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ABSTRACT

Using loan level data for France, we show that the introduction of negative rates by the European Central Bank is associated with an expansion in lending by banks with greater reliance on deposits. The impact is driven by banks with larger shares of rigid deposits, i.e. deposits whose rate becomes inelastic when the policy rate falls below zero, such as short-term and households deposits. Consistent with risk-taking, negative rates appear to elicit reallocation away from safe assets, as banks increase exposure to smaller firms and corporate debt securities, as well as increase fee income. Finally, we document that these findings generalize to banks in the Euro Area. Our results suggest that negative rates encourage banks most reliant on deposits to engage in riskier activities to shield profitability, and that the composition of banks' deposits plays a key role in the transmission of monetary policy rates below the zero lower bound.

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1. Introduction

Since 2012, some central banks started to push interest rates below zero. Once an intellectual curiosity, as of 2019 interest rates were negative in countries accounting for one quarter of world GDP, and more than \$17 trillion worth of debt securities offered a negative yield.¹ Negative rates turn the principles of finance upside down: commercial banks are charged to hold reserves at the central bank, while some companies and sovereigns are paid to borrow. Going negative constitutes a radical innovation in monetary policy as much as a challenge to conventional economic thinking, as the mere notion of negative nominal rates was traditionally jarring to most economists due to the existence of cash (Hicks, 1937; Black, 1995). Yet negative rates are increasingly regarded as a feasible policy option when interest rates reach the zero lower bound (ZLB) (Schnabel, 2020; Tenreiro, 2021). While central banks are currently raising interest rates in response to inflationary pressure following the outbreaks of the COVID-19 pandemic and the war in Ukraine, the low level of interest rates and their historical decline (Fig. 1) (Caballero and Farhi, 2018; Jordà and Taylor, 2019; Schmelzing, 2019) suggest that advanced economies may remain close to the ZLB in the near future (Kiley and Roberts, 2017). The ability to lower real interest rates by cutting policy rates below zero may hence become an important resource in responding to future economic downturns (Rogoff, 2016; Rogoff, 2017).

However, the wider financial ramifications of negative rates are still not well understood, nor is it clear how they transmit to real economic activity through the banking system.² On the one hand, negative rates may stimulate aggregate demand by removing the zero bound on short-term interest rates and thus achieve their intended purpose in complementarity with other monetary measures (Bernanke, 2020). On the other, long spells of sub-zero rates could increase the risk of financial disruptions (Carney, 2016). The existence of cash makes banks reluctant to pass negative rates onto retail depositors, so that the ZLB is likely to remain in place for deposits at least in the short-term (Heider et al., 2021). Due to this nominal rigidity, the transmission of a rate cut below zero is somewhat special, and a protracted period of negative rates may squeeze banks' net interest margins, erode equity, the value of the deposit franchise, and ultimately have contractionary effects on credit supply (Eggertsson et al., 2019). The importance of understanding the transmission mechanism of negative rates is also underscored by the scarce consensus on the efficacy of other unconventional monetary policies – e.g. quantitative easing and forward guidance – in supporting lending and aggregate demand (Greenlaw et al., 2018; Swanson, 2017; Krishnamurthy et al., 2018).

In this paper, we study the transmission of negative rates to French banks using credit registry data from the Banque de France. We show that banks most reliant on deposit funding extend more loans relative to other banks after the European Central Bank (ECB) lowered the Deposit Facility Rate (DFR) below zero for the first time in June 2014. In the three months around the policy change, a one-standard-deviation increase in banks' deposits to assets ratio is associated with 0.53% higher credit growth rate for customer firms. This finding is robust to controlling for firm credit demand, other bank-specific co-determinant of lending decisions, and to a range of robustness checks. More generally, negative rates induce banks more reliant on deposits to hold riskier assets. After the DFR crosses zero, these banks supply more loans to small firms, and increase holdings of corporate loans and privately issued debt securities, while leaving their holdings of mortgages and government bonds in line with other banks. Finally, we show that banks with large fractions of deposits increase fee and commission income by more than other banks after the introduction of negative rates, while we find no evidence that these banks experience lower profitability.

These results support a transmission mechanism of negative rates that reconciles some of the findings in the literature (Heider et al., 2019; Bottero et al., 2022; Bubeck et al., 2020; Demiralp et al., 2021; Hong and Kandrac, 2022). Negative rates threaten to compress net interest margins for banks that rely on deposits funding. At the same time, negative rates flatten and lower the yield curve, which accentuates risk-taking behavior and induces investors to climb up the maturity ladder to search for yield and preserve earnings (Rajan, 2006; Hanson and Stein, 2015). High-deposits banks thus have an incentive to shield profitability by increasing lending and taking additional risk. We refer to this mechanism as the *Risk-Taking Hypothesis*. By contrast, we find no evidence that negative rates have a contractionary effect on credit supply through the erosion of bank equity and profitability (Eggertsson et al., 2019; Ulate, 2021).

We generalize this principle by conjecturing that exposure to negative rates depends on the degree to which banks can transmit policy rate cuts below zero to their depositors. We posit that the lending response to negative rates should then increase with a bank's share of *rigid* deposits, i.e. deposit accounts whose interest rate becomes insensitive to the policy rate when it turns negative. For instance, while banks may be unwilling to charge negative interest rates on small deposits by households, they may find it easier to negotiate negative rates on large corporate deposits (Heider et al., 2021). Analogously, banks reliant on overnight deposits that offer almost no interest rate and are freely convertible to cash should be more exposed to negative rates relative to banks that rely on long-term deposits and savings products that offer comparatively higher rates and are locked in for term.

We find evidence supporting these hypotheses. First, the increase in lending associated with negative rates is stronger for banks with larger shares of households and short-term deposits. Moreover, deposit maturity matters independently of deposit counterpart: among banks reliant on deposits by households, the increase in lending following the introduction of negative rates is larger for those with larger shares of short-term accounts. We find analogous results for banks that depend on corporate deposits. Second, banks reliant on regulated deposits – a special category of accounts whose interest

¹ BIS Quarterly Review, International banking and financial market developments, September 2019.

² See, for instance, Arteta et al. (2018) and IMF (2018) for early appraisals of negative interest rate policies, or Heider et al. (2021) and Balloch et al. (2022) for more recent reviews of the literature.

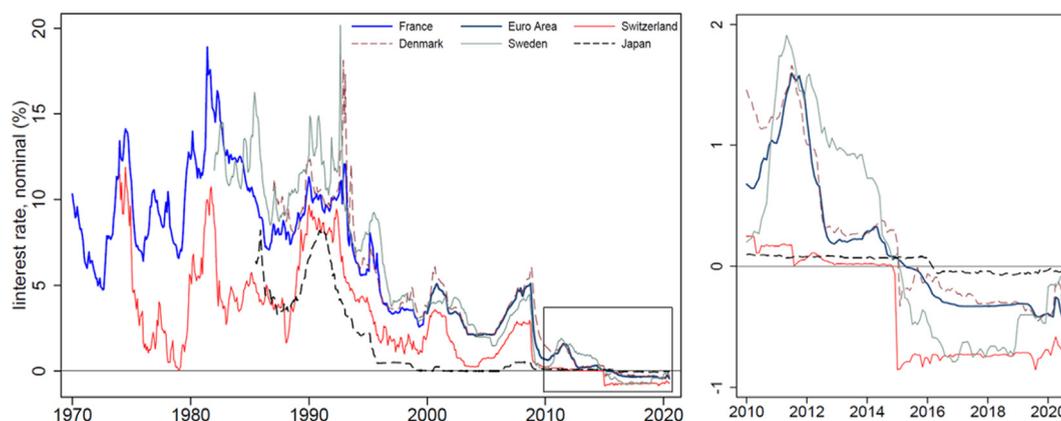


Fig. 1. Interbank rates (%) in Denmark, the Euro Area/France, Japan, Sweden and Switzerland. Data source: OECD (2020).

rates are partly set by the French government – also increase lending by more relative to other banks after the introduction of negative rates.

Finally, we explore the external validity of our results drawing from a sample of banks covering all 19 Euro Area countries. In line with our previous results, banks more reliant on deposits increase credit and fees by more with respect to other banks in the years following the introduction of negative rates. Negative rates appear to elicit risk-taking, as deposit-dependent banks increase their share of private securities and decrease that of government securities following the introduction of the policy. Consistent with recent international evidence (Lopez et al., 2020), we find no differences in profit margins across high and low-deposits banks in the wake of the introduction of negative rates. Together with our previous results, this finding suggests that Euro Area banks succeeded in shielding their margins from the impact of negative rates.

This paper directly relates to the growing literature on the transmission of negative rates. Empirical work provides contrasting indications as to the effectiveness of this new policy instrument. Heider et al. (2019) use Euro Area syndicated loan data and document that banks with high shares of deposits cut lending by more relative to other banks after the introduction of negative rates. The authors also find that high-deposits banks take on more risk in the form of increased lending to firms exhibiting higher return-on-assets volatility. Similarly, Eggertsson et al. (2019) use Swedish data and find that the introduction of negative rates had a limited pass-through to lending rates, with deposits-heavy banks reducing lending relative to other banks. By contrast, employing bank level data on, respectively, Swiss and Euro Area banks, Schelling and Towbin (2018) and Tan (2019) find that banks most reliant on deposits loosen lending spreads and lend out more than other banks as policy rates move below zero. In the same vein, Bubeck et al. (2020) show that the introduction of negative rates induces banks more reliant on deposits to increase holdings of higher yielding securities with respect to other banks. A number of studies on Italian (Bottero et al., 2022), Swiss (Basten and Mariathan, 2018) and Euro Area data (Demiralp et al., 2021) also conclude that negative rates have expansionary effects through stimulating lending by banks with high amounts of reserves and excess liquidity.³ Similarly, Hong and Kandrak (2022) show that Japanese banks whose share price fell the most upon the announcement of negative rates by the Bank of Japan increased credit supply and took on more risk relative to other banks. By contrast, in a slightly different study Arce et al. (2018) show that Spanish banks declaring their net interest income to be negatively affected by negative rates do not adjust their lending differently with respect to other banks. Finally, Altavilla et al. (2021) support the expansionary effect of negative rates in the sense that firms linked to banks that charge negative rates on corporate deposits tend to increase investment and decrease cash holdings to avoid the costs associated with negative rates.

