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ABSTRACT

We examine how a policy change by the FDIC, which unexpectedly exempted some banks, affects corporate lending via changes in reserves during the Quantitative Easing (QE) era. To address the endogeneity of reserves, we use a unique hand-collected dataset on the bank's share of exemption from the policy shift, and differentiate between loan demand and loan supply. We find important differences in loan-level outcomes, attributed to the heterogeneous impact of the new regulation on the net return on holding reserves. The effectiveness of the risk-taking channel is significantly weaker for banks with larger exemption shares and this has real effects in terms of borrowers' leverage, growth, and return on assets.

1. Introduction

What is the role of bank reserves regulation in the transmission mechanism of unconventional monetary policy? Starting with the global financial crisis, and continuing through the European sovereign debt crisis and the COVID-19 downturn, central banks have increasingly turned to quantitative easing (QE) and lending facilities in lieu of reducing the short-term interest rate. As a matter of accounting, a direct consequence of the dramatic expansion of assets held by central banks is the forced increase in reserves held by the banking sector. The tight link between unconventional monetary policy and reserves' creation means that reserves consume increasingly large shares of bank assets in advanced economies.¹

Although the effects of large reserve balances have sparked substantial controversy in the public domain, the potential transmission mechanisms generated by the reserve-creating aspect of QE have been less explored in academic work.² Importantly,

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¹ The \$3.7 trillion of Treasury and mortgage-backed securities purchased by the Fed over three rounds of QE between 2008 and 2014 increased reserves from roughly 0.5% to nearly 20% of total banking system assets. Moreover, forceful responses to avert crises can lead to reserve injections that rise sharply over short time periods. The reactivation of QE and other emergency facilities by the Fed in response to the COVID-19 crisis led to a new all-time high for banks' reserves.

² Early criticism centered on fears of excessive credit growth and runaway inflation (see, e.g., an open letter to Fed Chairman Ben Bernanke in the Wall Street Journal of 15 November 2010 signed by academics and financial market economists). The expansion of reserves from QE led to concerns surrounding the Federal Reserve's interest payments to banks (e.g., Ben Bernanke and Donald Kohn's Brookings article, "The Fed's interest payments to banks" February 16, 2016).

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concerns about the appropriate regulatory response to the risks of the new macro-financial environment that the QE shaped are even less explored. Banks interact with the Fed and other regulators in the context of monetary policy implementation and macroprudential regulation. Thus, regulations that aim to affect the behavior of banks to render the financial sector more robust should be taken into account by the Fed when conducting monetary policy, since they will also shape the final effect on the real economy. In turn, monetary policy innovations should be taken into account by regulators, in their effort to promote financial stability (IMF, 2013; BIS, 2015; Kashyap and Siegart, 2020).

We expect that the relation between a bank's lending and its increase in reserves crucially depends on the net return that the bank enjoys on reserve balances. The higher the return, the lower might be the banks' willingness to invest in riskier assets (particularly loans). This is especially the case, when the opportunity cost of holding reserves is relatively low. This pattern disarrays the 'search for yield' component of the risk-taking channel (Borio and Zhu, 2012; Jiménez et al., 2014), in which banks accumulate riskier assets to achieve nominal profitability targets following expansionary monetary policy. Explorations of the risk-taking channel in the literature have thus far disregarded the effect of reserves-related regulatory policy within the QE programs and the associated theoretical debate on how this effect shapes corporate lending and real firm outcomes. Our paper aims to empirically fill this void in the literature.

The setting for our analysis is the post-crisis experience in the United States, when the Fed implemented three rounds of QE. We face two main empirical challenges to identify the link between reserve accumulation and bank lending behavior. First, we need to distinguish between loan supply and loan demand effects (Jiménez et al., 2014). Second, while aggregate reserves are determined by the policy actions of the central bank, individual banks may influence the distribution of reserves in the system through their normal course of business. Thus, an individual bank's optimal reserves position may be tied to factors that influence its credit extension. For example, a shift in strategy could cause a bank to allow reserves to run off while increasing its loan portfolio. Conversely, a bank might increase its reserves position to counterbalance a growing loan portfolio and otherwise illiquid balance sheet.

Our solution to the first identification problem is to combine syndicated loan-level data with the shock to reserves in the banking system under the FDIC rule. The granularity of our dataset at the loan level, allows for the inclusion of firm-year fixed effects (among others), which insulate our model from unobserved demand-side characteristics affecting bank lending (and leaving the remainder effects to be supply-side). In addition, the multi-level information on a loan tranche issued by many banks creates heterogeneity in the effect of a *change* in reserves on the loan amount even for the same loan, because we observe how the multiple banks involved in a loan syndicate decide on the amount of a single loan based on the interaction of their own changes in reserves and the implementation of a QE program.

In addressing the challenge of discerning exogenous factors influencing quarterly variation in bank reserves, our study employs a unique regulatory shift initiated by the FDIC in April 2011. This regulatory change, a response to the Dodd-Frank mandate, altered the assessment base for insurance charges on banks, expanding it to include reserves. The FDIC proposal was first announced on November 2010, a few weeks prior to the start of QE2. Importantly, the change unexpectedly allowed bankers' banks and banks with a large custodial business, including systemically important ones like Bank of America Merrill Lynch, to exclude reserves from their assessment base, subject to a maximum cap. We note that since October 2008 the Federal Reserve pays a uniform interest rate on reserves (IOR) to all banks. We argue that heterogeneity in the cost of holding reserves, due to the FDIC regulation change, generates meaningful differences in the net return from reserves between assessed and exempted banks.

Before the public announcement of the FDIC proposal, there was optimism among market participants that all banks might be able to exclude reserve holdings at the Fed from their assessment base (Smedley, 2010; Kreicher et al., 2013). Contrary to these expectations, exemptions were only granted to specific banks, leaving the majority to be assessed. Our analysis focuses on the pre-announcement phase to mitigate the risk of anticipatory actions by banks, capturing their behavior under the assumption of a status quo rather than reacting to expected policy changes. Using hand-collected data, we measure each bank's exemption share (ratio of excludable assets over equity) as of 2010q2, preceding the FDIC proposal.

Following the regulatory change, banks with exemptions faced a smaller (or no) decline in the net return of reserves. In contrast, assessed banks had a clear incentive to hold fewer reserves and increase their lending. Phrased differently, the unexpected nature of the FDIC's decision to exempt some banks creates a semi-natural experiment on reserves accumulation and, by extension, bank lending. Importantly, we demonstrate that the magnitude of the change in the assessment base and the impact of the exemptions are substantial enough to affect changes in bank behavior. The average (annualized) combined benefit from IOR interest and the exemptions is 22% of the bank's net income at 2011, with meaningful variation across banks. Thus, our main empirical analysis entails a triple interaction term, comparing the effect of changes in bank reserves on the loan amount, during (and outside) QE periods, allowing for differences based on the degree of exemption enjoyed by each bank.

Summarizing the main findings, we first show that, after the initiation of each QE program, there is a positive effect of a bank's changes in reserves on the amount contributed to a syndicated loan. This result is consistent with an operational risk-taking channel and also robust to several tests to rule out alternative explanations. Most important for our goals, using the interaction between the second and third QE programs and the FDIC exemption rule, we find that the positive effect of QE2 (2010q4–2011q2) is significantly weaker for banks with larger exemption shares (banks that enjoy a higher net return on reserves). Exploiting the pre-regulation period as a placebo test, we confirm that banks' exemptions from the FDIC rule did not affect the link between reserves and lending during QE1 (2008q4–2010q1), when these exemptions had no bearing on the net return of reserves. The same holds for QE3 (2012q3–2014q4), when the opportunity cost of holding reserves was substantially higher, due to an improved economic environment that generated better lending opportunities. These results are robust to the use of (i) different loan-level outcome variables reflecting risk (e.g., the shares of the lead arranger and firm ratings), (ii) different mix of fixed effects, and (iii) several other robustness tests.

The last stage of our empirical analysis examines whether our results on corporate bank lending have real firm outcomes. Formally, we use the predicted values from the lending equations for each QE period in firm leverage, growth, and profitability equations. Consistent with our main results, we find that predicted lending negatively and significantly affects leverage, growth, and return on assets of affected borrowing firms following the regulatory policy (in the QE2 program). The results are exactly the opposite in the QE3 program, when banks had renewed incentives to increase lending.

Our paper contributes to three strands of literature. First, a growing body of work aims to identify the transmission mechanism of unconventional monetary policy via the risk-taking channel. Most of these studies analyze the effects of ultra-low, or negative, nominal rates and/or QE and emergency lending facilities on financial markets (Gagnon et al., 2011; D'Amico et al., 2012), bank lending (Drechsler et al., 2016; Rodnyansky and Darmouni, 2017; Chakraborty et al., 2020), and risk-taking (Jiménez et al., 2014; Paligorova and Santos, 2017; Morais et al., 2019).

