a higher θ^*. The effect of a change in the degree of competition in the deposit market is more involved as it now matters how this change affects the deposit contract $\{r_1, r_2\}$ since the two repayments have a different effect on θ^*. While a higher early repayment r_1 is always associated with a higher θ^*, a higher r_2 in equilibrium is always associated with a lower θ^*.[6] The potential detrimental effect that competition has on stability, through the increase in deposit rates, emerges in Ahnert and Martinez-Miera (2021). In their framework, $r_1 = r_2 = r$ and banks compete for deposits along

[5] For the purpose of this article, we do not formally derive the run threshold θ^*. The derivations and associated formal proof is analogous to the one in Carletti, Leonello and Marquez (2023).

[6] The comparative statics of θ^* with respect to r_2 is not monotone: for low r_2, θ^* is decreasing in r_2, while it is increasing for higher values of r_2. However, it is never optimal for a bank to choose r_2 in the range where it leads to an increase in θ^* as the bank could always do better (i.e., earning higher expected profits) by choosing a lower r_2.

a circle, like in Salop (1979). The probability of a bank run is strictly increasing in the face value of deposits r. Hence, in their framework, when the number of banks increases, each of them offers a higher repayment r to depositors in an attempt to maintain their market share, thus leading to a higher run probability.

6 Interaction between asset and liability side

So far, we have looked at the effect that bank market power has on the probability of a bank failure by considering separately failures on the asset and liability side, i.e., excessive risk-taking and runs. However, there are clearly important spillovers between the two sides of bank balance sheets and they jointly determine banks' and depositors' incentives. In other words, bank risk-taking decisions on the asset side are affected by depositors' incentives to run. Similarly, depositors' incentives to run depend to a large extent on their views about the bank's diligence in monitoring its' borrowers, thus ensuring repayment of their deposits, or on the bank's ex-ante screening to reduce overall portfolio risk.

As before, many of the salient and important aspects related to this interaction between the asset and liability sides of the bank can be illustrated using the framework provided above. Let's go back to the specification presented in Section 4 but, unlike in that section, assume that $r_1 > 0$, so that deposits are now redeemable in the interim period. As a result, as analyzed in Section 5, depositors run on the bank whenever economic fundamentals, θ, are sufficiently poor. We assume that the bank has promised more to depositors at the interim date than the resources it has available (i.e., that $Dr_1 > \ell\,(E+D)$), and use the notation of the threshold value θ^* introduced in Section 5 to denote the risk of a depositor run at the interim date.

Turning to the effect that run risk has on bank risk-taking on the asset side, we start by rewriting the bank's profit in the presence of run risk as follows:

$$\Pi = q\int_{\theta^*}^{1}\left(R\left(\beta\right)\theta\left(E+D\right)-Dr_2\right)d\theta-\frac{c}{2}q^2. \tag{8}$$

Note that the bank obtains profits only when it survives until the final date, which occurs whenever $\theta \geq \theta^*$, in which case its profit is the residual between the project's return $R\left(\beta\right)\theta\left(E+D\right)$ and the promise to depositors, Dr_2. Depositors' participation constraint is given by

$$q\int_{\theta^*}^{1} Dr_2 d\theta \geq u, \tag{9}$$

which reflects that depositors receive the full repayment from the bank in case it does not fail, i.e., effort q is successful and no run has occurred.

We can now use these two expressions to study the feedback between the bank's risk-taking decisions and depositors' incentives to run. Using (8), the first order condition for the bank is

$$\int_{\theta^*}^{1}\left(R\left(\beta\right)\theta-Dr_2\right)d\theta-q\frac{\partial\theta^*}{\partial q}R\left(\beta\right)\theta^*-cq=0.$$

Unlike the case discussed in Section 4 where there was no possibility of a run by depositors, now the bank's risk-taking choice q clearly depends on how this choice affects depositors' incentives to withdraw early, $\frac{\partial \theta^*}{\partial q}$. Since $\frac{\partial \theta^*}{\partial q} < 0$, the bank has an additional marginal incentive to limit its risk-taking and put in more effort toward ensuring the success of its project.

Conversely, this argument also establishes that depositor behavior is also a function of the bank's asset-side choice q, with safer portfolio choices inducing depositors to be more willing to wait until the final date to withdraw, while a riskier portfolio (i.e., lower q) leads to a greater probability of a run at the interim date. The magnitude of $\frac{\partial \theta^*}{\partial q}$ will then depend on the sensitivity of depositors' behavior to the safety of the bank's portfolio, which is determined by the degree of complementarity among depositors' actions.