We make two distinct contributions to this literature. First, we provide comprehensive evidence on the role of deposits in the transmission mechanism of negative rates drawing from the universe of banks' activities in France, the second biggest economy and largest banking system in the Euro Area. The coverage of the data provided by the Banque de France allows us to reliably test for the transmission of negative rates for an entire credit market at a high level of granularity. In this sense, our analysis broadens the focus from the securities (Bubeck et al., 2020), mortgage (Eggertsson et al., 2019) and syndicated lending market (Heider et al., 2019) to the full credit and asset portfolio of domestic banks. The increase in scope is particularly important because it allows capturing the full extent of bank risk-taking triggered by negative rates. In this respect, studies that focus on low-risk loans (such as syndicated loans) would tend to underestimate the effect of negative rates on lending. Combining credit register, balance sheet and income statement information, we provide coherent evidence that high-deposits banks respond to negative rates by shielding their profitability through an increase in non-interest income and lending volumes, and additional risk in the form of loans to riskier counterparts and at longer maturities, as well as in terms of higher-yielding securities holdings. Furthermore, we show that our results generalize to a wider sample of banks

³ These results are corroborated by a meta-analysis of various studies supporting the view that the use of negative rates had a positive impact on loan growth in the Euro Area (Schnabel, 2020).

covering all Euro Area countries. Providing external validity on the effectiveness of negative rates is important because of their unprecedented nature and the potential for heterogeneity of their transmission across the monetary union (Bittner et al., 2019).

Second, we show that the composition and maturity of deposits matter for how negative rates transmit to the banking system. While exposure to negative rates generally increases with banks' share of deposits, we show that this effect is concentrated in banks reliant on deposits most subject to downward rigidity, such as households, short-term and regulated deposits. In particular, we disentangle the role of deposit maturity and counterpart, and show that the former is potentially more important than the latter for the transmission of negative rates. Overall, this result adds to our understanding of the transmission of negative rates since it implies that the transmission of negative rates depends not only on banks' overall reliance on deposits, but also on their deposit structure in terms of account type, maturity and counterpart. Since banks reliant on households and short-term deposits account for a large share of total credit supplied (67% in our sample), our findings suggest the introduction of negative rates is likely to have had sizable aggregate implications.

The remainder of the paper is structured as follows. Section 2 offers background information on the implementation of negative rates by the ECB and discusses the possible transmission channels working through the banking sector. Section 3 presents the data and descriptive statistics, discusses the identification strategy and outlines the econometric models. Section 4 discusses the results, while the last section offers concluding remarks.

2. Background and hypotheses

On June 11, 2014, the European Central Bank lowered the Deposit Facility Rate (DFR henceforth) to -10 basis points. As the DFR is the rate on commercial banks' reserves above the regulatory minimum held at the central bank, the move effectively charged banks' excess liquidity. On September 10, 2014, the same rate was lowered to -0.20% and was since lowered three more times: on December 9, 2015 to -0.30% , on March 16, 2016 to -0.40% and on September 18, 2019 to -0.50% , where it remained until July 27, 2022, when it was raised to 0% .⁴ While some central banks introduced negative rates in an attempt to stabilize the exchange rate (e.g. Denmark and Switzerland), the stated goal of the ECB was to provide additional monetary accommodation in the face of lingering deflation risks (Praet, 2014).

The premise of our empirical analysis is the imperfect transmission of negative rates to retail deposits. When monetary policy rates are above zero, cutting the DFR immediately lowers both deposits and money markets rates, thus reducing banks' funding costs. Below zero, however, DFR cuts affect the cost of deposit and market-based funding differently. As illustrated in Fig. 2, DFR cuts into negative territory succeeded in bringing short-term interbank rates below zero, implying a complete pass-through to money market rates. Similarly, long-term rates on bonds and loans adjusted downward over time, consistent with a compression of risk spreads brought about by the lower level of short-term interest rates (Bräuning and Wu, 2017). For instance, the average loan rate for firms in the Euro Area fell from 3.26% to 1.77% between June 2014 and June 2020. By contrast, the transmission to retail deposit rates was incomplete, as deposit rates remained bounded at just above zero. Equivalently, the distribution of banks' deposits rates in France has progressively bunched at zero, rather than entering negative territory (see Fig. 3). This phenomenon extends beyond France, as banks across the Euro Area have not imposed negative rates on retail depositors (Schnabel, 2020; Heider et al., 2021).

The zero bound on deposits rates is a nominal friction that stems from the existence of cash and banks' reluctance or inability to pass negative rates to retail depositors. Since cash offers a zero nominal return and deposits are seen as equivalent to currency, lowering deposits rates below zero may induce a dramatic rise in the supply elasticity of deposits. That is, negative nominal rates may prompt retail depositors to swap checking accounts for cash (or for accounts at competitor banks that do not charge negative rates) as alternative store of value and means of payment.⁵ In turn, banks are wary of losing deposits given their unique value as a stable and dependable source of funding (Hanson et al., 2015), preferred treatment under Basel III liquidity provisions, and increasing marginal cost of wholesale funding (Stein, 1998). Credit institutions also derive substantial market power from deposits which compensates the large operating costs of maintaining a deposit franchise (Drechsler et al., 2017; Li et al., 2019). Finally, it remains unclear whether it is legal for banks to apply negative rates on retail depositors. Under the French civil code, it exists an implicit lower bound at 0% for the interest rate applied to loan and deposit contracts. A negative deposits rate may be legal only if expressly stipulated in the contract, unless this clause could be considered as unfair (Haut Comité Juridique de la Place Financière de Paris, 2017). For all these reasons, banks remain unable or unwilling to pass negative rates onto retail depositors.⁶

⁴ The experience with negative policy rates was then interrupted in September 2022 when the ECB raised the DFR to 0.75% . At that time, with the exception of the Bank of Japan, all the central banks that introduced negative rates have increased rates well into positive territory to counter rising inflation rates.

⁵ According to a survey by ING (2015) conducted in 2015, more than 60% of French households would withdraw their deposits if charged a negative rate. Note that this reasoning applies strictly to nominal rates since the real (inflation-adjusted) rates had already been negative in the past. In other words, banks may worry that depositors suffer of money illusion and focus on the nominal value of interest payments as opposed to the real value of goods and services they can purchase with (Darriet et al., 2020). Furthermore, given the storage costs of holding cash, the effective lower bound may be below zero (Eggertsson et al., 2019). Alternatively, banks may be willing to charge negative rates in principle, but hesitant to be the first to do so given concerns about reputational costs and competition over deposits associated with a "first-mover curse" (IMF, 2018).

⁶ In a recent case, the French Cour de Cassation has clarified that 0% must be considered as the floor for the loan rate (Verdict of the Cour de Cassation dated March 25, 2020). Legislators and courts in the Euro Area have also maintained a legal framework that would pose hurdles and litigation risks to imposing negative rates on retail customers (ECB, 2020b).

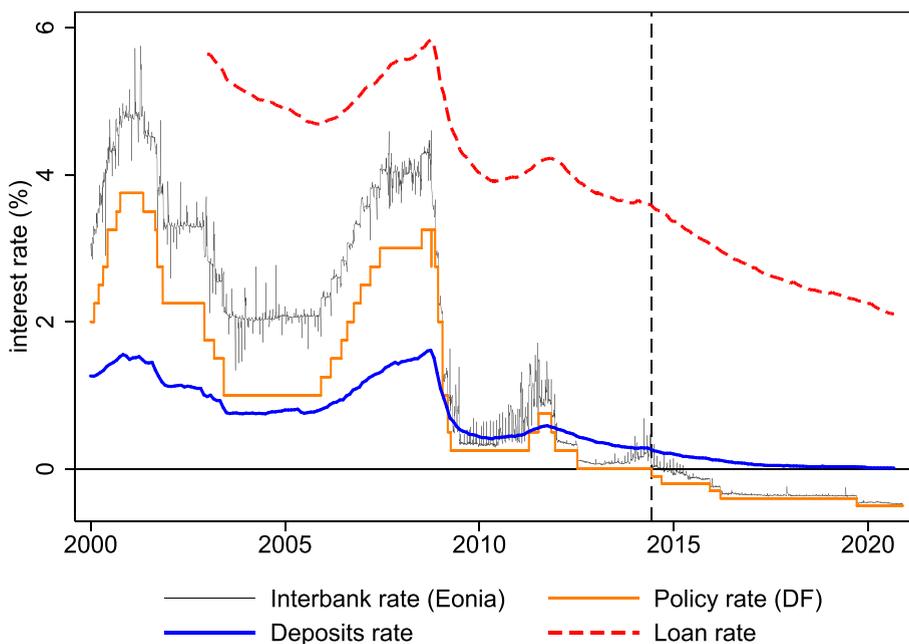


Fig. 2. Deposit Facility Rate, Eonia rate, loans and overnight deposit rate for households and non-financial corporations (weighted average) in the Euro Area. Data source: ECB Statistical Data Warehouse (2021).

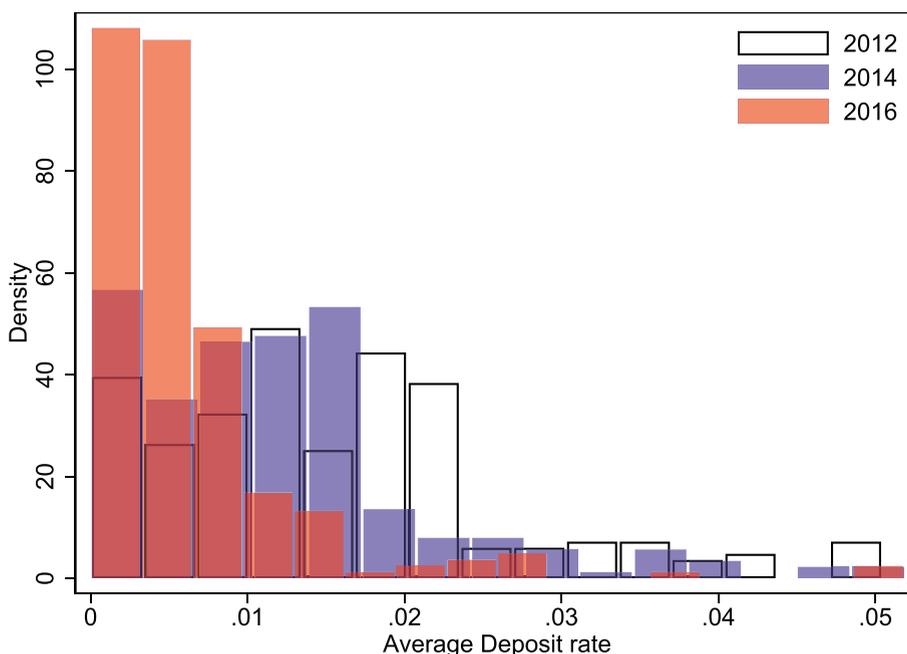


Fig. 3. Distribution of deposits rates (computed as interest expenses over total deposits) offered by French banks over time. Data source: SITUATION and CPTÉ RESULTAT Databases, produced by Banque de France.

Banks would therefore be exposed to negative rates according to their reliance on deposits. Because of the ZLB on retail deposits, after a rate cut in negative territory banks with large shares of deposits (high-deposits banks) would experience a lower reduction in funding costs relative to banks with lower shares of deposits (low-deposits banks) that can readily transmit the lower policy rates to their market-based liabilities. Yet, not all deposits are alike, and some may be inherently more susceptible to downward rigidity at zero. For instance, banks may be willing to charge negative interest rates on large corporate deposits (Altavilla et al., 2021) but not on small households deposits (Heider et al., 2019). The main reason is that

large deposits cannot realistically be quickly withdrawn and stored in cash given the presence of storage costs. In this respect, Heider et al. (2021) document that since mid-2016 banks in the Euro Area have passed negative rates on a modest but increasing fraction of their corporate deposits. By contrast, the amount of households deposits incurring negative rates is negligible (ECB, 2020b).