A part of this literature focuses on reserves accumulation as the measure of bank-level exposure to QE and thus is more closely associated with our study (Bianchi and Bigio, 2017; Kandrac and Schlusche, 2021; Christensen and Krogstrup, 2019). Kandrac and Schlusche (2021) use the FDIC regulation change as an instrument to identify the effect of increased reserves on bank lending during QE. They employ aggregate Call Report data and cross-sectional analysis, covering the QE2 and QE3 programs, and find that reserve creation is associated with higher loan growth.³ The contribution that we offer to this strand of literature is twofold. First, we focus on whether the FDIC regulatory change counteracts the expansionary effect of unconventional monetary policy by differentially changing the net returns on holding reserves across banks. To the best of our knowledge, the mitigating role of regulation on the link between reserves' changes during QE and bank lending behavior has not been examined in the literature. Second, we highlight the real effects of the counteraction. Specifically, we find important implications for firms' leverage, growth, and return on assets. Again, these implications for real outcomes originate in the combined effect of unconventional monetary policy and reserves regulation.

Second, our analysis connects to the scant literature that examines the interaction between monetary policy and regulation. Existing studies focus on the role of macro-prudential policies in dealing with the financial stability consequences of protracted periods of low interest rates and QE (Carboni et al., 2013; Woodford, 2016; Kashyap and Siebert, 2020), with marginal analysis of the risk-taking channel. We focus on the extent to which a reserves-related policy affects the potency of the risk-taking channel. An interrelated issue on this novel element of our work is that both the regulatory and monetary policies affect a single variable, namely the availability of reserves.

A third related strand of the literature concerns the impact of liquidity regulation, such as the Liquidity Coverage Ratio (LCR) requirement, on bank behavior. The LCR requires that banks hold sufficient quantities of high-quality liquid assets, including cash, reserves at the Fed and Treasuries, as a buffer against expected net cash outflows for a 30-day stress scenario.⁴ Previous studies have examined theoretically and empirically the effect of the LCR and show that it is associated with increased holdings of high-quality liquid assets at the expense of lending (Sundaresan and Xiao, 2018; Rezende et al., 2021; Raz et al., 2022; Roberts et al., 2023). Our work links with this strand of the literature since we show that regulatory requirements affect bank behavior from the viewpoint of incentives to hold on to reserves vs. new lending.

2. Data and empirical model

2.1. Data

We draw data from three sources, namely Thomson Reuters LPC Dealscan, Call Reports from the FFIEC, and Compustat. We mostly use the period 2011q1–2016q2, which encompasses the regulatory initiative by the FDIC in April 2011. To incorporate some further counterfactuals, we expand our sample beginning date to 2007q1.

We begin with a brief description of the syndicated loan market, as this market has been extensively analyzed by several studies (e.g., Sufi, 2007; Delis et al., 2017). Syndicated loans are granted by a group of banks to a single borrower. The borrowing firm signs a loan agreement with the lead arranger and specifies the loan characteristics (collateral, loan amount, covenant, a range for the interest rate, etc.). The lenders of the syndicate fall into three groups, namely, the lead arranger or co-leads, the co-agents, and the participant lenders. The first group consists of senior syndicate members and is led by one or more lenders, typically acting as mandated arrangers, arrangers, lead managers or agents. Lead arrangers coordinate the documentation process and receive a fee from the borrower for arranging and managing the syndicated loan.

We gather information for syndicated loan deals from DealScan. We have detailed information on a deal's characteristics (amount, maturity, collateral, borrowing spread, performance pricing provisions, etc.), as well as a description of the members of the syndicate,

³ With respect to Kandrac and Schlusche (2021), our methodological approach is quite different. Instead of relying on cross-sectional bank-level analysis, we employ a panel estimation approach with granular loan-level data that includes lending volumes and other key loan characteristics. This approach allows for a better identification of loan demand vs. loan supply effects using appropriate fixed effects specifications.

⁴ The LCR was introduced in January 2013 as part of the Basel III regulatory framework. The final rule was published at the end of 2014, with implementation date January 1, 2015. Requirements depend on bank size; small banks (less than \$10bn assets) do not have to conform to the LCR, while large banks (more than \$250bn assets) face the tightest requirements.

the lead bank, the share of each bank in the syndicate, and the firm that receives the loan.⁵ We identify loans as credit lines and term loans A, B, C, D, and E, and exclude term loans B because banks hold none of these loans after the syndication. Term loans B are structured specifically for institutional investors and almost entirely sold off in the secondary market. Also, following Roberts (2015), we drop loans that are likely to be amendments to existing loans and do not necessarily involve new funds because these are misreported in DealScan.

To supplement the bank-level information in DealScan, we match these data with the Call Reports. We hand-match DealScan's lender ID with the bank's RSSD ID in the Call Reports to obtain a consistent identifier for each bank. Because the Call Reports are quarterly, we match the information on the origination date of the loan deal to the same quarter. In a similar fashion, we match the loan-level data in DealScan to borrower-level data in Compustat using the link provided by Chava and Roberts (2008). We exclude firms headquartered outside the U.S. that received cross-border lending in the U.S. syndicated market.

The matching process yields a maximum of 26,482 observations between 2011q1 and 2016q2, with 5163 loans originated by 200 banks to 1575 non-financial firms. This sample is a so-called 'multi-level' data set, which has observations on (lower level) banks and firms and (higher level) loan deals. This feature of the data aids in the identification of shifts in loan supply. Table TO.1 in the online Appendix defines all variables used in the empirical analysis and Table 1 reports summary statistics. The statistics are fully consistent with the extant literature.

2.2. Identification strategy

Our empirical approach allows us to address the potential endogeneity of reserves and, at the same time, provides insights into the interaction between monetary and regulatory policies. To this end, we use the following specification:

$$\begin{aligned}
 Y_{l,f,b,t} = & \sum_{j=2}^3 \kappa_j \cdot QE_j + \delta_0 \cdot \left[\frac{\Delta(Reserves)}{Assets} \right]_{b,t} + \delta_1 \cdot Exempted_b \\
 & + \rho_1 \cdot \left[\frac{\Delta(Reserves)}{Assets} \right]_{b,t} \cdot Exempted_b \\
 & + \sum_{j=2}^3 \rho_j \cdot QE_j \cdot Exempted_b \\
 & + \sum_{j=2}^3 \gamma_j \cdot QE_j \cdot \left[\frac{\Delta(Reserves)}{Assets} \right]_{b,t} \\
 & + \sum_{j=2}^3 \lambda_j \cdot QE_j \cdot \left[\frac{\Delta(Reserves)}{Assets} \right]_{b,t} \cdot Exempted_b \\
 & + \Phi_{f,b,t} + \beta'_1 L_{l,t} + \beta'_2 F_{f,t-1} + \beta'_3 B_{b,t-1} + \epsilon_{l,f,b,t},
 \end{aligned} \tag{1}$$

where $Y_{l,f,b,t}$ represents the natural logarithm for the loan amount l that firm f borrowed from bank b at time t , and $QE_j \cdot \left[\frac{\Delta(Reserves)}{Assets} \right]_{b,t}$ denotes the quarterly changes in reserves relative to assets during one of the $j \in \{2, 3\}$ QE episodes. The exemption share variable ($Exempted_b$) is constructed for each bank by dividing its excludable assets by the bank's equity (please see later discussion in this section for more institutional details).

L , F , and B are vectors of loan, firm, and bank characteristics. $\Phi_{f,b,t}$ denotes different levels of fixed effects described below, and $\epsilon_{l,f,b,t}$ is the stochastic disturbance. In the vector L , we use loan maturity; a dummy variable that indicates if a firm has borrowed from a lender in the last five years; and a series of dummy variables describing loan-quality characteristics, including whether the loan is secured and if the loan is a term loan. For bank-level control variables, we include bank specialization (sectoral exposure within the bank's syndicated loan portfolio) and the natural logarithm of total assets as a proxy for bank size. At the firm level, we control for the natural logarithm of total assets; the natural logarithm of market-to-book (Tobin's Q); and the ratio of net income to total assets (ROA), as a measure of profitability (Adams and Ferreira, 2009).