We can now use this framework to consider how changes in bank market power affect bank and depositor behavior, as well as financial sector stability. Consider a reduction in bank market power in the loan market, characterized by an increase in β. The increase in β should, all things equal, lead to an increase in bank risk-taking, which here means a reduction in q. This makes the bank's portfolio riskier and more subject to failure, but also has another knock-on effect: by reducing q, depositor run risk increases since depositors becomes more worried about the prospect of the bank's portfolio failing, and their deposits becoming at risk as a result. Hence, θ^* increases, further reducing financial sector stability. The increase has an additional effect via depositors' participation constraint as characterized in (9). As a result of an increase in both bank risk-taking q and the run threshold θ^*, the deposit rate needs to increase as well, thus producing additional effects on q and θ^*.

A similar logic applies to changes in bank's deposit market power – to the extent that reduced market power implies an increase in depositors' outside option u, the bank must now offer a greater expected repayment to investors in order to induce them to deposit their funds at the bank, as can be clearly seen from (9). The main tool the bank has for achieving this is to increase the promised repayment at the final date, r_2. While, all things equal, this reduces depositors' run risk θ^*, the larger promised repayment also reduces the residual return to the bank in the event of project success, $R(\beta)\,\theta\,(E+D) - Dr_2$. This latter effect has a depressing impact on the bank's risk-taking decision, q. While which effect may dominate is likely determined by the exact setting being considered (i.e., the degree of leverage, the extent of complementarities in depositor behavior, the degree of pass-through onto deposit rates of benchmark funding shocks, etc.), the main issue is that the relationship between financial sector stability, bank and depositor behavior, and changes in the degree of market power is complicated given the various channels through which each effect operates, and the feedback between the two sides of the balance sheet. Carletti, Leonello, and Marquez (2023) explore one particular aspect of these relationships, related to the extent to which the value of loan guarantees gets passed on to bank customers – either borrowers or depositors – but many unexplored issues remain.

7 New challenges

In recent years the debate on the role of market power has come to the forefront again in relation to the development of the digital economy and the transmission of monetary policy. Concerning the former, banks are now facing the competition of new players. On the asset side, banks face competition from FinTech and BigTech companies that rely on advanced screening and monitoring technologies to acquire information on their clients in the provision of credit. On the liability side, new digital forms of payments such as central a bank digital currencies may represent a potential competitor to bank deposits, thus having implications for stability and credit provision. Concerning the latter, market power in the deposit market plays a key role in the transmission of monetary policy by determining the pricing and the ability of banks to retain their funding.

7.1 Central bank digital currency (CBDC)

In the debate on the introduction and design of CBDC, concerns have been raised about the risk of disintermediation and sudden liquidity shortfalls for banks triggered by its adoption. These concerns primarily hinge on the safety and positive returns investors can accrue holding CBDC, which make CBDC a profitable alternative investment opportunity, de facto emerging as a potential new competitor to banks in the funding market. It is not surprising then that the current efforts in policy circles are devoted to analyzing design features and implementation to curb these concerns and so maximize the benefits of the introduction of CBDC.[7]

This perspective, whereby CBDC appears to reduce bank market power in the deposit market, has spurred a number of academic contributions focusing on the reaction of banks to the introduction of CBDC and, ultimately, on stability and credit provision. The central idea in these papers is that, as for any other competitive threats, banks are not going to be passive to the introduction of CBDC but will, instead, adjust deposit rates in response.

In the context of our stylized framework, the introduction of CBDC and the associated erosion of banks' market power can be modelled as an alternative investment available to depositors affecting their outside opportunity u. This is the approach followed in the recent paper by Ahnert et al. (2023), where they explore the implications that CBDC remuneration has for financial stability. In their framework, banks are only funded via deposits, i.e., $E = 0$ and $D = 1$, and investors can hold their funds as bank deposits or

[7] For an extensive discussion of the rationale and benefits for the introduction of CBDC, see Ahnert et al. (2022), which also includes a review of the literature.