Analogous differences can be made for deposit maturity. While long-term savings accounts are locked in for terms and cannot be costlessly withdrawn, overnight checking accounts are freely convertible to cash. Furthermore, rates on savings accounts with longer maturities were well above zero in June 2014 and had ample room to fall in absolute terms, while by then overnight checking accounts were already offering no remuneration in France (see Figs. B1 and B2). One would therefore expect that banks with larger shares of short-term deposit accounts be relatively more exposed to negative rates. More generally, exposure to negative rates may depend on the degree to which banks can transmit policy rate cuts below zero to their deposits. In other words, the deposit structure matters: everything else constant, banks' exposure to negative interest rates will increase with their share of deposits subject to downward rigidity at zero (*rigid deposits* henceforth), since these banks will be less able to transmit the lower policy rate to lower funding costs.

In principle, the compression of banks' margins could have different implications. A first possibility is that banks with large shares of rigid deposits attempt to preserve current earnings by searching for yield, through increasing lending and investment in riskier assets, and/or decreasing their holdings of reserves. For instance, Hong and Kandrac (2022) show that, if banks are averse to future losses, those more exposed to negative rates because of their business model will optimally choose to take on additional risk to compensate for the expected reduction in profits. Increase in risk-taking may then occur if banks lend to riskier borrowers and lower credit standards.⁷ Similarly, Bittner et al. (2019) show that, under negative rates, the squeeze in margins can push deposits-dependent banks to switch lending technology through relaxing their monitoring efforts in exchange for a small private benefit. Less monitoring, in turn, implies an increase in the average riskiness of banks' loan portfolios. Overall, we view this mechanism as an expression of the standard risk-taking channel of monetary policy (Gambacorta, 2009; Adrian and Shin, 2010; Borio and Zhu, 2012; Jiménez et al., 2014; Ioannidou et al., 2015) in the context of negative policy rates, whereby low interest rates increase incentives for banks and financial institutions with fixed-rate liabilities to take on more risk and search for yield to meet a target level of earnings (Rajan, 2006).⁸ Under this channel, risk-taking can materialize in two different ways: (i) banks substitute reserves and/or other safe assets for more credit; (ii) banks keep their loan share fixed but lend to riskier borrowers or invest in riskier securities (i.e. increase credit risk), or lend at longer horizons (i.e. increase maturity risk). While only (i) implies higher overall lending, one may expect exposed banks to engage in both types of behaviors.

Banks may also attempt to restore profitability through non-interest income, for instance by charging higher fees, in a surreptitious application of negative rates. From banks' standpoint, higher fees may be more appealing than outright negative nominal rates because customers are already used to accounting and transactions commissions. The scope for raising fees could however be limited by explicit government regulation aimed at consumer protection and by competition for deposits (IMF, 2018).⁹ Overall, these conjectures can be summarized in the following testable predictions:

H1 Risk-Taking Hypothesis:

- (i) following the introduction of negative rates, banks with large shares of deposits should increase lending and/or invest in riskier assets relative to banks with lower shares of deposits.
- (ii) this effect should be relatively more pronounced for banks with large shares of rigid deposits, i.e. deposits whose rate becomes inelastic when the policy rate falls below zero.

A second possibility is that, if capital constraints bind, the erosion of equity caused by negative rates forces exposed banks to deleverage in order to restore regulatory ratios (Eggertsson et al., 2019; Ulate, 2021). Since banks face an external finance premium that is inversely related to their financial health, lower net worth should limit their ability to perform intermediation and supply credit (Van den Heuvel, 2002; Gertler and Kiyotaki, 2010; Disyatat, 2011). A sufficiently low negative rate may thus reach the "reversal rate", i.e. a level of the monetary policy rate below which further reductions become contractionary because the compression in net interest margin (NIM) outweighs the capital gains on securities held on banks' balance sheets (Abadi et al., 2022).¹⁰ While breaching regulatory capital constraints may be unlikely for French banks – Tier 1 capital ratio for the six largest French banking groups was 11.8% as of 2014, well over the 6% regulatory minimum fixed by Basel III (ACPR, 2021) – one can take this view as suggesting that exposed banks are expected to contract lending in order to stay above (unobserved) minimum capital ratios imposed by the markets.

⁷ This view is also supported by the evidence that banks facing adverse profit shocks typically grow their assets (Capie and Wood, 1991; Beck and Casu, 2017) and engage in practices aimed at offsetting losses by taking additional risk (Beatty et al., 2002; Willman et al., 2002; Pennacchi and Santos, 2018).

⁸ One can also view this mechanism as portfolio rebalancing. A reduction in short-term interest rates could induce yield-oriented investors to rebalance their portfolio toward longer term assets in the attempt to keep the overall portfolio yield from declining (Hanson and Stein, 2015). Negative rates provide particular incentives for rebalancing since their introduction led to a substantial flattening of the yield curve, which increased the wedge between safe and risky assets for a given return (Lane, 2019; Bottero et al., 2022). Because of the effective zero lower bound on their liabilities, banks dependent on deposits may then respond to (negative) interest rate cuts by investing in higher yielding assets to restore income.

⁹ Increasing competition from low-fees online banking services providers and the widespread use of online fees comparators (such as the one provided by the Comité consultatif du secteur financier in France) are also likely to reduce the extent to which banks can increase fees without losing market shares.

¹⁰ We note that, according to Abadi et al. (2022), the notion of reversal rate is independent of nominal policy rates becoming negative. According to the authors, monetary policy may well reach a reversal rate threshold while still in positive territory.

H2 Reversal Rate Hypothesis:

- (i) following the introduction of negative rates, banks with large shares of deposits should decrease lending relative to banks with lower shares of deposits.
- (ii) this effect should be relatively more pronounced for banks with large shares of rigid deposits, i.e. deposits whose rate becomes inelastic when the policy rate falls below zero.

We note that in principle the *Reversal Rate* and *Risk Taking* channels are not mutually exclusive. Both may be active at the same time, and one may empirically observe one channel dominating over the other depending on the characteristics of banks and firms under study. We will return to this issue in Section 4.1.

3. Empirical strategy

3.1. Data

France provides good testing ground for the transmission of negative rates to bank lending. While capital markets are well developed, banks remain the main funding source for most firms, especially small and medium-sized enterprises (SMEs henceforth) which are a fundamental component of the economy.¹¹ Because of banks' role in financing the real economy, the transmission of monetary policy to bank lending is particularly significant in France (Andrade et al., 2018; Cahn et al., 2017).

We use four datasets produced by the Banque de France.¹² First, we draw from the Service Centrale des Risques (SCR database), i.e. the French credit register.¹³ This dataset collects the universe of credit exposures between resident credit institutions to resident firms on a monthly basis. Banks must report all credit exposures larger than €25,000 which include loaned funds (drawn credit), commitment on credit lines (undrawn credit) as well as guarantees and specific operations such as long-term leases, factoring and securitized loans. In the credit registry, firms are defined as legal units, i.e. they are not consolidated under the parent company if they belong to a corporate group. The population of firms then include single businesses, corporations and sole proprietors engaged in professional activities. This database also contains information on firms' geographical location and industrial sector. Our main measure of credit is the amount of total credit granted by bank j and effectively drawn by firm i in a given month.¹⁴ One potential concern is that credit draw-downs by firms and changes in the provisions of new (i.e. not-precommitted) loans by banks may occur simultaneously and in opposite directions (Ivashina and Scharfstein, 2010). In Appendix C.5 we will rerun our analysis using a measure of total credit exposure that sums drawn and undrawn credit to capture changes in overall credit availability and limit the scope for this type of measurement error (Andrade et al., 2018). For each loan exposure of a bank-firm pair that we observe both in the months before and after June 2014, we compute the percentage change in credit. As a result, in our study we assess the intensive margin of the growth of bank credit to firms in the months around the introduction of negative rates. To minimize the impact of outliers, we trim our credit growth measure at the 2% level, that is, we remove observations above the 98th percentile and below the 2nd percentile.¹⁵

Second, we join credit registry data to quarterly banks' balance sheet information (SITUATION database).¹⁶ Similarly to Andrade et al. (2018), we remove all banks with growth rates of total assets beyond $\pm 50\%$ between 2012 and 2016, as these are likely to reflect mergers or acquisitions. In addition, we winsorize all bank variables at the 2% level. Third, we add detailed unconsolidated balance sheet information from the Individual Balance Sheet Indicators dataset for a subset of 25 banks (IBSI database).¹⁷ This source contains granular information on maturity of loans, deposits and securities, as well as sector and geography of the counterpart. Fourth, we draw from income statement information to obtain half-yearly data on banks' net interest margin, operating profits and fees (CPTÉ RESU database).¹⁸

Overall, our final estimating sample includes 1,434,626 firms, 262 banks and almost 1.7 million credit relationships, accounting for 92% of all credit supplied to domestic non-financial corporations as of June 2014. Descriptive statistics on key variables are provided in Table A1.

¹¹ As of end-2016 bank loans and advances represented 53% of all external debt of French SMEs. In turn, SMEs made up 96% of all enterprises, 47% of total employment and 38% of added value. Source: Centre de Documentation Economie-Finances (2016).

¹² Between 2018 and 2022, we accessed the data employed in this study through the Banque de France's Open Data Room, a facility providing researchers access to confidential granular data on French credit institutions, financial intermediaries, non-financial corporations and households. Since 2022, access to some of the data used in this work was carried out in secure environments provided by CASD – Centre d'Accès Sécurisé aux Données (Ref. 10.34724/CASD).

¹³ SCR Database – Crédit Distribué aux Entreprises par les Banques, produced by the Banque de France and described on the CASD website.

¹⁴ Specifically, we restrict credit measures to short-term credit and medium/long-term credit, thus excluding guarantees, long-term lease, factoring, securitized loans and other specific transactions.

¹⁵ In Appendix C.4 we further explore the sensitivity of our results to outliers.

¹⁶ Synthèse Activité Par Opérations et Zones Géographiques – Etablissement de Crédit – EN, produced by the Banque de France and described on the CASD website.

¹⁷ IBSI Database – Données Agrégées de Bilan Des Établissements de Crédit, produced by the Banque de France and described on the CASD website.

¹⁸ Compte de Résultat – Etablissements de Crédit – EN Database, produced by the Banque de France and described on the CASD website.