Recovering the causal effect of reserve changes in Eq. (1) faces several identification challenges. The first involves separating loan supply from loan demand. The consensus in the extant literature is to use a mix of fixed effects and models with interaction terms to tackle this problem. On the one hand, the interaction term of a supply-side variable (reserves) with the QE dummies implies that the response is predominantly supply-driven (Kashyap and Stein, 2000). On the other hand, focusing on loan-level data allows including important firm, bank, and loan controls, as well as granular fixed effects to account for many levels of unobserved

⁵ We apply two sample filters to achieve a more uniform sample. This is an essential part of the sample selection process that is absent from most empirical studies using the DealScan database (e.g., Lim et al., 2014). First, we separate banks from non-banks. We consider a loan facility to have a non-bank institutional investor if at least one institutional investor that is neither a commercial nor an investment bank is involved in the lending syndicate. Non-bank institutions include hedge funds, private equity funds, mutual funds, pension funds and endowments, insurance companies, and finance companies. To identify commercial bank lenders, we start with lenders whose type in DealScan is *US Bank*, *African Bank*, *Asian-Pacific Bank*, *Foreign Bank*, *Eastern Europe/Russian Bank*, *Middle Eastern Bank*, *Western European Bank*, or *Thrift/S&L*. We manually exclude the observations that are classified as a bank by DealScan but actually are not, such as the General Motors Acceptance Corporation (GMAC) Commercial Finance, which did not become a bank holding company until December 2008. Second, we exclude loans granted to utilities or to financial companies.

heterogeneity (e.g., Jiménez et al., 2014). Specifically, the inclusion of firm * year fixed effects insulates our specification from time-varying demand side omitted factors that can affect bank lending (and leaving the remainder effect to the supply side).

A second challenge is to identify an exogenous source of variation in quarterly changes in reserves. It is possible that banks with a higher propensity to accumulate reserves are better able to grant large corporate loans during QE for reasons unrelated to QE-driven reserve accumulation. Moreover, bank regulations themselves are usually a response to problems identified in the banking sector, seeking solutions for the ultimate goal of financial stability. To this end, we utilize an exogenous shift by the FDIC regulator, which differentially affected the net return on holding reserves across U.S. banks.

Specifically, in April 2011, the Federal Depositary Insurance Corporation (FDIC) enacted a change in the insurance charges on banks, which helped fund the FDIC's Deposit Insurance Fund (DIF). The change followed the 2010 Dodd-Frank Wall Street Reform and Consumer Protection Act (Dodd-Frank) mandate to alter the assessment base upon which the fee was charged. While banks were previously assessed based on their domestic deposits, the change expanded the assessment base to equal average consolidated total assets minus tangible equity (defined as Tier 1 Capital; FDIC, 2011; Whalen, 2011). Consequently, short-term wholesale funding became part of the assessment base to achieve the policy goal of placing a corrective tax on such funding. The FDIC proposal was first announced on 9 November 2010, a few weeks prior to the start of QE2, with a final rule published on 9 February 2011 and an implementation date of 1 April 2011. As of 2011q2, assessed banks faced an FDIC fee, which is a new cost of maintaining reserve balances at the Fed (Kreicher et al., 2013; Ennis and Wolman, 2015; Kandrac and Schlusche, 2021).

Importantly for our purposes, the regulatory change permitted, quite unexpectedly, some banks to deduct reserve holdings from their assessment base. Specifically, bankers' banks and banks with a large custodial business were permitted to exclude low-risk liquid assets, including reserves, from their assessment base, subject to a maximum cap. In addition, uninsured branches and agencies established after 19 December 1991 were entirely exempt from any FDIC assessment both before and after the change. We should stress that the set of exempted banks includes large systemically important institutions, like Bank of America Merrill Lynch, and Citibank, among others.⁶ The descriptive statistics in Panel B of Table 1 show that exempted banks are larger, hold more reserves and are less well-capitalized, relative to assessed banks.

Reserve exemptions came in three forms. First, for uninsured institutions, reserves are completely exempt from the FDIC assessment. Second, banker's banks can exempt the average amount of reserve balances passed through to the Fed, the average amount of reserve balances held for its own account, and all of its federal funds sold. The banker's bank exemption is subject to a cap that is equal to the sum of the bank's average total deposits of domestic depository institutions plus its average federal funds purchased. Third, custodial banks can exempt all 0% and half of the 20% Basel risk-weighted assets regardless of maturity, subject to a cap equal to the average of the custodial bank's deposits that are identified as being directly linked to a fiduciary or custodial safekeeping account.

Before the FDIC proposal became public in November 2010, market participants hoped that reserve holdings at the Fed might be excluded from the assessment base of *all banks* (Smedley, 2010; Kreicher et al., 2013). Against these expectations, only bankers' banks and banks with custodial business were allowed exemptions, in contrast with the majority of US banks.⁷ Our analysis specifically targets the period before the FDIC's proposal became public in November 2010, to mitigate the risk of anticipatory actions by banks. By concentrating on this pre-announcement phase, we aim to capture the banks' behavior under the assumption of status quo, rather than reactions to expected policy changes. This approach allows for a more accurate assessment of the banks' operational norms and strategies without the confounding influence of their foresight into regulatory shifts. Therefore, any observed shifts in behavior can be attributed more to prevailing market conditions and less to strategic anticipation of the forthcoming policy changes. Moreover, the fact that this policy came just after QE2, potentially affecting reserve creation only after this wave of unconventional monetary expansion, implies an insightful placebo test using QE1.⁸

Based upon reading the FDIC regulation, we scrutinize each banks' asset categories and subsequently we determine the specific assets that receive exemptions and the relevant exemption shares. Following that, we calculate each bank's exemption share as the ratio of excludable assets to its equity. We measure each bank's exemption and equity as of 2010q2 – before the FDIC's proposed rule – to avoid including any anticipatory behavior by banks to maximize their exemption prior to the rule's implementation.⁹ The summary statistics in Table 1 show that the exemption share ranges from 0, for assessed banks, to 1 (100%) for banks that enjoy full exemption. The average exemption share is 34%.

The reserve exemptions described in the final FDIC rule generate cross-sectional variation in banks' costs of holding reserve balances. Banks with reserve balances that are mostly or completely exempt from an FDIC fee enjoy a potential arbitrage given the

⁶ This is evident in Table 2, where we list the bank names and RSSD identifiers of reserves-exempt institutions that operate in the syndicated loan market during that period. Also, in online Appendix Table TO.2, we list the sample size at the bank-quarter level for assessed and exempt banks since 2011q2.

⁷ Bankers' banks exist for servicing small charter banks, some of which are typically their founders. Their principal service is the management of payment balances with other banks, but nowadays they usually provide all banking services. Custodial (or custodian) banks are financial institutions that work as asset safekeepers for all asset holders (in addition to providing all other banking services). For the purpose of calculating FDIC deposit insurance assessments, a banker's bank is defined as in code 12 U.S.C.24, while a custodial bank is defined in terms of total fiduciary and custody and safekeeping assets and revenues (FDIC, 2011). Specifically, we use the reporting forms FFIEC 031 and collect the RCFDK656 and RCFDK659 series to screen for the bankers' and custodial bank status, respectively.

⁸ Kreicher et al. (2013) and Whalen (2011) provide a comprehensive analysis for the FDIC change in the assessment base.

⁹ While uninsured institutions and banker's banks reported sufficient information to calculate the exempt amounts as of 2010q2, the custodial bank exemption cap is unobserved. To overcome this, we predict custodial banks' exemption caps as of 2010 using the results from a post-implementation regression of their reported custodial deposit share on the fiduciary income share, bank fixed effects, and several deposit sub-components including the share of deposits of individuals, governments, foreign banks, and foreign governments.

Table 1
Summary statistics.

	Level	N	Mean	Std	Min	Median	Max
Panel A: Summary statistics							
Loan amount	Loan	26,482	4.242	0.915	0.000	4.175	10.222
Shares	Loan	26,482	0.133	0.123	0.001	0.100	1.000
# of lenders	Loan	26,482	12.661	7.837	1.000	11.000	57.000
New relationship	Loan	26,482	0.862	0.345	0.000	1.000	1.000
Firm rating	Firm	4382	14.311	5.059	1.000	13.000	21.000
QE1	Bank	26,482	0.096	0.294	0.000	0.000	1.000
QE2	Bank	26,482	0.110	0.313	0.000	0.000	1.000
QE3	Bank	26,482	0.263	0.440	0.000	0.000	1.000
$\Delta(\text{Res})/\text{TA}$	Bank	26,482	0.001	0.055	-1.433	0.000	0.516
Exempted	Bank	25,182	0.340	0.690	0.000	0.190	1.000
Relationship lending	Loan	26,482	0.671	0.470	0.000	1.000	1.000
Performance-pricing	Loan	26,482	0.522	0.500	0.000	1.000	1.000
Maturity	Loan	26,482	51.133	16.229	1.000	60.000	180
Secured	Loan	26,482	0.391	0.488	0.000	0.000	1.000
Term	Loan	26,482	0.161	0.367	0.000	0.000	1.000
Firm size	Firm	26,482	8.342	1.473	4.012	8.258	13.569
Leverage ratio	Firm	25,680	0.303	0.194	0.000	0.283	2.028
Tobin's q	Firm	26,482	1.878	0.878	0.445	1.683	8.929
ROA	Firm	26,482	0.035	0.110	-4.844	0.042	1.336
Bank specialization	Bank	26,482	5.029	7.007	0.002	2.905	100
Bank size	Bank	26,348	19.394	1.757	9.407	19.389	21.463
MBS	Bank	18,227	0.040	0.069	0.000	0.001	0.519
Panel B: Summary statistics by groups							
		Assessed banks (A)		Exempted banks (B)		Difference (B)-(A)	
	Level	N	Mean	N	Mean	Mean	T-test
Bank size	Bank	3135	17.618	12,018	20.124	2.506	***
Reserves	Bank	2552	14.72	12,054	16.94	2.22	***
Tier1/TA	Bank	1546	0.139	7464	0.083	-0.056	***

Panel A reports summary statistics for the variables used in analysis. Panel B reports summary statistics for assessed and exempted banks. The variables are defined in the online Appendix Table TO.1.