in CBDC. Banks promise a repayment $r_1 = 1$ to depositors withdrawing at the interim date and $r_2 > r_1$ if they withdraw at the final date, while CBDC yield a (gross) per period return $\omega \geq 1$. The main result of their paper is a U-shaped relationship between CBDC remuneration and stability, in that increases in CBDC remuneration lead to a reduction in the run probability when remuneration is low and to an increase otherwise. This result hinges on the existence of two contrasting effects of ω on the probability of runs. On the one hand, there is a direct effect: Relative to an economy with only cash as alternative to bank deposits, CBDC allows investors to obtain a higher return on the funds they withdraw from the bank prematurely, thus increasing their incentives to run. In deciding when to withdraw, depositors compare the expected payoff they could obtain from keeping their funds in the bank until the final date with what they obtain if they withdraw their deposit and convert it to CBDC at the interim date. As in Section 5, they will decide to withdraw whenever the value of fundamentals θ falls below the threshold θ^* as given by the solution to

$$\phi_2(\theta) r_2 = \omega \phi_1 r_1,$$

where ϕ_1 and $\phi_2(\theta)$ represent the probability that the bank is able to pay the promised repayments at date 1 and 2, respectively. Since $\phi_2(\theta)$ is increasing in θ, it follows that θ^* is increasing in ω.

On the other hand, the introduction of CBDC affects investors' participation constraint at date 0 as follows:

$$\int_{\theta^*}^{1} r_2 d\theta \geq \omega^2.$$

As ω increases, depositors require a higher deposit rate r_2 in order to deposit their funds into a bank. Since a higher r_2 reduces depositors' incentive to run, higher ω indirectly leads to a lower θ^*. Ahnert et al. (2023) show that it is precisely because banks react to the introduction of CBDC by offering more generous repayments that the introduction of a positively remunerated CBDC may lead to a reduction of bank instability. The ability of banks to adjust the deposit rate depends on the competitive structure of the banking sector. In Ahnert et al. (2023), the U-shaped relationship between CBDC remuneration and the run probability is maintained as long as competition in the banking sector is not too intense. They show that when banks operate in a perfectly competitive environment, the indirect channel is not strong enough to offset the direct one and so the probability of a run monotonically increases with CBDC remuneration.

The effect that CBDC has on the cost of bank funding and the role of competitive structure of the banking sectors are also key elements in other recent papers studying the implications of CBDC on credit provision. In the context of perfectly competitive banking sector, Keister and Sanches (2022) show that the introduction of a remunerated CBDC leads to an increase in funding costs and a reduction of investment. A different result is, instead, obtained by Chiu et al. (2023) and Andolfatto (2021) as a result of bank market power. Similarly to Keister and Sanches (2022), they find that the introduction of CBDC would induce banks to offer better deposit rates. However, because of bank market power, the increase in deposit rates would be sufficient to encourage depositors to keep their wealth in bank deposits, thus limiting the take-up of CBDC.

7.2 The transmission of monetary policy

In recent years, bank market power in the deposit market has emerged as a key factor influencing the transmission of monetary policy and its effects on both credit provision and stability (Drechsler et al., 2017). Bank market power manifests in the ability of banks to offer deposit rates below the market rate, i.e., a deposit spread. A change in the interest rate set by the central bank determines a change in the deposit spread: Banks respond to an interest rate increase by raising deposit rates, but less than one-to-one. In other words, the interest rate pass-through is less than one. As a result, an interest rate increase is followed by a widening of the deposit spread, the more so the higher is bank market power. This mechanism has a crucial impact on credit provision and stability.

Concerning credit provision, Drechsler et al. (2017) show that the widening of the deposit spread following an interest rate increase causes some depositors to move their funds into better remunerated investment opportunities. These outflows, which constitute the so-called deposit channel of monetary policy, leads to a reduction in bank funding and so, in turn, to a contraction in credit provision.

To see this force at play in the context of our model, we revert to the specification of Section 4 with $r_1 = 0$ so that there are no runs and depositors' outside option is $u \equiv r(z)$, with r being the policy rate and z reflecting the mark-up over the policy rate. In other words, z is a measure of the bank's market power in the deposit market. Following Drechsler et al. (2017), we augment the framework with a portfolio choice for the investors between cash, bank deposits, and bonds. While the first two provide liquidity service, the last one has no liquidity service but entails a remuneration tied to r. This portfolio allocation pins down the supply of deposits D as a function of the policy rate.