3.2. Identification

To test the hypotheses outlined in Section 2, we exploit cross-sectional variation in reliance on deposits to identify bank-specific exposure to negative rates. We follow Heider et al. (2019) and adopt a difference-in-differences approach. The policy event corresponds to the lowering of the DFR below zero by the ECB in June 2014. The share of total deposits to total assets as of January 2014 is our main bank-specific ex-ante sensitivity to the policy – the “treatment intensity”. At a fundamental level, we will compare changes in lending by banks with different deposit exposure around the introduction of negative rates in June 2014. Banks with smaller shares of deposits (the control group) are hence assumed to provide a valid counterfactual for the behavior of banks with larger shares of deposits (the treated group) had the policy not been implemented.

In support of this assumption, we report descriptive statistics for banks with different shares of deposits, i.e. deposits over total assets. Table A2 focuses on two groups of banks: high- and low-deposits banks, defined according to whether their deposits share is, respectively, above or below the cross-sectional median as of March 2014 (31%), i.e. 3 months before the start of the policy. The two groups of banks have some similarities. They hold a similar share of non-performing loans (NPL) (3%) and have similar asset exposure to the interbank market and the real economy: the asset share of loans to non-financial agents (mainly households and non-financial corporations) is 54% for high-deposits banks and 50% for low-deposits banks, while the fraction of interbank assets is 24% for high-deposits banks and 16% for low-deposits banks. However, treated and control banks differ along several important dimensions. First, high-deposits banks are mainly funded by retail deposits (61% of total assets) and only marginally by interbank liabilities (19%) or debt securities (8%). Conversely, low-deposits banks rely more heavily on interbank liabilities (53%) and debt securities (14%), with retail deposits accounting for a relatively low share (10%). Second, low-deposits banks are better capitalized than high-deposits banks (7% vs. 6% of equity ratio). Finally, high-deposits banks have more liquidity. In terms of net interbank position (i.e. the difference between interbank assets and liabilities scaled by assets), high-deposits banks tend to be net lenders on interbank markets (5% of total assets), while low-deposits banks are net borrowers (−37%). High-deposits banks also hold more liquid assets (6% vs. 4%) and reserves at the central bank (1.8% vs. 0.8%, respectively). The tight relationship between deposits and liquidity is a potential source of concern for identification (see Fig. B3).¹⁹ Indeed, both Bottero et al. (2022) and Demiralp et al. (2021) identify excess liquidity as a key determinant of banks' response to negative rates independently of the share of deposit funding. To alleviate these concerns, in Section 3.3 we separately analyze the transmission channels working through deposits and excess liquidity.²⁰

The econometric validity of our difference-in-differences strategy depends on three assumptions. First, the decision to introduce negative rates must have been a surprise, for otherwise banks could anticipate lending decisions ahead of the policy event. In fact, policymakers had long indicated that negative rates were a potential scenario. Substantial preparation was required to ensure that financial institutions were ready to operate in an environment where interest rates fall below zero (Bech and Malkhozov, 2016). This included reviewing IT systems, legal documentation and accounts rules. ECB policy makers also carefully signalled the possibility of negative rates to market participants and the public. On the other hand, precisely because negative rates were unprecedented, there was considerable uncertainty around their implementation and immediate repercussions. The actual timing was also difficult to foresee. Consistent with this discussion, French banks did not adjust their lending ahead of the announcement (see Fig. B4). On the whole, even if the possibility of negative rates was internalized by banks, expectations did not appear to translate into lending decisions ahead of the actual start of the policy.

Second, there should be no compositional changes within treatment and control groups over time. In other words, for identification it must be the case that banks do not reduce their share of deposits following the introduction of negative rates. Fig. 4 suggests that this assumption holds in our sample. The figure plots banks' deposits ratios before and after the introduction of negative rates (2014:Q1 and 2016:Q1), and shows that observations mostly lay on the 45° line, suggesting that banks' shares of deposits are constant. If anything, one can observe a slight increase in banks' deposits ratio over time.²¹ The stability of deposits shares likely reflects the fact that a bank's fraction of deposits is typically a function of its business model (Demiralp et al., 2021). In particular, low-deposits banks in our sample are mostly wholesale and investment banks, while high-deposits banks are retail and savings banks. Overall, these statistics lend support to the validity of the time-invariant composition assumption since treated banks did not switch into the control group following the introduction of negative rates.

Third, under the standard parallel trend assumption (PTA), treated and control banks should exhibit parallel trends in lending. Had negative policy rates not been implemented, differences in lending between high- and low-deposits banks would have remained constant over time. Fig. 5 supports this assumption. The figure reports the dynamic impact of deposit exposure ± 5 quarters around the introduction of negative rates. Reassuringly, we observe no trend before the introduction of the policy, implying a broad co-movement of lending between treated and control banks prior to 2014. The figure also suggests a positive treatment effect following the introduction of negative rates.²²

¹⁹ The cross-sectional correlation coefficient between banks' deposit ratio and net interbank position as of March 2014 is 0.50.

²⁰ More broadly, we perform a balancing analysis to assess the balance of our sample along treated and control banks (i.e. high and low-deposits banks). Table A3 suggests that the sample is reasonably balanced along bank characteristics and a Hansen's J test of over-identifying restrictions cannot reject the hypothesis that covariates are balanced. Similar to what observed in descriptive statistics, we observe substantial differences across treated and control groups for bank size, capitalization, interbank liabilities and debt securities. For this reason, we include these variables in our set of control variables in regression analysis.

²¹ Fig. B5 further corroborates this stylized fact.

²² Estimation and full results are presented in Appendix C.1.

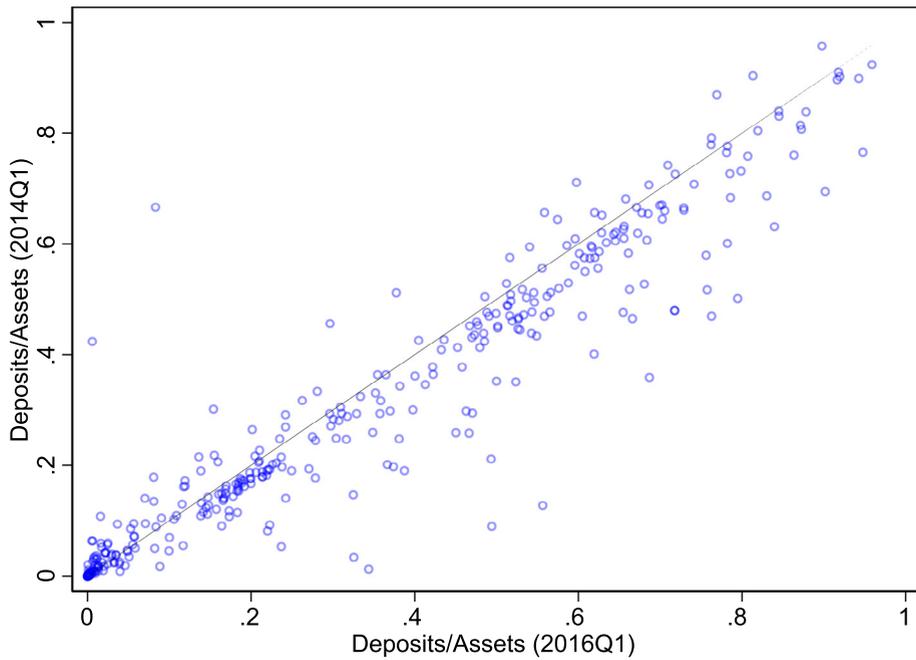


Fig. 4. Banks' deposits ratio before and after the introduction of negative rates. Data source: SITUATION Database, produced by Banque de France.

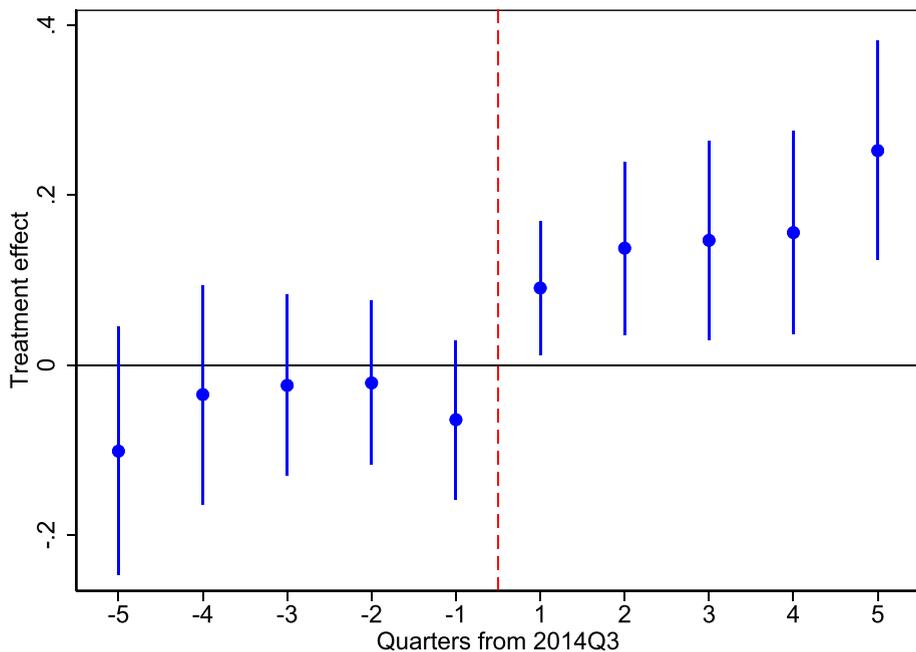


Fig. 5. Time-varying treatment effect of negative rates on loans relative to 2014:Q3.

In our difference-in-differences set-up, however, the treatment exposure (i.e. banks' deposits to assets ratio) is continuous. Although variation in treatment intensity may help make a causal interpretation more plausible, Callaway et al. (2021) show that continuous treatments define more treatment effect parameters than binary treatments. Callaway et al. (2021) show that difference-in-differences parameters can be interpreted as an average causal response suggested by Angrist and Imbens (1995) under a stronger version of PTA, whereby the evolution of potential lending outcomes around the introduction of negative rates would be similar for banks in the absence of treatment (i.e. with no deposits) and across treatment doses (i.e. across different levels of deposit ratio).

A potential concern is that the strong PTA is not satisfied in our case. Because in our setting our measure of exposure sorts banks by business model, one may hence worry that it would be implausible to expect the same path of outcomes across treatment doses because of inherent differences between the two groups of banks that may affect their response to the *same* dose. In this respect, as noted above the unexpected timing of the introduction of negative rates suggests that no bank could pro-actively select the level of deposits ratio as a function of its desired path of lending outcomes. Furthermore, while we do not directly observe banks' type in our data, in our analysis we will control for several observable characteristics that usually correlate with bank business model, such as size (total assets), share of nonfinancial loans over assets, level of equity capital, holdings of liquid assets, and non-performing loans. We would expect these variables to jointly capture some of the variation in outcomes attributable to differences between banks' business models. Finally, Callaway et al. (2021) show that weak PTA is still sufficient to identify level effects, i.e. the average treatment on the treated (ATT) banks. In Appendix C.3 we recover standard ATT-type parameters and discuss them in comparison with parameter estimates presented in Section 4.1 (Cingano et al. (2016), Holmstrom and Tirole (1997), Imai and Ratkovic (2014), Kandrac (2020)).