Fed's 25 basis points (bp) remuneration on such balances. Conversely, banks that face higher costs of holding reserve balances would see greater compression in their net interest margin from an additional dollar of reserves, and might desire an asset mix tilted to higher-yielding non-reserve assets. In this way, banks with larger (smaller) exemption amounts could pursue fewer (more) lending opportunities on the margin. Observing such behavior helps identify a mechanism by which reserves affect loan supply, whereas the unexpected nature of the dichotomy creates an ideal setting to study the interplay between the QE-led reserves expansion and associated regulations on these reserves.

The key contribution of our paper relies on the differential net return in holding reserves that may influence lending and risk-taking by banks. To support our proposed mechanism, in Table 2 we analyze the magnitude of the FDIC assessment base change and the related exemptions. Panel A shows the FDIC assessment base, exempted amounts and reserves in two quarters: before the regulation change (2010q2; assessment based on domestic deposits) and after the change (2011q2; assessment based on assets minus equity). Panel A highlights that the FDIC shift is associated with a large increase in the assessment base. The average \$ rise in the assessment base for the twenty exempted banks in our sample is \$181bn, corresponding to percentage change of 156% (see Panel B), with substantial variation across banks.¹⁰ For example, the JP Morgan's assessment base increased from \$633bn in 2010q2 to \$1681bn in 2010q2 (a rise of 165%), while the Union Bank's base increased by \$14bn (a rise of 22%). Importantly, the FDIC change coincided with a rise in reserves for most of our sample banks, due to QE2, expanding the assessment base in a heterogeneous manner across banks, depending on their exemption status. Following up with the previous example, JP Morgan's reserves recorded an almost twenty-fold increase between 2010q2 (\$7.5bn) and 2011q2 (\$140.2bn), whereas Union Bank's reserves recorded a small decline. Thus, given the major rise in the assessment base, and the associated higher insurance premiums, the allowance of exemptions is crucial.

To get an insight on the economic magnitude of the exemptions, in Panel B we calculate the ratio of exempted amounts over assets minus equity at 2011q2. Overall, the average exempted amount as a percentage of the assessment base is 8%. The ratio varies significantly across banks, with the largest value in State Street Bank (43%) and smallest value in Huntington National Bank (0.2%). To quantify the impact of exemptions, we calculate for each exempted bank the IOR revenue from reserves and the benefit from the FDIC exemption (exemption premium). The former is equal to the product of the IOR (25 bp) with the bank's reserves, with an

¹⁰ These findings are in line with Whalen (2011) who analyzes the top-ten U.S. commercial banks and also points out that the FDIC change is associated with large increases in the assessment base.

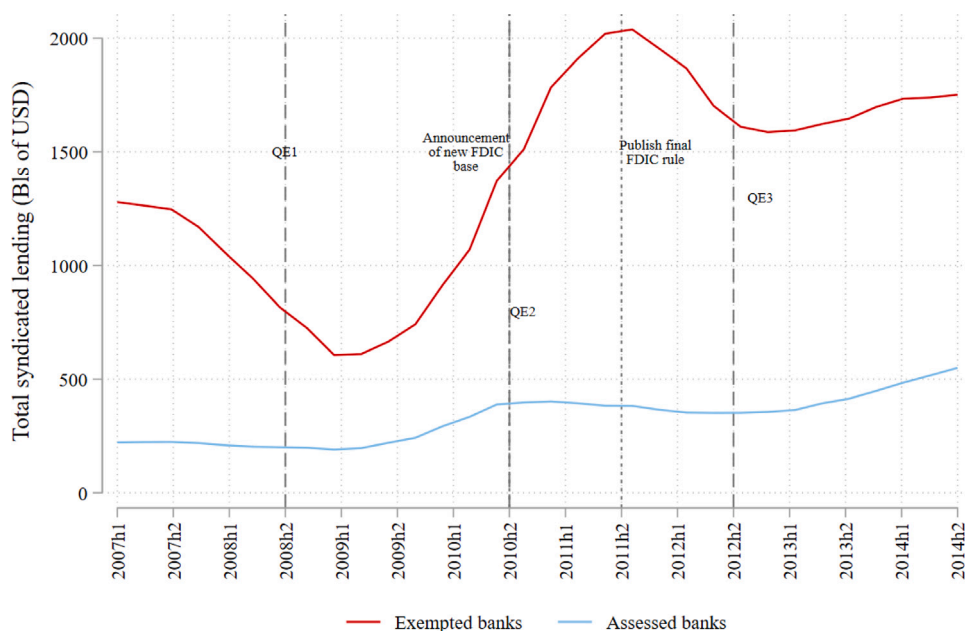


Fig. 1. Lending over time.

Note: This figure displays the syndicated lending activity from 2007h1 to 2014h2. Loan volumes are shown in \$bn, and significant related events are highlighted on the timeline: QE1 to QE3, the announcement of the FDIC rule coinciding with QE2, and the publication of the final FDIC rule. A bank is defined as exempted if reserves were partially exempted from the FDIC rule.

(annualized) average value for 2011 of \$0.25bn (see Panel B).¹¹ The latter (exemption premium) is the product of the assessment rate with the exemption amount. The exemption premium provides an estimate of the additional income that banks generate due to the exemptions. Note that, as Kreicher et al. (2013) point out, the actual assessment rates used by the FDIC are proprietary and not easy to ascertain, especially for large and highly complex banks. Hence, we assume an assessment rate of 20 bp for all banks, a figure in the average risk category II range in the FDIC schedule (prior to adjustments; Kreicher et al., 2013).¹² To arrive at an estimate of the importance of exemptions for the bank's income, we add up the IOR revenue and the exemption premium, and scale by the bank's net income. The average (annualized) figure is 22%, with meaningful variation across banks. In sum, Table 2 provides evidence that the magnitude of the change in the assessment base and the impact of the exemptions are substantive enough to trigger changes in bank behavior.

To gain understanding on the lending behavior of assessed vs. exempted banks, Fig. 1 reports the time path of syndicated loan volumes for these two groups. Overall, lending activity in the syndicated market is primarily driven by the exempted banks. There are parallel trends before the eruption of the 2007–2008 financial crisis. We find a break in parallel trends following the onset of the crisis before the QE1. This is intuitive, as the exempted banks were the ones mostly affected by the crisis since they were heavily involved in complex financial products. Consequently, they significantly reduced new loan origination in the syndicated market (Ivashina and Scharfstein, 2010). Following the start of QE1, lending activity for exempted banks increased significantly. However, the publication of the final FDIC rule in early 2011 is associated with a decrease in syndicated lending, which is consistent with our conjecture. Specifically, we argued that the lending volumes should be attenuated for exempted banks because of the higher relative compensation on reserve balances.¹³ Finally, it appears that QE3 restores the parallel trends.

3. Empirical results

3.1. Bank lending

Table 3 reports the results from estimating Eq. (1). Importantly, and as discussed in Section 2.2, we include firm * year fixed effects as a key remedy against demand-side explanations of our findings (along with the interaction of QE with reserves).

¹¹ The IOR is steady at 25 bp throughout our sample, with the exemption of the last two quarters (2016q1 and q2), when it rises to 50 bp. Hence, changes in banks' revenues from holding reserves almost exclusively reflect changes in bank-level reserves.

¹² The rate applied by the FDIC on the assessment base depends on the bank's riskiness, as summarized by its CAMELS rating, as well as on whether the bank is large and highly complex, with further adjustments according to the bank's long-term unsecured debt and brokered deposits (Whalen, 2011).