As long as banks have market power, and thus $\frac{du}{dr} < 1$, changes in the policy rate are only partially passed on to depositors. Assuming for simplicity that the expected return from lending equals the policy rate r (i.e., that $\Pr\left(\theta > \widetilde{\theta}\right) R = r$, where $\Pr\left(\theta > \widetilde{\theta}\right)$ represents the probability that the fundamental θ is large enough that the bank can repay the claims against it and hence doesn't default) and that banks invest their own funds E as well as the amount of deposits D, they enjoy a deposit spread $s = \frac{r}{\Pr\left(\theta > \widetilde{\theta}\right)} - r_2$, which is increasing with bank market power (i.e., the lower is z).

The deposit spread s plays a crucial role in the determination of the deposit supply, which can be derived from the investors' portfolio allocation. When the central bank raises the policy rate, cash becomes more expensive to hold, and this allows banks to raise deposit spreads without losing deposits to cash. As the policy rate keeps increasing, investors eventually move funds into bonds so that a lower D materializes in equilibrium. If the bank is unable to substitute the reduced deposit funding with more equity, bank lending goes down.

In the analysis above, we have kept the asset side of the bank fixed. However, market power in the deposit market, which allows banks to earn a deposit spread that it is relatively insensitive to changes in the interest rate, also affects bank portfolio choices, by inducing them to hold a large share of long-term fixed-rate assets in their portfolio in order to hedge against interest rate risk (Drechsler et al., 2021). This strategy, which entails a maturity mismatch between assets and liabilities, allows them to match the interest rate sensitivities of their income and expenses, thus also limiting the impact that interest rate changes have on bank net worth. A complementary argument is in Dell'Ariccia et al. (2014), who primarily focus on bank risk-taking, bank leverage, and total volume of lending, in the context of low interest rate environments. Faced with a downward sloping demand curve for loans (i.e., when banks have market power over customers on the credit market), reductions in benchmark interest rates lead banks to increase risk taking and leverage as spreads change and bank's opportunity costs are reduced. The extent of these effects depend largely on the degree of market power banks have, in terms of how much of the change in the benchmark interest rate gets passed on to consumers.

Market power also plays an important role in determining the effects of monetary policy changes on bank stability. This can be seen through the lenses of our simple theoretical framework as captured by the effect that an interest rate increase has on the probability of a run θ^*. The effect on θ^* of a change in the interest rate is twofold. First, there is a direct effect capturing the deposit channel of monetary policy: For a given deposit contract $\{r_1, r_2\}$, higher rates imply that depositors have more incentives to withdraw their funds and move them into more profitable investment opportunities. We refer to this as the direct effect, which is always positive, i.e., $\frac{\partial \theta^*}{\partial r} > 0$. Second, similarly to what was pointed out above describing the deposit channel of monetary policy, an interest rate change leads to a change in the deposit contract offered by banks. Following a change in the benchmark rate, both r_1 and r_2 are going to change, thus inducing a change in θ^* as well. While the sign of the direct effect is clear, that of the indirect effect is not. This is due to the fact that r_1 and r_2 have opposite effects on θ^*, i.e., $\frac{\partial \theta^*}{\partial r_1} > 0$ and $\frac{\partial \theta^*}{\partial r_2} < 0$ and it is also crucial how the change in r affects banks' decision concerning deposit repayments at either date.

Formally, the overall effect of r on θ^* can be written as

$$\frac{d\theta^*}{dr} = \underbrace{\frac{\partial \theta^*}{\partial r}}_{\text{direct effect}} + \underbrace{\frac{\partial \theta^*}{\partial u}\frac{du}{dr}}_{\text{indirect effect}},$$

where the indirect effect can be further decomposed as follows:

$$\frac{\partial\theta^*}{\partial u}\frac{du}{dr} = \frac{\partial\theta^*}{\partial r_1}\frac{\partial r_1}{\partial u}\frac{du}{dr} + \frac{\partial\theta^*}{\partial r_2}\frac{\partial r_2}{\partial u}\frac{du}{dr} \tag{10}$$

The sign of $\frac{d\theta^*}{dr}$ depends on the sign and relative magnitude of the direct and indirect effects, for which market power plays a crucial role. In a simple scenario in which r_1 is independent of r so that the indirect effect is negative (as the first term in (10) is zero), the sign of $\frac{d\theta^*}{dr}$ can be potentially ambiguous. In this context, high market power is more likely to be associated with a detrimental effect of a rate rise for financial stability (i.e., $\frac{d\theta^*}{dr} > 0$). The reason is that while market power strengthens the direct effect (Drechsel et al, 2023), it makes the indirect effect weaker because, as bank market power increases, the deposit rate, r_2 becomes less sensitive to changes in r.