Finally, the main danger to identification are time-varying differences between banks with different reliance on deposits that are correlated with factors other than the introduction of negative rates, such as other monetary, regulatory and prudential policies implemented around the same time. While constant differences between treatment and control groups will be removed by the difference-in-differences procedure, time-varying differences – such as credit demand – would violate even the weak version of PTA. In the next sections we will discuss econometric models and exploit information on bank-firm relationships in order to alleviate such concerns.

3.3. Econometric model

In this section we present the model used to estimate the impact of the introduction of negative rates. The model tests the two hypotheses discussed in Section 2. According to the *Risk-Taking Hypothesis (H1)*, the introduction of negative rates should induce banks with large shares of deposits to expand lending by relatively more with respect to other banks. Conversely, the *Reversal Rate Hypothesis (H2)* predicts that high-deposits banks should contract lending following the introduction of negative rates. The baseline model is specified as follows:

$$\Delta(\log Credit)_{ij} = \beta \text{ Deposits ratio}_j + \theta X_j + \alpha_i + \epsilon_{ij} \quad (1)$$

where i denotes firms and j banks. The dependent variable is the percentage change in credit granted by bank j to firm i in the ± 3 months period around the introduction of negative rates. Specifically, we collapse the time dimension of the data into a symmetric “pre” and “post” window around June 2014 by taking the average total credit provided by bank j to firm i in the pre/post periods, and then taking first differences (Khwaja and Mian, 2008; Andrade et al., 2018; Bottero et al., 2022). This procedure neuters concerns that auto-correlation in lending (in levels) within bank-firm pairs may induce serial correlation of residuals and lead to incorrect inference (Bertrand et al., 2004).²³

Our baseline specification focuses on the first three months following the introduction of negative rates because Fig. 5 indicates an impact as early as one quarter after the rate cut. In particular, for our main specification the “pre” period covers March-May 2014, while the “post” period covers July-September 2014, thus leaving June 2014, the month when negative interest rates were first introduced, out of the analysis. The appropriate length of the estimating window, however, is a priori uncertain. On the one hand, a shorter window would reduce the scope for confounding factors other than the introduction of negative rates.²⁴ On the other, a longer window would better capture the medium-term impact of the policy, as changes in banks' lending strategies may take time to materialize. We take an agnostic stance in this respect, and study the sensitivity to changing the estimating window to one, three, six and nine months around the introduction of negative rates in Appendix C.2.

The key explanatory variable is *Deposits ratio*, defined as total deposits over total assets measured as of March 2014, three months before negative rates were first announced. X is a vector containing additional bank level variables such as the natural logarithm of total assets and the ratios of capital, loans and non-performing loans over total assets. These variables are also measured as of March 2014 and are included to control for bank attributes that typically influence the transmission of monetary policy to credit supply (Kashyap and Stein, 1995; Kashyap and Stein, 2000; Kishan and Opiela, 2000; Jiménez et al., 2012).

The identification of shifts in credit supply requires controlling for loan demand, since both jointly determine lending decisions and are simultaneously affected by monetary, economic and financial conditions. In this sense, identification may be threatened if treated and control banks experienced different credit demand around the introduction of negative rates. For instance, suppose that high-deposits banks are more likely to lend to SMEs relative to low-deposits banks (Berlin and Mester, 1999). From a firm's standpoint, any cut in the policy rate should reduce user cost of capital, increase net worth and relax funding constraints (Altavilla et al., 2018). Under standard financial accelerator models, financially constrained firms would have stronger incentives to borrow in order to expand fixed investment and other production factors (Bernanke and Gertler, 1995). Everything else equal, high-deposits banks would then face higher credit demand relative to

²³ The downside of this approach – lower statistical power – is less of a concern in our case since we retain a rich cross-section.

²⁴ For instance, in mid-September 2014 the ECB implemented the Targeted Long-Term Refinancing Operations (TLTRO) program, a funding-for-lending scheme whereby banks that outperformed a specific lending benchmark would benefit of a borrowing rate indexed to the DFR (Rostagno et al., 2016).

low-deposits banks around the introduction of negative rates. The observed credit expansion, however, would stem from a demand channel.

In general, any time-varying differences in credit demand faced by banks with different fractions of deposits would violate the parallel trend assumption and hamper our identification strategy. To allay this concern, we include a firm fixed effect (α_i) to control for firm-specific credit demand in line with [Khwaja and Mian \(2008\)](#). Model 1 effectively tests if the *same* firm that borrows from multiple lenders obtained more or less credit from treated banks relative to control banks following the introduction of negative rates. Because the model is in first differences, we implicitly control for time-invariant bank-specific factors affecting credit supply that would be absorbed by bank fixed effects. On the downside, this procedure restricts the estimating sample to firms with at least two banking relationships (multibank firms henceforth), which are 201,000 in our sample and account for 28% of all credit relationships. In an alternative specification, we use the full sample and follow [Abuka et al. \(2019\)](#) and [Degryse et al. \(2019\)](#) by including industry-location-size (ILS) fixed effects under the assumption that firms of similar size that operate in the same geographical location and industrial sector experienced similar changes in credit demand around June 2014.

Model 1 is estimated with Ordinary Least Squares (OLS) and standard errors are double-clustered at the bank and firm level.²⁵ Under the strong PTA assumption discussed in Section 3.2, conditional on covariates and fixed effects $\hat{\beta}$ measures the causal response of lending to the introduction of negative rates. The *Risk-Taking Hypothesis (H1)* would imply $\hat{\beta} > 0$, indicating that high-deposits banks react to negative rates by attempting to restore profitability through higher lending volumes. Conversely, $\hat{\beta} < 0$ would mean that high-deposits banks are unable to offset the reduction in equity and net interest margins, and therefore cut down on lending. This outcome would be consistent with the *Reversal Rate Hypothesis (H2)*.

4. Results

4.1. Negative rates, bank lending and risk taking

We start by studying how bank lending responded to the introduction of negative rates. Results reported in [Table 1](#) indicate a positive and statistically significant treatment effect via deposits. In the ± 3 months around the introduction of negative rates, banks with larger shares of deposits extend more loans than banks with lower deposits exposure. With the inclusion of a firm fixed effect, the estimate indicates that the same firm borrowing from multiple banks obtained relatively more credit from lenders with higher reliance on deposits (Column 1). The effect is economically significant: a one-standard-deviation increase in *Deposits ratio* (0.28) is associated to $(0.28 \times 0.019) = 0.53$ percentage points higher credit growth during the pre/post policy period, which corresponds to a 19% increase relative to the average credit growth during this period.²⁶

In the following columns we test the sensitivity of this result. First, we add bank controls to capture bank-specific determinants of credit decisions. In particular, we include the log of bank assets, the equity-assets ratio and the ratios of non-financial loans and non-performing loans to total assets. Estimates for β reported in Column 2 remain virtually unchanged.

Second, we consider alternative explanations that emphasize excess liquidity as opposed to deposits. By charging reserves and penalizing the holding of liquid and safe assets, negative rates may induce banks with large liquidity positions to rebalance toward higher-yielding assets such as corporate loans ([Bottero et al., 2022](#); [Demiralp et al., 2021](#)). As discussed, since banks' share of deposits is correlated with their liquidity position, $\hat{\beta}$ may reflect the excess liquidity channel of negative rates. To address this concern, we add two measures of excess liquidity: *Interbank ratio*, computed as interbank assets minus interbank liabilities and scaled by total assets; and *Liquidity ratio*, corresponding to the sum of cash and securities over total assets, either alone (Column 3) or alongside banks' deposit ratio (Column 4). In Column 5 we include banks' asset share of reserves, another key component of excess liquidity ([Demiralp et al., 2021](#)).²⁷ We find that all measures of excess liquidity, either alone or along banks' deposit ratio, enter the model insignificantly or with a negative sign. These findings suggest that the excess liquidity channel of negative rates uncovered in other European countries does not appear to be operative in France. If anything, the negative coefficient on *Interbank Ratio* is consistent with the standard bank lending channel of monetary policy ([Kashyap and Stein, 2000](#); [Gambacorta, 2005](#)), whereby illiquid banks exhibit stronger lending responses following an interest rate cut. We return to this issue in Appendix C.7.

Finally, we test the robustness of the within-firm approach. As discussed, the inclusion of firm fixed effects restricts the estimating sample to firms with multiple lending relationships. Sample selection may introduce attenuation bias because multi-banks firms are typically larger, better able to tap capital markets, and thus less sensitive to changes in lending conditions ([Detragiache et al., 2000](#)). For these reasons, we follow [Abuka et al. \(2019\)](#) and [Degryse et al. \(2019\)](#) and re-estimate Model 1 with industry-location-size fixed effects (ILS) for the full sample. The intuition is that firms of similar size that operate in the same location and industrial sector should exhibit comparable credit demand patterns at a given point in time. In

²⁵ As noted by [Bottero et al. \(2022\)](#), this procedure allows for residual correlation within banks, given that our treatment variable varies at the bank level, as well as within firms, given that credit growth to the same firm may be correlated across banks (for firms with many such relationships) and not fully absorbed by firm fixed effects. In Appendix C.6 we show that inference is not affected by either no clustering or clustering standard errors at the bank level.

²⁶ More precisely, because the relevant variation in Model 1 is within-firm, it is more appropriate to consider a within-firm variation in banks' deposit ratios, i.e. variation in deposit ratios among the group of banks lending to the same multi-bank firm. In this case, a one-standard-deviation increase in *Deposits ratio* (0.21) is associated to $(0.21 \times 0.019) = 0.40$ percentage points higher credit growth during the pre/post policy period.

²⁷ The lower number of observations for this specification is due to the fact that information on reserves is available for only 199 banks.

Table 1
Negative rates and bank lending.