¹³ Such a pattern is also consistent with the evidence in Fuster et al. (2021) who demonstrate that the desired reserve position of individual banks depends importantly on the cost of those reserves and that, if anything, banks with lower costs of holding reserves are more restrictive in their lending policies and take less risk.

Table 2

Economic magnitude of FDIC assessment base change and related exemptions.

Panel A: FDIC assessment base, exemptions and reserves (\$bn)							
Exempted bank name	RSSD ID	2010q2			2011q2		
		Domestic deposits	Exempted amount	Reserves	Assets–equity	Exempted amount	Reserves
Bank of America Merrill Lynch	480228	828.9	32.5	116.9	1281.7	43.5	48.3
Bank of New York Mellon	541101	67.7	44.2	13.9	238.3	64.6	50.3
BMO Harris Bank NA	75633	30.0	0.6	10.2	83.3	1.1	16.8
Citibank NA	476810	254.5	41.4	64.5	1136.9	45.6	73.1
Comerica Bank NA	60143	38.9	0.5	3.3	54.0	1.0	2.4
Deutsche Bank Trust Co Americas	214807	13.7	9.0	8.5	42.8	9.9	20.6
Fifth Third Bank	723112	78.8	2.4	4.0	99.3	2.8	1.1
HSBC Bank USA NA	413208	92.0	1.2	9.0	186.5	1.3	22.5
Huntington National Bank	12311	39.5	0.1	0.4	50.1	0.1	0.3
JP Morgan Chase Bank NA	852218	633.1	51.8	7.5	1680.9	63.6	140.2
Key Bank NA	280110	61.8	1.4	1.4	76.1	0.4	4.0
Manufacturers & Traders Trust Co	501105	46.9	1.1	0.1	67.2	1.1	2.1
Northern Trust Co	210434	12.7	20.5	9.7	92.9	28.7	15.1
PNC Bank NA	817824	177.3	1.3	4.1	231.7	1.2	4.1
State Street Bank & Trust Co	35301	22.0	56.1	10.2	193.8	83.0	21.4
SunTrust Bank	675332	118.8	2.3	1.8	150.8	2.0	3.7
UMB Bank NA	936855	7.2	1.0	0.4	10.4	1.0	4.6
Union Bank NA	212465	64.4	2.3	2.9	78.5	3.9	2.5
US Bank National Association	504713	169.2	6.0	0.1	297.7	5.7	10.3
Wells Fargo Bank NA	451965	719.2	23.7	51.5	1038.1	20.9	61.3
Average		173.8	15.0	16.0	354.5	19.1	25.2
Panel B: Change in assessment base and exemption premium							
		Δ\$bn (assessment base)	Δ% (assessment base)	Exempted amount % of assets–equity	IOR revenue (\$bn)	Exemption premium (\$bn)	IOR + Exemption premium % of net income
Bank of America Merrill Lynch	480228	452.7	54.62%	3.39%	0.48	0.35	8.61%
Bank of New York Mellon	541101	170.6	251.94%	27.11%	0.50	0.52	61.34%
BMO Harris Bank NA	75633	53.3	177.68%	1.38%	0.17	0.01	49.64%
Citibank NA	476810	882.4	346.66%	4.01%	0.73	0.36	10.34%
Comerica Bank NA	60143	15.1	38.76%	1.77%	0.02	0.01	6.72%
Deutsche Bank Trust Co Americas	214807	29.1	212.96%	23.21%	0.21	0.08	44.09%
Fifth Third Bank	723112	20.4	25.92%	2.79%	0.01	0.02	2.44%
HSBC Bank USA NA	413208	94.5	102.79%	0.71%	0.23	0.01	21.30%
Huntington National Bank	12311	10.6	26.87%	0.20%	0.00	0.00	0.68%
JP Morgan Chase Bank NA	852218	1047.8	165.49%	3.78%	1.40	0.51	15.33%
Key Bank NA	280110	14.3	23.06%	0.50%	0.04	0.00	4.38%
Manufacturers & Traders Trust Co	501105	20.2	43.14%	1.63%	0.02	0.01	3.13%
Northern Trust Co	210434	80.3	633.51%	30.88%	0.15	0.23	66.67%
PNC Bank NA	817824	54.3	30.63%	0.51%	0.04	0.01	1.78%
State Street Bank & Trust Co	35301	171.8	779.13%	42.83%	0.21	0.66	49.53%
SunTrust Bank	675332	31.9	26.89%	1.31%	0.04	0.02	7.83%
UMB Bank NA	936855	3.3	45.47%	9.89%	0.05	0.01	70.59%
Union Bank NA	212465	14.1	21.85%	4.99%	0.03	0.03	7.21%
US Bank National Association	504713	128.6	76.01%	1.90%	0.10	0.05	3.19%
Wells Fargo Bank NA	451965	318.9	44.34%	2.01%	0.61	0.17	5.85%
Average		180.7	156.39%	8.24%	0.25	0.15	22.03%

This table reports the list of bank names and id (Call Reports: RSSD9001) that are reserve-exempted institutions with participation in the syndicated loan market after the announcement of the new FDIC deposit scheme assessment. A bank is defined as exempted if reserves were partially exempted from the FDIC rule. Panel A shows the FDIC assessment base, exempted amounts and reserves in two quarters: before the regulation change (2010q2; assessment based on domestic deposits) and after the change (2011q2; assessment based on assets minus equity). Panel B shows the change in the assessment base (in \$bn and percentage rate) between 2010q2–2011q2, the exempted amounts as share of assets minus equity at 2011q2, the annualized 2011 IOR revenue (4 * IOR rate of 25 bp * reserves of 2011q2), the annualized 2011 exemption premium (4 * assumed assessment rate of 20 bp * exempted amounts of 2011q2) and the sum of the annualized 2011 IOR revenue and exemption premium as percentage of the bank net income for 2011.

Our first focus is on the double interaction term $QE_j * \left[\frac{\Delta(Reserves)}{Assets} \right]_{b,t}$, which estimates the effect of reserve accumulation on syndicated loan volume during QE episodes. This approach to measuring banks' exposure to QE is an important feature of our study. While prior work has focused on banks' asset portfolios and the relationship with the types of assets purchased by the central

Table 3
The impact of reserves on lending.

Group	I	II	III	IV
	Baseline	Excludable assets Assets-equity	Only exempted banks	Including QE1
$\Delta(\text{RES})/\text{TA}$	−0.604*** (−12.604)	−0.597*** (−12.559)	−0.118 (−0.285)	−0.558*** (−8.363)
Exempted	−0.084*** (−8.614)	−0.099*** (−8.492)	−0.098*** (−8.321)	−0.088*** (−11.206)
$\Delta(\text{RES})/\text{TA} * \text{Exempted}$	0.099 (0.828)	0.122 (0.888)	−0.079 (−0.384)	0.092 (0.787)
QE1 * Exempted				0.010 (0.543)
QE1 * $\Delta(\text{RES})/\text{TA}$				0.952*** (3.914)
QE1 * $\Delta(\text{RES})/\text{TA} * \text{Exempted}$				−0.030 (−0.116)
QE2 * Exempted	0.027 (1.153)	0.039 (1.371)	0.029 (0.978)	−0.005 (−0.291)
QE2 * $\Delta(\text{RES})/\text{TA}$	2.274*** (8.748)	2.256*** (8.641)	0.116 (0.094)	1.797*** (8.282)
QE2 * $\Delta(\text{RES})/\text{TA} * \text{Exempted}$	−0.723*** (−2.609)	−0.777** (−2.403)	0.156 (0.292)	−0.562** (−1.998)
QE3 * Exempted	−0.012 (−0.900)	−0.014 (−0.939)	−0.014 (−0.831)	−0.010 (−0.863)
QE3 * $\Delta(\text{RES})/\text{TA}$	0.682* (1.893)	0.628* (1.696)	0.725 (1.169)	0.916** (2.439)
QE3 * $\Delta(\text{RES})/\text{TA} * \text{Exempted}$	0.288 (0.749)	0.276 (0.683)	0.179 (0.381)	0.244 (0.635)
QE control variables	Y	Y	Y	Y
Loan control variables	Y	Y	Y	Y
Bank control variables	Y	Y	Y	Y
Observations	14,662	14,662	11,829	25,052
Adjusted R-squared	0.769	0.769	0.777	0.789
Loan type FE	Y	Y	Y	Y
Purpose FE	Y	Y	Y	Y
Firm*Year FE	Y	Y	Y	Y
Clustered standard errors	Firm	Firm	Firm	Firm

The table reports coefficients and *t*-statistics (in parenthesis). The dependent variable is the log of the loan amount held by each lender. The sample consists of loan (bank-firm) observations from 2011q1 to 2016q2, except column IV where we include QE1 (for a placebo test) and the sample consists of loan observations from 2007q1 to 2016q2. The loan controls include *relationship dummy*, *performance pricing provisions*, *loan maturity*, *secured* and *term*. The bank controls include *bank specialization* and *bank size*. All variables are defined in the online Appendix Table TO.1. All specifications include fixed effects, as noted in the lower part of the table, to control for different levels of unobserved heterogeneity. Standard errors are robust and clustered at the firm level. The *, **, *** marks denote the statistical significance at the 10, 5, and 1% level, respectively.

bank (Rodnyansky and Darmouni, 2017; Chakraborty et al., 2020), we identify the banks' exposure to the *liabilities* created by the central bank to purchase those assets. A key difference in these approaches to measuring bank-level QE exposure is that only banks can hold the reserves created by QE. By contrast, the ultimate sellers of the securities purchased by the Fed can come from disparate sectors (Carpenter et al., 2015).