8 Conclusion

This article discusses the implications that bank market power, both in the loan and deposit market, has on credit provision and stability. It does so by developing a simple theoretical framework. On the asset side, banks choose the quality and quantity of loans to grant. On the liability side, banks choose the deposit contract to offer to depositors, who then choose whether to withdraw prematurely (run). Focusing on each side of the balance sheet in turn allows us to review the ample literature on the role of market power for credit provision and stability. The key feature of this framework is that it accounts for the spillovers between asset and liability side, in that credit decisions affect and are affected by bank exposure to runs and viceversa. This structure allows us to extend the analysis of changes on bank market power, thus incorporating its effects on the interaction between bank assets and liabilities. Overall, this suggests that there are relevant channels that deserve to be studied further, especially given the rising importance of bank market power in affecting the transmission of monetary policy and the changes in the competitive setup banks operate brought about by rise of the digital economy.

9 References

Acharya, V., and T. Yorulmazer (2008) "Cash-in-the-market pricing and optimal resolution of bank failures", *Review of Financial Studies*, 21(6), 2705-2742.

Ahnert, T., Assenmacher, K., Hoffmann, P., Leonello, A., Monnet, C., and D. Porcellacchia (2022) "The economics of central bank digital currency", *International Journal of Central Banking*, forthcoming.

Ahnert, T., Hoffmann, P., Leonello, A., and D. Porcellacchia (2023) "CBDC and financial stability", ECB Working Paper 2783.

Ahnert, T., and D. Martinez-Miera (2021) “Bank runs, bank competition and opacity”, CEPR Discussion Paper 16207.

Allen, F., and E. Carletti (2008) “Mark-to-market accounting and cash-in-the-market pricing”, *Journal of Accounting and Economics*, 45(2-3), 358-378.

Allen, F., Carletti, E., Goldstein, I., and A. Leonello (2018) “Government guarantees and financial stability”, *Journal of Economic Theory*, 177(C), 518-557.

Allen, F., Carletti, E., and R. Marquez (2011) “Credit market competition and capital regulation”, *The Review of Financial Studies*, 24(4), 983-1018.

Allen, F., and D. Gale (1998) “Optimal financial crises”, *Journal of Finance*, 53(4), 1245-1284.

Allen, F., and D. Gale (2000) “Comparing financial systems”, *MIT press*.

Allen, F., and D. Gale (2000b) “Financial contagion”, *Journal of Political Economy*, 108(1), 1-33.

Allen, F., and D. Gale (2004) “Competition and financial stability”, *Journal of Money, Credit and Banking*, 453-480.

Allen, F., and D. Gale (2005) “From cash-in-the-market pricing to financial fragility”, *Journal of the European Economic Association*, 3(2-3), 535-546.

Andolfatto, D. (2021) “Assessing the impact of central bank digital currency on private banks”, *Economic Journal*, 131(634), 525-540.

Armstrong, M. (2006) “Competition in two-sided markets”, *RAND Journal of Economics*, 37(3), 668-691.

Bebchuck, L., and I. Goldstein (2011) “Self-fulfilling credit market freezes”, *Review of Financial Studies*, 24(11), 3519-3555.

Berg, T., Fuster, A., and M. Puri (2022) “Fintech lending”, *Annual Review of Financial Economics*, 14, 187-207.

Bolton, P., and X. Freixas (2006) “Corporate finance and the monetary transmission mechanism”, *Review of Financial Studies*, 19(3), 829-870.

Bouckaert, J., and H. Degryse (2004) “Softening competition by inducing switching in credit markets”, *The Journal of Industrial Economics*, 52(1), 27-52.

Boyd, J. H., and G. De Nicolo (2005) “The theory of bank risk taking and competition revisited”, *The Journal of Finance*, 60(3), 1329-1343.

Broecker, T. (1990) “Credit-worthiness tests and interbank competition”, *Econometrica: Journal of the Econometric Society*, 429-452.

Carletti, E. (2008) “Competition and Regulation in Banking”, in A. Boot and A. Thakor (eds.), Handbook in Financial Intermediation, Elsevier, North Holland, 449-482.

Carletti, E., and A. Leonello (2019) “Credit market competition and liquidity crises”, *Review of Finance*, 23(5), 855-892.