Dependent variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	$\Delta \log(\text{Credit})_{ij}$									
Deposits ratio _j	0.019*** (0.005)	0.020*** (0.004)		0.042*** (0.010)	0.026*** (0.006)	0.011*** (0.004)	0.010*** (0.004)		0.038*** (0.013)	0.012** (0.006)
Interbank ratio _j			-0.007 (0.007)	-0.031*** (0.010)				-0.005 (0.007)	-0.033** (0.014)	
Liquidity ratio _j			-0.010 (0.015)	-0.005 (0.016)				-0.004 (0.010)	-0.004 (0.011)	
Reserves ratio _j					0.001 (0.058)					0.015 (0.036)
Bank controls		Yes	Yes	Yes	Yes		Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes					
ILS FE						Yes	Yes	Yes	Yes	Yes
Observations	446,780	446,780	446,780	446,780	311,131	1,694,811	1,694,811	1,694,811	1,694,811	1,431,887
R ²	0.472	0.473	0.473	0.474	0.487	0.163	0.163	0.163	0.164	0.171

Notes: The table reports results of OLS estimation of the following model at the bank-firm level:

$$\Delta(\log \text{Credit})_{ij} = \beta \text{Deposits ratio}_j + \theta X_j + \alpha_i + \epsilon_{ij}$$

where i denotes firms and j banks. For all specifications, the dependent variable is the percentage change in total credit supplied by bank j to firm i in the ± 3 months period around the introduction of negative rates. For a given firm-bank pair, the dependent variable is the percentage change between the average credit outstanding between July-September 2014 and the average credit outstanding between March-May 2014. *Deposits ratio* denotes a bank's deposits to assets ratio as of March 2014. *Interbank position* and *Liquidity ratio* denote a bank's net interbank position and liquid assets (cash and securities), respectively, scaled by total assets as of March 2014. *Reserves ratio* denotes the amount of banks' reserves at the Eurosystem scaled by total assets as of March 2014. Bank controls variables (not reported) include the log of total banking assets, the common equity to assets ratio, the ratio of non-financial loans to total assets and the share of non-performing loans to total assets. All control variables are predetermined and included as of March 2014. Firm and Industry-Location-Size (ILS) fixed effects are included as indicated. Standard errors are clustered at the bank level and reported in parentheses. *, **, *** refer to significance levels at 10%, 5% and 1%, respectively.

our sample, firms are distributed in 102 French "départements" (geographical units that are analogous to counties) and 730 industrial sectors according to the French NAF activity classifier.²⁸ We further sort firms across the deciles of the credit distribution, since firms' credit balances usually grow with firm size (Andrieu et al., 2018).²⁹ We replicate previous regressions with this alternative specification and find very similar results (columns 6–10). Within the same industry-location-size bin, firms related to banks with large deposit exposure experience stronger credit growth relative to other firms around the introduction of negative rates. Interestingly, despite the tripling of the estimating sample, point estimates remain remarkably close to our previous estimates.³⁰

Additional robustness checks are reported in Appendix C. Specifically, we test the sensitivity of our results to: a series of placebo regressions around previous policy rate cuts above zero (Appendix C.1); varying the width of the estimating window around the introduction of negative rates (Appendix C.2); obtaining ATT-type difference-in-differences estimates instead of average causal response (ACR) estimates (Appendix C.3); controlling more comprehensively for outliers (Appendix C.4); using an alternative measure of credit growth based on both drawn and undrawn credit (Appendix C.5); alternative adjustment of standard errors (Appendix C.6); coexistence of a deposit channel and the traditional bank lending channel (Appendix C.7); and studying if the effect we identify varies for banks with lower equity capital (Appendix C.8).

Results presented so far are consistent with negative rates having an expansionary impact on lending. Under the *Risk-Taking Hypothesis*, however, negative rates should induce banks to increase holdings of riskier and high-yield assets. We test this prediction in two ways. First, we test for differential treatment effects for small firms under the assumption that small businesses are inherently riskier than larger and more established companies because of information asymmetries (Schiantarelli, 1996). Specifically, we define small firms as those with total credit in the bottom three quartiles of the distribution as of March 2014, and large firms as those with total credit in the top quartile.³¹ Estimates reported in Table 2 suggest that the increase in lending supplied by high-deposits banks is between 0.09 and 0.13 percentage points larger for small firms relative to large firms.³²

²⁸ The Nomenclature d'Activités Française (NAF) is produced by the French Statistical Office (INSEE) and is analogous to the Nomenclature of Economic Activities (NACE) classification used at the European Union level, which in turn is derived from the International Standard Industrial Classification of All Economic Activities (ISIC).

²⁹ Specifically, we divide firms in 10 bins based on the size of their average credit line between January 2013 and March 2014. In Table A4 we show that the amount of credit for companies in our sample increases with the overall size of a firm, as measured by turnover.

³⁰ This result is in keeping with the observation that the ILS strategy to absorb credit demand yields estimates similar to those obtained with the standard within firm approach (Degryse et al., 2019).

³¹ This considers the right skew of the distribution and reflects the fact that the average credit amount for Small and Medium Sized Enterprises (SMEs) represent the 80th percentile of the credit distribution.

³² Note that the model controls for bank fixed effects, i.e. the fact that some banks may be specialized in lending to SMEs.

Table 2
Negative rates and lending to small firms.

Dependent variable	(1)	(2)
		$\Delta \log (\text{Credit})_{ij}$
Small firms _{<i>j</i>} ×Deposits ratio _{<i>j</i>}	0.013*** (0.005)	0.009*** (0.003)
Deposits ratio _{<i>j</i>}	0.036*** (0.010)	
Firm FE	Yes	Yes
Bank FE		Yes
Observations	446,780	446,757
R ²	0.474	0.477

Notes: The table reports results of OLS estimation of the following model at the bank-firm level:

$$\Delta \log (\text{Credit})_{ij} = \beta [\text{Deposits ratio}_j \times \text{Small firms}_i] + \theta X_j + \alpha_i + \gamma_j + \epsilon_{ij}$$

where i denotes firms and j banks. For all specifications, the dependent variable is the percentage change in total credit supplied by bank j to firm i in the ± 3 months period around the introduction of negative rates. For a given firm-bank pair, the dependent variable is the percentage change between the average credit outstanding between July-September 2014 and the average credit outstanding between March-May 2014. *Deposits ratio* denotes a bank's deposits to assets ratio as of March 2014. *Small Firm* is a dummy variable selecting firms in the bottom three quartiles of the distribution of total credit as of March 2014. Bank controls variables (not reported) include the log of total banking assets, the common equity to assets ratio, the ratio of non-financial loans to total assets, the share of non-performing loans to total assets, liquidity and interbank ratios. All control variables are predetermined and included as of March 2014. Firm, Bank and Industry-Location fixed effects are included as indicated. Standard errors are clustered at the bank and firm level, and reported in parentheses. ***, **, * refer to significance levels at 10%, 5% and 1%, respectively.

Table 3
Negative rates and risk taking.

Dependent variable	(1)			(2)			(3)			(4)			(5)			(6)			(7)		(8)
	$\log (\text{Loans}_{it})$									$\log (\text{Securities}_{it})$											
Counterpart	Households			NFCs			Government			Private											
Maturity	≤ 5 years	> 5 years	Total	≤ 5 years	> 5 years	Total	Total	Total	Total	Total	Total										
Deposit ratio _{<i>j</i>} ×Negative _{<i>t</i>}	-0.017 (0.027)	0.022 (0.023)	-0.005 (0.023)	0.137 (0.104)	0.096** (0.043)	0.190** (0.083)	-0.032 (0.069)	0.332** (0.160)													
Bank controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes											
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes											
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes											
Observations	331	405	508	548	553	563	450	493													
R ²	0.910	0.959	0.927	0.506	0.756	0.377	0.701	0.970													

Notes: The table reports results of OLS estimation of the following model at the bank level:

$$\log (Y_{it}) = \beta [\text{Deposits ratio}_j \times \text{Negative}_t] + \theta_1 [X_i \times \text{Negative}_t] + \theta_2 X_{it-1} + \alpha_i + \gamma_t + \epsilon_{it}$$

where i denotes banks and t months. The dependent variable denotes a series of assets on banks' balance sheets: loans to households (total maturity, house mortgages with maturity under 5 years, house mortgages with maturity over 5 years, columns 1–3); loans to non-financial corporations (total maturity, maturity under 5 years and maturity over 5 years, columns 4–6); debt securities holdings (issued by EA sovereign states, issued by banks, and issued by private financial and non-financial corporations, columns 7–8). The estimation window is ± 8 months around June 2014, hence spanning October 2013 - February 2015 (June 2014 is dropped from the sample). *Negative* is a dummy variable taking value 1 for all months following June 2014 and 0 otherwise. *Deposits ratio* denotes a bank's deposits/assets ratio as of March 2014. Lagged bank controls variables (not reported) include lags of the dependent variable and the log of a banks' total assets and the equity-assets ratio. Copies of these variables taken as of March 2014 are also included in interaction with the *Negative* dummy. Bank and month fixed effects are included as indicated. Bank and month fixed effects are included as indicated. Standard errors are clustered at the bank level and reported in parentheses. ***, **, * refer to significance levels at 10%, 5% and 1%, respectively.

Second, we test if high-deposits banks shifted to riskier asset classes. For this purpose, we draw from the IBSI database's granular information on asset allocation for a subsample of 25 banks. We estimate panel difference-in-differences models equivalent to Model 1, where the Deposits ratio (the deposits to assets ratio at the bank group level) is interacted with *Negative*, an indicator taking value 1 for all months after June 2014 and 0 otherwise. In this case, we choose an estimating window of ± 8 months around June 2014 to maximize the sample size to before the implementation of the ECB's Asset Purchase Program (APP) program in March 2015. Consistent with previous results, we find that high-deposits banks allocate resources more intensively toward riskier and longer-term assets following the introduction of negative rates and relative to other banks (Table 3). In particular, high-deposits banks increased corporate loans, especially at long maturities (Columns 4–6), while there are no significant differences for loans to households (Columns 1–3). Similarly, high-deposits banks increase their exposure to bonds issued by the private sector, i.e. financial and non-financial corporations (Column 8), while no similar effect is reported for bonds issued by Euro Area governments (Column 7).

Next, we test for the impact of negative interest rates on profitability. Under the *Reversal Rate Hypothesis*, high-deposits banks' reluctance to pass negative rates on depositors should compress their net interest margins. Conversely, under the *Risk-Taking Hypothesis* high-deposits banks offset the compression in margins by searching for yield. We test for these predictions using income statement data and estimating difference-in-differences regressions comparing the two semesters before (2013:H2-2014:H1) and after (2014:H2-2015:H1) the introduction of negative rates. Results presented in [Table 4](#) indicate that, after the introduction of negative rates, high-deposits banks did not report significantly different return on assets (ROA) and NIM relative to other banks (Columns 1 and 2). By contrast, since the introduction of negative rates high-deposit banks markedly increased their income share of fees and commissions relative to other banks, in particular for customer, financial and liquidity services (Columns 4 and 5).

Finally, we investigate the external validity of our results by running a similar analysis on a sample of banks covering all 19 Euro Area member states (see Appendix D). In line with our findings for France, we show that European banks with larger shares of deposits increase credit by relatively more than other banks following the introduction of negative rates. Furthermore, these banks also decrease their share of government bonds and increase that of private securities, while not experiencing lower profitability with respect to other banks. Although our Euro Area data is less granular than the French credit registry, results on European banks are qualitatively consistent with the evidence we presented on French banks, suggesting that the findings we presented in this section have validity outside of France.