Overall, our findings point to a positive and statistically significant impact of changes in reserves on the loan amounts during QE2 and QE3. The estimates of the impact of reserves are economically meaningful, albeit larger in magnitude and significance in QE2. According to the baseline specification in Table 3, and taking marginal effects with respect to the double term, one standard deviation increase in reserves relative to assets (5.2%) during QE2 is associated with an increase in the loan amount by 13.32%. This implies that our empirical results point to a significant risk-taking channel of unconventional monetary policy operating via bank reserves.

The important and most novel goal of our study is to examine the joint effect of monetary and regulatory policies on the risk-taking channel. Thus, our second and main focus is on the triple interaction. According to our theoretical conjecture, If banks with larger exemptions favor reserves more than banks with lower exemptions because of the higher net return, the effect of reserve accumulation on lending should be smaller, yielding a negative parameter estimate on the added triple interaction term. In other words, the lending volumes for corporate loans will be attenuated for bankers' banks and banks with a custodial business during QE because of the higher compensation on reserve balances. In the baseline specification, the coefficient of the triple interaction is only significant for QE2. The negative sign suggests that, consistent with our theoretical considerations, the positive effect of QE2 on bank lending via reserves (the double interaction term) is mitigated by the introduction of the FDIC rule for banks with larger exemption shares (the triple interaction term). We find that this mitigation is economically meaningful considering the total effects:

one std increase in reserves relative to assets during QE2 for a bank with an average exemption share (34%) is associated with an increase in the loan amount by 6.06%, a magnitude notably smaller compared to the overall effect for QE2 (13.32%).

Column II of Table 3 replicates the baseline specification, refining the definition of the exempted banks by dividing the excludable assets by total assets minus equity. The rationale for this change is to confirm that the effect in the baseline specification is driven by the reserve accumulation and not by a mechanical increase in banks' assets (net of equity). The consistency of our results under this change substantiates the role of reserve exemptions in driving the observed effect for the exempted banks.

Column III includes only the banks that were exempted from the FDIC assessment base rule. By doing so, we can assess whether the rule exemption itself is generating a heterogeneous behavior among the exempted banks. Our findings suggest that the estimated effects in our baseline specification are indeed driven by the differential effect of reserves held by the exempted and assessed banks, not within exempted banks. In column IV, we use the pre-regulation period (QE1) as an additional placebo test. The coefficient estimate on the triple interaction term for the QE1 exhibits no statistical significance and a magnitude that is far smaller than that for QE2. This placebo test shows that exemption amounts did not explain any differences in banks' reactions to QE through the reserves channel when these exemptions had no bearing on the net return on reserves. Evidently, bank characteristics that may correlate with the exemption amounts cannot explain the behavior observed after the FDIC fee was changed when the exemption amounts had a direct impact on the net cost of reserves.

The empirical results in Table 3 are in line with the graphical evidence in Fig. 1 since they highlight the significant (insignificant) bank lending impact of the interaction between QE2 (QE3) and the FDIC regulatory shift. These findings are in line with our conceptual framework that links the net income from holding reserves with the opportunity cost of doing so. The key difference between QE2 and QE3 concerns changes in the opportunity cost of holding reserves, that is, the potential income from lending and other investment activities. In particular, the opportunity cost of holding reserves is significantly higher at QE3, relative to QE2. Table TO.3 in the Online Appendix provide supporting evidence for this argument. First, the macroeconomic environment was in better shape in the run-up to QE3, and also further improved substantially during it, thereby implying better lending opportunities for banks. For example, the Economic Policy Uncertainty (EPU) measure of Baker et al. (2016) was lower in the six months preceding QE3, when compared to QE2, and decreased by 38% during it, a decline of almost double magnitude relative to QE2 (21% decline). Beyond the EPU, other key economic and financial indicators, such as the value of the stock market, consumer sentiment and unemployment also display similar patterns, in line with better conditions at QE3.

Second, the foregone interest income from not participating in the syndicated loan market was substantially higher during QE3, relative to QE2. Figure FO.1 in the Online Appendix calculates the syndicated interest income from 2010q1 to 2014q3, as the product of the loan volumes with the loan interest spread (AISD) per quarter. It is evident that the interest income from lending is significantly larger at QE3, highlighting a different regime. Thus, given the higher opportunity cost of holding reserves, there was a stronger impetus for banks to search for higher yield activities during QE3. This impetus counteracted the regulation-induced incentive of exempted banks to hold reserves and helps to explain the insignificant role of exemptions at QE3.

In Table 4, we examine several characteristics of loan supply as outcome variables, each providing distinct evidence of risk-taking behavior, and some robustness checks on our baseline results. Our emphasis will be mainly around the QE2 episode, which reveals the significant interplay between the monetary and regulatory policies, as shown in Table 3. Columns I to III of Table 4 represent different aspects of risk-taking by banks. In Column I, the positive coefficient on the double interaction term ($QE2 * \Delta(RES)/TA$) for *Shares* implies that during QE2, banks with a larger increase in reserve accumulation held a larger share with an average loan, implying a higher willingness to put 'skin in the game' and concentrate the credit risk exposure for each loan. This trend attenuates with the negative coefficient on the triple interaction term ($QE2 * \Delta(RES)/TA * Exempted$), showing that banks exempted from the FDIC rule held relatively smaller shares of loans post-FDIC. A similar picture arises in column II, where the outcome variable is the average *Number of Lenders* within a syndicate. Conceptually, *Shares* and *Number of Lenders* can be considered as substitutes because as one increases the other decreases. In addition, less transparent firms, which are typically riskier, obtain smaller loans and have a smaller number of lenders within a syndicate (Sufi, 2007). Column II shows that during QE2, the number of lenders (per loan) declines, indicating higher appetite for new risk with the effect being attenuated for exempted firms.

Column III in Table 4 investigates the firm's Standard and Poor's rating. The positive coefficient on the double interaction term suggests that during QE2, banks with more reserves extend more credit to lower-rated, higher risk firms. Overall, all measures (columns I–III) highlight complementary aspects of risk-taking that are attenuated for exempted banks. In column IV, we further support the argument that our baseline results mainly reflect supply-side factors, as opposed to demand-side factors. By applying bank * year fixed effects, we manage to isolate our model from potential supply-side explanations. The lack of statistical significance in this context suggests that our initial results were indeed detecting shifts in bank lending from the supply-side, encapsulated here by the bank * year fixed effects. Finally, in column V, we double cluster our standard errors at the firm and bank level and the results remain in line with our baseline findings, further underpinning the robustness of our conclusions.

Confounding factors. In Table 5, we conduct a number of tests to address some potential confounding factors. In columns I and II, we refine our analysis by focusing exclusively on credit lines and term loans, respectively (although in previous specifications, we control for these differences using loan type fixed effects). These two types of loans have fundamental differences in terms of their structure and usage, and by isolating them, we provide further robustness to our baseline results. In the case of credit lines, these are often regarded as a form of liquidity insurance for businesses. A firm may draw upon its credit line when needed, giving them flexibility in managing its liquidity needs. Hence, an increase in aggregate demand for credit lines could be indicative of a heightened need for liquidity insurance among firms, especially in uncertain economic environments (Ivashina and Scharfstein, 2010). Conversely, term loans are often used for specific, planned expenditures such as funding capital investments or acquisitions.

Table 4
Other supply-side outcome variables, fixed effects, and clustering.