Carletti, E., Leonello, A., and R. Marquez (2023) “Loan guarantees, bank underwriting policies and financial stability”, *Journal of Financial Economics*, 149(2), 260-295.

Carletti E., Leonello A. and R. Marquez (2024) " Market power in banking", *Annual Review of Financial Economics*, 16, submitted.

Carlson, M., Correia, S., and S. Luck (2022) “The effects of banking competition on growth and financial stability: Evidence from the national banking era”, *Journal of Political Economy*, 130(2), 462-520.

Chiu, J., Davoodalhosseini, S. M., Jiang, J., and Y. Zhu (2023) “Bank market power and central bank digital currency: Theory and quantitative assessment”, *Journal of Political Economy*, 131 (5), 1213-48.

Claessens, S., and L. Laeven (2004) “What drives bank competition? Some international evidence”, *Journal of Money, Credit and Banking*, 563-583.

Dell ’Ariccia, G. (2001) "Asymmetric information and the structure of the banking industry," *European Economic Review, Elsevier*, 45(10), 1957-1980.

Dell’Ariccia, G., Friedman, E., and R. Marquez (1999) “Adverse selection as a barrier to entry in the banking industry”, *The RAND Journal of Economics*, 515-534.

Dell’Ariccia, G., Laeven, L., and R. Marquez (2014) “Real interest rates, leverage, and bank risk-taking”, *Journal of Economic Theory*, 149, 65-99.

Dell’Ariccia, G., and R. Marquez (2004) “Information and bank credit allocation”, *Journal of Financial Economics*, 72, 185-214.

Dell’Ariccia, G., and R. Marquez (2006) “Competition among regulators and credit market integration”, *Journal of Financial Economics*, 79, 401-430.

Dell’Ariccia, G., and R. Marquez (2006b) “Lending booms and lending standards”, *Journal of Finance*, 61(5), 2511-2546.

Diamond, D. W. (1984) “Financial intermediation and delegated monitoring”, *The Review of Economic Studies*, 51(3), 393-414.

Diamond, D. W., and P. H. Dybvig (1983) “Bank runs, deposit insurance, and liquidity”, *Journal of Political Economy*, 91(3), 401-419.

Diamond, D. W., and R. G. Rajan (2011) “Fear of fire sales, illiquidity seeking, and credit freezes”, *Quarterly Journal of Economics*, 126(2), 557-591.

Diamond, P. A. (1971) “A model of price adjustment”, *Journal of Economic Theory*, 3(2), 156-168.

Drechsler, I., Savov, A., and P. Schnabl (2017) “The deposit channel of monetary policy”, *Quarterly Journal of Economics*, 132, 1819-1876.

Drechsler, I., Savov, A., and P. Schnabl (2018) “Liquidity, risk-premia and the financial transmission of monetary policy”, *Annual Review of Financial Economics*, 309-328.

Drechsler, I., Savov, A., and P. Schnabl (2021) “Banking on deposits: Maturity transformation without interest rate risk”, *Journal of Finance*, 76(3), 1091-1143.

Drechsler, I., Savov, A., P. Schnabl and O. Wang (2023) "Banking on Uninsured Deposits", working paper.

Egan, M., A. Hortacsu, and G. Matvos (2017) "Deposit competition and financial fragility: Evidence from the us banking sector," *American Economic Review* 107 (1), 169–216.

Eisenbach, T. (2017) “Rollover risk as market discipline: A two-sided inefficiency”, *Journal of Financial Economics*, 126(2), 252-269.

Gambacorta, L., Khalil, F., and B. Parigi (2022) “Big Techs vs Banks”, Bank for International Settlements, Monetary and Economic Department.

Gao, J., and R. R. Reed (2021) “Sunspot bank runs and fragility: The role of financial sector competition”, *European Economic Review*, 139, 103877.

Goldstein, I. (2012) “Empirical literature on financial crises: fundamental vs. panic”, in G. Caprio (ed.), Evidence and Impact of Financial Globalization, Elsevier, Amsterdam.

Goldstein, I., and E. Pauzner (2005) “Demand-deposit contracts and the probability of bank runs”, *Journal of Finance*, 60(3), 1293-1327.

Gorton, G. (1988) “Banking panics and business cycles”, Oxford Economic Papers, 40(4), 751-781.

auswald, R., and R. Marquez (2003) “Information technology and financial services competition”, *Review of Financial Studies*, 16(3), 921-948.