Overall, the evidence presented in this section is consistent with the *Risk-Taking Hypothesis (H1)* and results from other European countries and Japan ([Hong and Kandrac, 2022](#); [Bottero et al., 2022](#); [Demiralp et al., 2021](#); [Bubeck et al., 2020](#); [Schelling and Towbin, 2018](#)). Exposed banks react to the introduction of negative rates by expanding credit supply and taking additional risk, in the form of credit (loans to riskier firms), maturity (loans at longer maturities) or security risk (exposure to higher-yielding corporate debt), as well as by increasing fees and commissions. The result that exposed banks do not experience changes in profitability is consistent with the findings of [Lopez et al. \(2020\)](#) and the idea that deposit-dependent banks offset the impact of negative rates.³³

Our findings contrast instead with earlier evidence that negative rates are associated with a *decline* in lending by banks more reliant on deposits ([Heider et al., 2019](#)). The discrepancy may be driven by differences in the samples of firms under study. In this study, we observe the universe of credit relationships between firms and banks in France, while [Heider et al. \(2019\)](#) rely on a sample of European banks' syndicated loans, which are typically extended to large and established firms ([Dennis and Mullineaux, 2000](#); [Altunbas et al., 2010](#)). Specifically, mean loan size in [Heider et al. \(2019\)](#) is €740 million, while the average credit exposure in our sample is €0.42 million, reflecting the fact that our sample includes a large number of SMEs.³⁴

Differences in firm size may matter because exposed banks' risk-taking in the loan market is likely to be partly directed to small borrowers, which are traditionally considered riskier because of information asymmetries, at the expense of safer loan segments – which is consistent with the findings presented in [Table 2](#). In this sense, [Heider et al. \(2019\)](#)'s result that high deposits banks cut syndicated lending around the introduction of negative rates may reflect a (unobserved) credit reallocation by the same banks to smaller and riskier firms.³⁵ Based on these observations and our reading of the literature, we suggest that the primary reason behind the differences between our results and [Heider et al. \(2019\)](#) may be the higher presence of SMEs and the larger scope for risk-taking in lending inherent to the type of firms included in our dataset relative to those studied by [Heider et al. \(2019\)](#).

Finally, our results are inconsistent with a reversal rate kicking in at the zero lower bound. The fact that negative rates are not associated with a contraction in credit supply can be interpreted in different ways. First, the reversal rate mechanism implicitly assumes that banks cannot prevent negative rates from squeezing their margins, so that if no additional equity is raised or dividend payouts are not reduced, bank equity will inevitably decline, which in turn should constrain banks' ability to make new loans ([Abadi et al., 2022](#)). By contrast, our results line up with the view that banks actively offset the squeeze in margins occasioned by negative rates by taking additional risk, either by substituting reserves for loans or by lending to riskier borrowers and lowering their credit standards ([Hong and Kandrac, 2022](#)). Second, the reversal rate may not have been reached, as also suggested by [Arce et al. \(2018\)](#). A reversal rate can take time to materialize ([Abadi et al., 2022](#)), and there is evidence that forward-looking variables such as banks' stock prices did decline upon announcements of surprise policy rate cuts below zero ([Bats et al., 2020](#)), especially for high-deposits banks ([Ampudia and Van den Heuvel, 2017](#)) or for banks particularly exposed due to their business model ([Hong and Kandrac, 2022](#)). Third, the theoretical mechanism of the reversal rate requires banks to face a binding capital constraint, otherwise any cut in the policy rate would normally lead to higher lending ([Repullo, 2020](#)). As discussed in Section 3.2, French banks in our sample had sufficient equity buffers in 2014. The

³³ The muted impact on profitability also depends on changes in the macroeconomic outlook. As lower interest rates support macroeconomic conditions, higher demand increases intermediation volumes. On the other hand, lower interest rates increase borrowers' net worth and creditworthiness, thus reducing banks' loan loss provisions ([Altavilla et al., 2018](#)). In this sense, there is indeed evidence that net interest income has remained fairly constant for European banks over this period, as higher intermediation volumes have compensated lower margins ([ECB, 2020a](#)).

³⁴ Specifically, for the sample intersect between the Credit Registry and the FIBEN database, which contains balance sheet accounts for over 390,000 firms, 93% of all firms are SMEs.

³⁵ In fact, [Heider et al. \(2019\)](#) validate this interpretation by reporting that high deposits banks extend syndicated finance to *riskier* firms, as identified by their ROA standard deviation. In a similar analysis using syndicated loan data, [Bubeck et al. \(2020\)](#) also find that banks more dependent on retail deposits increase lending exposure to ex ante riskier borrowers relative to low deposit ratio banks.

Table 4
Negative rates, profitability and fees.

Dependent variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Profitability		Fees & Commissions (as share of total income)						
	ROA	NIM	Total	Customer Services	Financial Services	Liquidity Services	Off-balance Ops.	FX Ops.	Securities Ops.
Deposit ratio _{<i>t</i>} × Negative _{<i>t</i>}	0.274 (0.421)	0.031 (0.067)	2.159*** (0.657)	0.883*** (0.335)	0.595** (0.277)	0.531*** (0.121)	0.002 (0.002)	0.014 (0.012)	-0.064 (0.050)
Bank controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Semester FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,083	976	1,147	1,051	1,139	659	1,125	672	227
R ²	0.873	0.874	0.971	0.956	0.979	0.955	0.581	0.865	0.939

Notes: The table reports results of OLS estimation of the following model at the bank level:

$$y_{it} = \beta[\text{Deposits ratio}_i \times \text{Negative}_t] + \theta[X_i \times \text{Negative}_t] + \alpha_i + \gamma_t + \epsilon_{it}$$

where i denotes banks and t semesters. The dependent variable denotes a series of items on banks' income statements: (i) Return on Assets (ROA), computed as total income over assets (column 1); (ii) Net Interest Margin (NIM), computed as interest income minus interest expenses and scaled by total assets (column 2); (iii) fees & commission income as share of total income (column 3). This variable is further broken down into six subcomponents, i.e. the share of fees accruing from customer services (related to depositors and borrowers), financial services, interbank and liquidity operations, off-balance sheet operations, foreign exchange operations and operations on securities (column 4–9). In line with other bank-level regressions, the estimation window is consistent with a ± 8 months around June 2014, hence spanning 2013H2–2015H1 (i.e. from the second semester of 2013 to the first semester of 2015). *Negative* is a dummy variable taking value 1 for the two semesters following June 2014 and 0 otherwise. Note that in this case we do not drop the semester containing the start of the policy to obtain a symmetric difference-in-differences test, with two periods of post-treatment and two periods of pre-treatment. Results are similar if we exclude 2014H2 and conduct an asymmetric test. *Deposits ratio* denotes a bank's deposits/assets ratio as of March 2014. Bank controls variables (not reported) include the log of a banks' total assets, the equity-assets ratio as well as the shares of retail loans and non-performing loans over assets taken as of March 2014 and interacted with the *Negative* dummy. Bank and semester fixed effects are included as indicated. Bank and month fixed effects are included as indicated. Standard errors are clustered at the bank level and reported in parentheses. *, **, *** refer to significance levels at 10%, 5% and 1%, respectively.

lack of capital constraint may thus explain why the reversal rate may not have been reached in France during the period we consider. We further test and explain this hypothesis and the role of bank capital in Appendix C.8.

Finally, we note that the *Reversal Rate* and *Risk Taking* channels are not mutually exclusive.³⁶ We suggest that both channels may well be active in France, and that the latter channel dominates the former in our particular sample. The relative weight of the two channels may also change over time. Based on their review of the literature, [Balloch et al. \(2022\)](#) suggest that the expansionary impact of negative rates may fade or even reverse over time, as the *Reversal Rate* channel prevails over the *Risk Taking* channel.

4.2. Negative rates and rigid deposits

In this section we test our second hypothesis whereby banks' exposure to negative rates increases with the share of rigid deposits, i.e. deposits whose rate is subject to downward rigidity around zero. As discussed, not all deposits are equal: some are more susceptible than others to downward rigidity at zero because of their low rates and inherent withdrawal risk. For instance, banks appear reluctant to charge negative rates on deposits by households or small businesses, while at the same time they do so for deposit held by large corporations ([Heider et al., 2021](#); [ECB, 2020b](#); [Altavilla et al., 2021](#)). This behavior may be related to the degree of depositors' loss aversion and/or financial sophistication ([Stettler, 2020](#)), or to the fact that small and large deposits exhibit different storage costs and withdrawal risks ([Eggertsson et al., 2019](#)).

Analogously, while long-term savings accounts bear relatively high interest rates and cannot be costlessly withdrawn, overnight checking accounts offer almost no return to holders and are readily and freely convertible to cash. In this respect, the rate on overnight checking deposits in France was already close to zero when the DFR went negative (Fig. B1). Furthermore, the interest rate on households checking accounts was the lowest compared to other major European countries (Fig. B2). By contrast, rates on savings accounts with longer maturities were well above zero and had ample room to fall after June 2014. Because negative rates intensify the competition between deposits and cash, the zero bound should be harder for deposits that offer near-zero remuneration and that can be readily withdrawn were they charged a negative rate. As a result, banks that rely on these types of deposits would be under even stronger pressure to find avenues to restore profitability. These considerations allow us to sharpen the predictions implied by the *Risk-Taking (H1)* and *Reversal Rate (H2)* hypotheses. Specifically, after the introduction of negative rates banks reliant on households and short-term deposits should expand (*H1*) or contract (*H2*) lending by more relative to banks funded by corporate and less liquid deposits, respectively.

We test these predictions using information on deposits counterparts and maturity for the subset of 25 banks covered in the IBSI database. For each bank we compute the asset share of deposits by households and non-financial corporations. Similarly, we calculate the share of overnight deposits (zero maturity), deposits redeemable at notice (less than 3 months), and

³⁶ We are thankful to an anonymous referee for this suggestion.

Table 5
Negative rates and rigid deposits.