Dependent variable	I	II	III	IV	V
	Shares (%)	# of lenders	Firm rating	Loan amount	Loan amount
$\Delta(\text{RES})/\text{TA}$	−0.055*** (−10.355)	0.477*** (2.713)	−4.654*** (−10.412)	0.056 (0.499)	−0.450** (−2.755)
Exempted	−0.004*** (−3.896)	0.043* (1.714)	0.006 (0.395)		−0.088*** (−8.089)
$\Delta(\text{RES})/\text{TA} * \text{Exempted}$	−0.004 (−0.436)	−0.618* (−1.813)	1.231*** (6.928)	−0.072 (−0.623)	0.123** (2.513)
QE2 * Exempted	0.002 (0.638)	−0.073 (−1.584)	−0.131 (−1.291)	0.003 (0.134)	−0.009 (−0.709)
QE2 * $\Delta(\text{RES})/\text{TA}$	0.259*** (11.588)	−2.935* (−1.944)	4.773* (1.691)	−0.553 (−1.381)	1.670*** (5.337)
QE2 * $\Delta(\text{RES})/\text{TA} * \text{Exempted}$	−0.070*** (−3.131)	2.464*** (3.521)	0.886 (0.609)	0.504 (1.349)	−0.536*** (−5.144)
QE3 * Exempted	−0.000 (−0.248)	0.022 (0.433)	−0.031 (−1.475)	0.043* (1.720)	−0.012 (−0.706)
QE3 * $\Delta(\text{RES})/\text{TA}$	0.078 (1.479)	−0.549 (−0.333)	5.902*** (5.325)	0.391 (0.902)	0.830 (0.911)
QE3 * $\Delta(\text{RES})/\text{TA} * \text{Exempted}$	0.026 (1.016)	0.978 (0.744)	−3.385** (−2.512)	0.519 (1.368)	0.207 (0.324)
QE control variables	Y	Y	Y	Y	Y
Loan control variables	Y	Y	Y	Y	Y
Bank control variables	Y	Y	Y	Y	Y
Observations	14,692	14,692	4142	25,003	25,052
Adjusted R-squared	0.715	0.924	0.975	0.812	0.739
Loan type FE	Y	Y	Y	Y	Y
Purpose FE	Y	Y	Y	Y	Y
Firm*Year FE	Y	Y	Y	Y	Y
Bank*Year FE				Y	
Clustered standard errors	Firm	Firm	Firm	Firm	Firm, Bank

The table reports coefficients and *t*-statistics (in parenthesis). The dependent variable is reported in the second row. The sample consists of loan (bank-firm) observations from 2011q1 to 2016q2. The loan controls include *relationship lending*, *performance pricing*, *loan maturity*, *secured* and *term*. The bank controls include *bank specialization* and *bank size*. All variables are defined in the online Appendix Table TO.1. All specifications include fixed effects, as noted in the lower part of the table, to control for different levels of unobserved heterogeneity. Standard errors in columns I-IV are robust and clustered at the bank level, while in column V are clustered at the firm and bank levels. The *, **, *** marks denote the statistical significance at the 10, 5, and 1% level, respectively.

Unlike credit lines, they are not typically used to manage short-term liquidity needs, but rather to finance long-term projects. Our results show that economically, the negative coefficient on the triple interaction term is significantly larger for term loans.

In column III, we exclude loans originated for leveraged buyouts (LBOs) or mergers and acquisitions (M&As) because these loans can increase the asymmetric information between the bank and the borrowing firm due to the complexity of the transactions (Ivashina and Kovner, 2011). However, the results are not much changed. In column IV, we drop loans in which the lead arranger is one of the largest three U.S. banks (namely J.P. Morgan Chase, Bank of America, and Citigroup) based on the number of deals. This analysis allows us to examine whether results are driven by the efficiency of the largest banks in originating large loan deals, which also tend to hold large reserve balances. Results are similar to the baseline.

Next, we confront the possibility that our results are driven by an alternate channel that works through the banks' holdings of mortgage-backed securities (MBS) (Rodnyansky and Darmouni, 2017). If banks with larger increases in reserves also held more of the MBS purchased in each QE program, alternative channels working through liquidity or mark-to-market and realized gains might explain the results. In column V, we include the natural logarithm of each bank's holdings of MBS prior to each QE programme. Our results are consistent with prior specifications, even though not all QE programmes included MBS purchases. As a further robustness check on the identification strategy, in column VI we interact bank controls with the QE indicators, as in Rodnyansky and Darmouni (2017). This approach helps us to control for differences in bank characteristics, such as size, that might influence lending behavior during QE episodes. Reassuringly, the results are qualitatively and quantitatively similar to our baseline. This suggests that the cost of reserves is the primary driver of the observed lending behavior.¹⁴

¹⁴ In unreported results, available upon request, we conducted a matched-sample analysis. Specifically, we estimate a propensity score to determine the probability of a bank being in the treatment group based on observed characteristics. To do so, we use a logistic regression where the outcome variable is the treatment variable, and the main covariates include the log of bank size, total deposits, and the log of off-balance-sheet items. The propensity score gives us a balanced sample where treated and control units have similar characteristics. Next, we performed the matching sample analysis, where each treated unit was matched with the closest control unit based on the propensity score, within a maximum allowable difference of 0.1. The results remain similar to our baseline.

Table 5

Loan amount regression: Confounding factors.

Group	I	II	III	IV	V	VI
	Only Credit line loans	Only term loans	Exclude LBO and M&A's loans	Exclude Top3 banks	MBS	Interaction of QE with bank controls
$\Delta(\text{RES})/\text{TA}$	−0.559*** (−14.033)	−0.698*** (−5.100)	−0.616*** (−13.124)	−0.578*** (−11.426)	−0.664*** (−12.860)	−0.657*** (−12.574)
Exempted	−0.080*** (−7.298)	−0.096*** (−5.377)	−0.083*** (−8.249)	−0.085*** (−8.554)	−0.091*** (−8.276)	−0.087*** (−7.507)
$\Delta(\text{RES})/\text{TA} * \text{Exempted}$	0.020 (0.140)	0.294 (1.276)	0.046 (0.379)	0.108 (0.907)	0.098 (0.843)	0.092 (0.789)
QE2 * Exempted	0.007 (0.282)	0.111* (1.811)	0.020 (0.819)	0.023 (1.104)	0.014 (0.592)	0.050 (1.562)
QE2 * $\Delta(\text{RES})/\text{TA}$	2.384*** (7.720)	2.523*** (3.507)	2.267*** (8.713)	2.234*** (8.239)	2.290*** (8.341)	2.225*** (8.318)
QE2 * $\Delta(\text{RES})/\text{TA} * \text{Exempted}$	−0.608** (−2.215)	−1.681*** (−2.991)	−0.624** (−2.225)	−0.718*** (−2.647)	−0.523* (−1.811)	−0.835** (−2.574)
QE3 * Exempted	−0.004 (−0.320)	−0.043 (−1.483)	−0.015 (−1.118)	−0.009 (−0.735)	−0.000 (−0.023)	−0.009 (−0.642)
QE3 * $\Delta(\text{RES})/\text{TA}$	0.604 (1.474)	0.520 (0.741)	0.553 (1.514)	0.394 (0.905)	1.379*** (2.975)	1.250*** (2.683)
QE3 * $\Delta(\text{RES})/\text{TA} * \text{Exempted}$	0.189 (0.494)	0.289 (0.384)	0.408 (1.039)	0.354 (0.929)	0.009 (0.023)	0.044 (0.113)
MBS					−0.021** (−2.098)	−0.012 (−1.055)
QE2 * MBS					−0.007 (−0.653)	0.045 (1.380)
QE3 * MBS					0.013 (1.637)	−0.009 (−0.610)
QE2 * Bank size						−0.057* (−1.731)
QE3 * Bank size						0.027 (1.437)
QE2 * Bank specialization						0.010 (0.704)
QE3 * Bank specialization						0.004 (0.644)
QE control variables	Y	Y	Y	Y	Y	Y
Loan control variables	Y	Y	Y	Y	Y	Y
Bank control variables	Y	Y	Y	Y	Y	Y
Observations	10,887	3481	13,835	11,173	13,772	13,772
Adjusted R-squared	0.740	0.745	0.722	0.703	0.717	0.773
Loan type FE	Y	Y	Y	Y	Y	Y
Purpose FE	Y	Y	Y	Y	Y	Y
Firm*Year FE	Y	Y	Y	Y	Y	Y
Clustered standard errors	Firm	Firm	Firm	Firm	Firm	Firm

The table reports coefficients and *t*-statistics (in parentheses). The dependent variable is the log of the loan amount held by each lender. The sample consists of loan (bank-firm) observations from 2011q1 to 2016q2. In columns I and II, we restrict our specifications only to credit line and term loans, respectively. In column III, we exclude loans granted for Leveraged Buyouts (LBOs) or Mergers and Acquisitions (M&As). In column IV, we exclude loans from the top three US banks. In column V, we use the natural logarithm of each bank's holdings of MBS one quarter before each QE round. In column VI, we interact all bank controls with the QE indicators. The loan controls include *relationship dummy*, *performance pricing provisions*, *loan maturity*, *secured*. The bank controls include *bank specialization* and *bank size*. All variables are defined in the online Appendix Table TO.1. All specifications include fixed effects, as noted in the lower part of the table, to control for different levels of unobserved heterogeneity. Standard errors are robust and clustered at the bank level. The *, **, *** marks denote the statistical significance at the 10, 5, and 1% level, respectively.