Hauswald, R., and R. Marquez (2006) “Competition and strategic information acquisition in credit markets”, *Review of Financial Studies*, 19(3), 967-1000.

Igan, D., Martinez Peria, M. S., Pierri, N., and A. Presbitero (2021) “When they go low, we go high? Measuring bank market power in a low-for-long environment”, IMF Working Paper No. 2021/149.

Jacklin, C., and S. Bhattacharya (1988) “Distinguishing panics and information-based bank runs: Welfare and policy implications”, *Journal of Political Economy*, 96(3), 568-592.

James, C. (1991) “The losses realized in bank failures”, *The Journal of Finance*, 46(4), 1223-1242.

Keister, T., and D. Sanches (2022) “Should central banks issue digital currency?”, *Review of Economic Studies*, 90(1), 404-31.

Marquez, R. (2002) “Competition, adverse selection, and information dispersion in the banking industry”, *Review of Financial Studies*, 15(3), 901-926.

Martinez-Miera, D., and R. Repullo (2017) “Search for yield”, *Econometrica*, 85(2), 351-378.

Matutes, C., and X. Vives (1996) “Competition for deposits, fragility, and insurance”, *Journal of Financial Intermediation*, 5(2), 184-216.

Rajan, R. G. (1992) “Insiders and outsiders: The choice between informed and arm’s-length debt”, *The Journal of Finance*, 47(4), 1367-1400.

Reinhart, C., and K. Rogoff (2009) “This Time is Different: Eight Centuries of Financial Folly”, Oxford and Princeton, NJ, Princeton University Press.

Rochet, J. C., and J. Tirole (2003) “Platform competition in two-sided markets”, *Journal of the European Economic Association*, 1(4), 990-1029.

Rochet, J. C., and J. Tirole (2006) “Two-sided markets: a progress report”, *RAND Journal of Economics*, 37(3), 645-667.

Rysman, M. (2009) “The economics of two-sided markets”, *Journal of Economic Perspectives*, 23(3), 125-43.

Salop, S. C. (1979) “Monopolistic competition with outside goods”, *Bell Journal of Economics*, 10(1), 141-156.

Saunders, A., Cornett, M. M., and O. Erhemjamts (2021) "Financial institutions management: A risk management approach", McGraw-Hill.

Sharpe, S. A. (1990) “Asymmetric information, bank lending, and implicit contracts: A stylized model of customer relationships”, *The Journal of Finance*, 45(4), 1069-1087.

Stiroh, K. J. (2002) “Information technology and the US productivity revival: what do the industry data say?”, *American Economic Review*, 92(5), 1559-1576.

Vives, X. (2001) “Competition in the changing world of banking”, *Oxford Review of Economic Policy*, 17(4), 535-547.

Vives, X. (2014) “Strategic complementarity, fragility and regulation”, *Review of Financial Studies*, 27(12), 3547-3592.

Vives, X. (2019) “Digital disruption in banking”, *Annual Review of Financial Economics*, 11, 243-272.

Wang, Y., Whited, T. M., Wu, Y., and K. Xiao (2022) “Bank market power and monetary policy transmission: Evidence from a structural estimation”, *The Journal of Finance*, 77(4), 2093-2141.

Whited, T., Wu, Y., and K. Xiao (2023) “Will central bank digital currency disintermediate banks?”, mimeo.

Acknowledgements

We thank Majo Arteaga and Chiara Bargellesi for excellent research support. The views expressed here are the authors' and do not necessarily reflect those of the ECB and the Eurosystem. Elena Carletti acknowledges financial support from Baffi-Carefin Centre at Bocconi University. This paper builds on Carletti, Leonello and Marquez (2024).

Elena Carletti
Bocconi University, Baffi-Carefin, Igier, Milan, Italy; Centre for Economic Policy Research, London, United Kingdom;
email: elena.carletti@unibocconi.it

Agnese Leonello
European Central Bank, Frankfurt am Main, Germany; email: Agnese.Leonello@ecb.europa.eu

Robert Marquez
University of California, Davis, United States, email: rsmarquez@ucdavis.edu

Postal address 60640 Frankfurt am Main, Germany
Telephone +49 69 1344 0
Website www.ecb.europa.eu

PDF ISBN 978-92-899-6366-4 ISSN 1725-2806 doi:10.2866/042649 QB-AR-24-003-EN-N