Dependent variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	$\Delta \log (\text{Credit})_{ij}$						
Deposits by Households _j /Assets _j	0.082*** (0.029)						
Deposits by NFCs _j /Assets _j	-0.279*** (0.079)						
<i>Assets Share of Deposits with maturity:</i>							
Overnight _j		0.139*** (0.042)					
Redeemable at notice _j		0.167** (0.069)					
Agreed maturity (under 1 year) _j		-2.959*** (0.460)					
Agreed maturity (over 1 year) _j		-0.217* (0.112)					
Overnight Deposits by Households _j /Deposits by Households _j			0.031*** (0.008)				
Overnight Deposits by NFCs _j /Deposits by NFC _j				0.020*** (0.005)			
Deposits by Institutional Investors _j /Assets _j					-0.187 (1.253)		
Regulated Deposits _j /Assets _j						0.014*** (0.003)	
Deposits by Non-residents _j /Assets _j							-0.047* (0.024)
Bank controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	72,396	72,396	59,413	60,073	72,396	371,813	384,458
R ²	0.504	0.505	0.513	0.513	0.504	0.494	0.484

Notes: The table reports results of OLS estimation of the following model:

$$\Delta \log (\text{Credit})_{ij} = \beta \text{Rigid Deposits}_j + \theta X_j + \alpha_i + \epsilon_{ij}$$

where i denotes firms and j banks (columns 1–7). For all specifications, the dependent variable is the percentage change in credit borrowed by firm i from bank j in the ± 3 months period around the introduction of negative rates. For a given firm-bank pair, ΔCredit is the percentage change between the average credit outstanding between July–September 2014 and the average credit outstanding between March–May 2014. *Deposits by Households* and *Deposits by NFCs* denote, respectively, a bank's stock of households deposits and corporate deposits. *Overnight* indicate the volume of overnight deposits; *Redeemable at notice* is the stock of deposits redeemable at a notice under 1 month. These variables are taken as share of total assets and as of January 2014. *Agreed maturity (under 1 year)* and *Agreed maturity (over 1 year)* denote, respectively, a bank's stock of deposits with agreed maturity under 1 year and over 1 year. These variables are measured as of July 2015. *Deposits by Institutional Investors* is the stock of deposits held by Pension Funds and Insurance Companies. *Regulated Deposits* is the volume of deposits whose remuneration is formally regulated under French Law: Livret A, Plan d'Epargne Logement, Livret Bleu et Jaune, Livret de Developpement Durable, Livret d'Epargne Populaire and Compte d'Epargne Logement. *Deposits by Non Residents* is the stock deposits held by firms or households outside France. Lagged bank controls variables (not reported) include the log of total banking assets, the common equity to assets ratio and the share of loans and non-performing loans over assets. Standard errors are double clustered at the bank and firm level and reported in parentheses. *, **, *** refer to significance levels at 10%, 5% and 1%, respectively.

deposits with agreed maturity (under 1 year and over 1 year). The former two deposits classes are demandable and highly liquid, while the latter two contain accounts that are locked in for term and hence less liquid (Drechsler et al., 2017).^{37,38} We then estimate a variant of Model 1 which allows to compare the differential lending response of banks that rely on deposits with different counterparts and maturity. Again, we include firm fixed effects to measure the percentage change in credit observed for the same firm that borrows from banks reliant on different types of deposits ± 3 months around the introduction of negative rates.

Results presented in Table 5 confirm that differences across deposits matter for the transmission of negative rates. Following the introduction of negative rates, firms related to banks with larger share of households (corporate) deposits obtain more (less) credit relative to firms related to banks with lower shares of such deposits (Column 1). The term structure of deposits also matters. Specifically, firms experience larger increases in credit from banks reliant on short-term/liquid deposits (overnight deposits and deposits redeemable at notice), while they obtain less credit from banks reliant on long-term/illiquid deposits (deposits with agreed maturity) (Column 2). These results suggest that the transmission of negative rates depends on the counterparts and inherent characteristics of the type of deposits banks rely on in the context of interest rates

³⁷ Overnight deposits are defined as "convertible into currency and/or transferable on demand by cheque, banker's order, debit entry or similar means, without significant delay, restriction or penalty". Similarly, deposits redeemable at notice are defined as "non-transferable deposits, usually with no agreed maturity, but which may be withdrawn without penalty only after a period of notice". Conversely, deposits with agreed maturity are "non-transferable deposits which cannot be withdrawn before an agreed fixed term, or that can be withdrawn only subject to a penalty" (ECB, 2021).

³⁸ Unfortunately, we have no observations on deposits with agreed maturity before July 2015. As a result, all deposits share by maturity are measured as of July 2015. This choice is supported by the fact that banks' deposits shares remain constant over time as suggested by Figs. B6 and B7.

going below zero. Specifically, the increase in lending and risk taking behavior associated with the introduction of negative rates grows with the share of households and liquid deposits held by banks.

One may worry that if households deposits have shorter maturities and offer lower rates relative to corporate deposits, differences in deposit maturity merely mirror differences in deposit counterparts as shown by Heider et al. (2019). To alleviate this concern, we look at deposit maturity for a given counterpart. In particular, for each bank we compute the fraction of overnight deposits by households over total deposits by households at all maturities, and the fraction of overnight deposits by non-financial corporations over total corporate deposits at all maturities. Results indicate that deposit maturity matters even within the *same* counterpart. Specifically, following the introduction of negative rates, banks with larger fractions of overnight household deposits expand lending by more relative to banks with larger fractions of long-term household deposits (Column 3). Similarly, the increase in credit for banks with larger shares of overnight corporate deposits is larger relative to banks with larger shares of long-term corporate deposits (Column 4). These findings support the idea that deposit maturity has an independent role in mediating the transmission of negative rates to lending, regardless of deposit counterpart.

We carry out additional tests to corroborate the interpretation that differences across deposits matter for the transmission of negative rates. First, we look at banks' share of deposits by institutional investors, i.e. pension funds and insurance companies. This test is a counterpoint to that carried out in Column 1 in that, contrary to deposits by households that tend to be small and numerous, deposits by institutional investors are, for a given bank, usually fewer in number and very large. In addition, banks appear to negotiate deposit rates below money market rates to accept the large liquidity inflows from institutional investors. As a result, one would expect these banks to be relatively insulated from the impact of negative rates (ECB, 2017).³⁹ Consistent with this idea, we find no statistically significant differential changes in credit for firms related to banks with large exposure to institutional investors around June 2014 (Column 5).

Second, we exploit the existence of institutional frictions that generate a different source of downward rigidity on deposit rates. A number of savings products in France offer a remuneration that is fixed by regulation. The most important regulated savings accounts are the A passbook (Livret A) and other ownership saving schemes, which represent two-thirds of these products as of June 2014 (see Fig. B8).⁴⁰ The interest rates on these accounts are set on the basis of formulas that depend on Euro Area money market rates and the French inflation rate. In addition, both the Governor of the Banque de France and the French government may choose to deviate from the rate implied by the formula. As a result, while rates on other deposits are freely determined by banks according to market conditions, the remuneration of regulated deposits does not strictly co-move with ECB monetary policy rates (Duquerroy et al., 2020) (See Fig. B9). Moreover, because the remuneration on regulated deposits is guaranteed by the government as a way to preserve households' purchasing power, the lower bound for these deposits is even more binding since floor rates are explicitly or implicitly set above zero.⁴¹ As a result, one would expect that banks that rely heavily on regulated deposits should be more exposed to negative rates in terms of profitability and incentives to search for yield. Estimates reported in Column 6 confirm that the same firms experienced larger credit increases from banks with larger shares of regulated deposits relative to other banks following the introduction of negative rates.

Finally, we study deposits held by non-residents. In principle, deposits by non-residents are less likely to be subject to downward rigidity at zero because they typically consist of large deposits held by very large foreign firms and multinational corporations. For instance, as of 2019 more than 60% of non-resident deposits collected by French banks belonged to foreign financial (non-banks) and non-financial corporations (ACPR, 2019). In line with our results for corporate deposits, we find that firms that borrow from banks with greater reliance on deposits by non-residents experience lower credit growth around the introduction of negative rates (Column 7).

Overall, these results are in line with the *Risk-Taking Hypothesis* and show that the transmission of negative rates depends on the rigidity of deposits held by banks. Specifically, negative rates are associated with larger increases in lending by banks reliant on deposits classes most susceptible to downward rigidity emanating from the zero lower bound. While Heider et al. (2019) provide similar evidence on the importance of households deposits, we reveal that the maturity structure of deposits as well as other inherent characteristics matter greatly for the transmission of negative rates. In general, banks with larger shares of rigid deposits may face a larger threat to their funding model with respect to other banks. The former, unwilling to break the zero lower bound, were unable to pass negative rates on their average liability, while the latter could adjust downward their average deposit rates still in positive territory. This result adds to our understanding of the transmission of negative rates, suggesting that the mechanism depends not only on banks' overall reliance on deposits, but also on the particular composition of their deposit structure across different types of accounts, maturities and counterparts. The relevance of this finding is underscored by the fact that banks that rely on households and short-term deposits account for the largest part of credit supplied to the real economy in our sample. Specifically, banks with above-median shares of households and short-term deposits accounted for two-thirds of all credit volumes in our sample in the three months around the introduction of negative rates (Table A5).⁴²

³⁹ We are grateful to Angela Maddaloni who first suggested this to us.

⁴⁰ Other regulated deposits include home ownership saving schemes, the PEL (Plan d'Épargne Logement) and CEL (Compte d'Épargne Logement), and specific passbooks, the Livret Bleu, Livret Jeune, LDD (Livret de Développement Durable) and LEP (Livret d'Épargne Populaire).

⁴¹ The floor rate was set at 0.5% for the Livret A and 1% for the PEL for the period under study.

⁴² More generally, as of 2014, in the euro area household deposits represented, on average, 28% of banks' balance sheets, ranging between 13% (Luxembourg) to 51% (Malta) (Eisenschmidt and Smets, 2019).

5. Conclusion

We study the transmission of negative monetary policy rates and document that banks most reliant on deposits react to this policy by increasing lending volumes, taking additional risk and increasing fee income relative to other banks. Furthermore, the transmission of negative rates is stronger for rigid deposits, i.e. deposits most subject to downward rigidity when the policy rate breaches the zero lower bound. Specifically, the increase in lending associated with negative rates is concentrated in banks funded by deposits that could be easily withdrawn were they charged a negative rate (households and short-term deposits) or by deposits with remuneration fixed by regulation (regulated deposits). Our preferred explanation is that banks react to negative rates by looking for avenues to preserve profitability and search for yield: increasing lending volumes, credit and maturity risk as well as increasing non-interest income. We find instead no evidence for the hypothesis that negative rates are contractionary because of their effect on the equity position of banks most reliant on deposits.

From a policy perspective, these findings indicate that negative rates are effective in stimulating the economy when nominal interest rates hit the zero lower bound, although this comes at the price of greater risk taking by banks with large shares of retail deposits that typically account for the lion share of credit to the real economy. The evidence provided in this article hence cautions policymakers that the additional accommodation provided by venturing into negative territory should be weighed against the potential build up of risk in the banking system and attending concerns for financial stability. In this sense, additional research using bank group level data would allow to better explore the aggregate and prudential ramifications of negative rates on the French banking sector. Furthermore, our understanding of the transmission of negative rates would also be enhanced by studies on their interaction with other policies, such as the introduction of a tiering system introduced by the ECB in 2019, under which only an adjustable fraction of banks' excess reserves incurs a negative charge (Balloch and Koby, 2019; Berentsen et al., 2020).

Finally, it is plausible that the transmission channel we document in this paper is a short-lived anomaly. The emphasis on deposits may lose relevance if policy rates remain positive or banks pass negative rates on an increasingly larger fraction of their depositors (Altavilla et al., 2021; ECB, 2020b)⁴³. Even so, the efficacy of negative rates may still depend on the particular deposit structure of different banking systems and the average level of deposits rates (Bittner et al., 2019). In this respect, diversity in the prevalence of particular types of deposits and in their remuneration and average maturity, in bank capital structure as well as in institutional and regulatory frameworks may increase the heterogeneity in the transmission of monetary policy in the Euro Area.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary material

Supplementary data associated with this article can be found, in the online version, at <https://doi.org/10.1016/j.jimonfin.2023.102810>.

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⁴³ As of September 2020, the share of households overnight deposits in the Euro Area with a negative rate had reached 7% (ECB, 2020c).

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