All in all, our results reveals that reserve growth does not spur as much lending activity when banks earn a higher net return on those reserves. This evidence suggests that search-for-yield incentives can help explain why forced reserve accumulation results in somewhat faster loan growth. Such an interpretation aligns exactly with the results from the September 2020 Federal Reserve Senior Financial Officer Survey, in which banks reported that, “the factor most often cited as the most or second most important driver for potentially taking action to decrease the level or growth of reserve balances was concern over net interest margins”.

3.2. Firm (real) outcomes

The preceding analysis lays the groundwork for asking whether the observed attenuation of credit expansion during QE2, due to the FDIC rule effect on exempted banks' behavior, impacted real economic activity. Essentially, we seek to understand how the combined monetary and regulatory policies affect the following firm outcomes: leverage ratio, size and profitability. To do so, we use the in-sample predicted values of lending from Eq. (1). Specifically, we use the baseline specification of Table 3 to generate the

Table 6

Firm-level outcomes.

Dependent variable	I	II	III	IV	V	VI
Period	Leverage ratio _{<i>t+1</i>}		Firm size _{<i>t+1</i>}		ROA _{<i>t+1</i>}	
	QE2	QE3	QE2	QE3	QE2	QE3
Predicted lending	0.037 (0.721)	0.106*** (4.776)	−0.832** (−2.424)	−0.122 (−0.671)	−0.135** (−2.258)	−0.031 (−1.383)
Observations	273	1463	273	1467	273	1466
Adjusted R-squared	0.005	0.016	0.024	0.027	0.001	0.049
Firm FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Clustered standard errors	Firm	Firm	Firm	Firm	Firm	Firm

The table reports coefficients and *t*-statistics (in parenthesis). We aggregate a sample of U.S. syndicated loans at the firm-year level from 2011 to 2016. The dependent variables are reported in the second line. Predicted lending is the fitted values during QE episodes, using the baseline column of Table 3. In all specifications, we include firm and year fixed effects, as noted in the table's lower part. Standard errors are robust and clustered at the firm level. The *, **, *** marks denote the statistical significance at the 10, 5, and 1% level, respectively.

(partial) predictions for QE2 and QE3. In turn, we aggregate the loan-level data at the firm-year level and estimate the following model:

$$F_{f,t+1} = \alpha_t + \alpha_f + \sum_{j=2}^3 \kappa_j \cdot \hat{L}_{j,f,t} + \epsilon_{f,t}, \quad (2)$$

where firm outcomes F are the leverage ratio, size, and ROA (defined in the online Appendix Table TO.1) for each firm f at year $t+1$, $\hat{L}$ are the predicted lending values for each QE episode and α denotes firm and year fixed effects. We estimate Eq. (2) separately for QE2 and QE3.¹⁵

We report the results in Table 6. Consistent with the evidence in Tables 3 and 4, we find that the mitigation effect of the FDIC rule effect on syndicated lending following QE2 was associated with a deterioration of firm fundamentals. Specifically, we find no additional leverage to firms from QE2. In contrast, during QE3, firms significantly expanded their leverage ratio, consistent with banks seeking more profitable opportunities than holding reserves. From the borrowers' viewpoint, this implies higher leverage ratios to increase return on investment potentially. The results in the rest of the specifications of Table 6 are also consistent with these suggestions. In particular, we find firm size shrinks and ROA declines during the QE2 period, while both variables remain unaffected by lending during the QE3 period.

4. Conclusions

In this paper, we use the syndicated loan market to examine the interplay of a regulatory policy on bank reserves and QE in affecting corporate bank lending. The setting for our analysis is the post-crisis experience, when several rounds of QE generated large changes in aggregate reserves. The FDIC regulation introduced, during the period of the second QE, a fee on reserve balances at the Fed but also exempted important banks from that fee.

We find that the positive effect of QE2 on bank lending is significantly weaker for banks with larger exemption shares, that enjoy a higher net return on holding reserves. Moreover, the mitigation effect was associated with a deterioration of firm fundamentals during QE2. These findings corroborate the unexplored view that (unconventional) monetary policy innovations must be considered in tandem with regulatory innovations when examining the potency of the risk-taking channel and the overall pass through of expansionary monetary policy. Our analysis also suggests that the conflicting results of the two policies (monetary and regulatory) have important real effects on the borrowing firms.

CRediT authorship contribution statement

Manthos Delis: Writing – review & editing, Writing – original draft, Validation, Resources, Project administration, Methodology, Investigation, Conceptualization. **Sotirios Kokas:** Writing – review & editing, Writing – original draft, Validation, Supervision, Software, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Alexandros Kon-tonikas:** Writing – review & editing, Writing – original draft, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

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.

¹⁵ We also control with a dummy variable whether the firm's lead arranger bank was exempted from the FDIC rule.

Data availability

The authors do not have permission to share data.

References

- Adams, R.B., Ferreira, D., 2009. Women in the boardroom and their impact on governance and performance. *J. Financ. Econ.* 94, 291–309.
- Baker, S.R., Bloom, N., Davis, S.J., 2016. Measuring economic policy uncertainty*. *Q. J. Econ.* 131 (4), 1593–1636.
- Bianchi, J., Bigio, S., 2017. Banks, Liquidity Management and Monetary Policy. Technical Report 503, Federal Reserve Bank of Minneapolis Staff Report.
- BIS, 2015. Regulatory Change and Monetary Policy. Technical Report 54, Bank for International Settlements.
- Borio, C., Zhu, H., 2012. Capital regulation, risk-taking and monetary policy: a missing link in the transmission mechanism? *J. Financ. Stab.* 8 (4), 236–251.
- Carboni, G., Darracq-Paries, M., Kok, C., 2013. Exploring the nexus between macro-prudential policies and monetary policy measures. *Financ. Stab. Rev.* 1.
- Carpenter, S., Demiralp, S., Ihrig, J., Klee, E., 2015. Analyzing federal reserve asset purchases: From whom does the fed buy? *J. Bank. Financ.* 52, 230–244.
- Chakraborty, I., Goldstein, I., MacKinlay, A., 2020. Monetary stimulus and bank lending. *J. Financ. Econ.*
- Chava, S., Roberts, M.R., 2008. How does financing impact investment? The role of debt covenants. *J. Finance* 63 (5), 2085–2121.
- Christensen, J.H., Krogstrup, S., 2019. Transmission of quantitative easing: The role of central bank reserves. *Econ. J.* 129 (617), 249–272.
- D'Amico, S., English, W., López-Salido, D., Nelson, E., 2012. The federal Reserve's large-scale asset purchase programmes: rationale and effects. *Econ. J.* 122 (564), F415–F446.
- Delis, M.D., Kokas, S., Ongena, S., 2017. Bank market power and firm performance. *Rev. Finance* 21, 299.
- Drechsler, L., Drechsel, T., Marques-Ibanez, D., Schnabl, P., 2016. Who borrows from the lender of last resort? *J. Finance* 71 (5), 1933–1974.
- Ennis, H.M., Wolman, A.L., 2015. Large excess reserves in the United States: A view from the cross-section of banks. *Int. J. Central Bank.* 11 (1), 251–289.
- FDIC, 2011. Final rule: Deposit insurance assessment base, assessment rate adjustments, dividends, assessment rates, and large bank pricing methodology. *Financ. Inst. Lett.* (FIL-8-2011).
- Fuster, A., Schelling, T., Towbin, P., 2021. Tiers of Joy?: Reserve Tiering and Bank Behavior in a Negative-rate Environment. Technical report, Swiss National Bank.
- Gagnon, J., Raskin, M., Remache, J., Sack, B., 2011. The financial market effects of the federal reserve's large-scale asset purchases. *Int. J. Central Bank.* 7, 3–43.
- IMF, 2013. Unconventional monetary policies—Recent experience and prospects.
- Ivashina, V., Kovner, A., 2011. The private equity advantage: Leveraged buyout firms and relationship banking. *Rev. Financ. Stud.* 24 (7), 2462–2498.
- Ivashina, V., Scharfstein, D., 2010. Bank lending during the financial crisis of 2008. *J. Financ. Econ.* 97, 319–338.
- Jiménez, G., Ongena, S., Peydró, J.-L., Saurina, J., 2014. Hazardous times for monetary policy: What do twenty-three million bank loans say about the effects of monetary policy on credit risk-taking? *Econometrica* 82, 463–505.
- Kandrac, J., Schlusche, B., 2021. Quantitative easing and bank risk taking: evidence from lending. *J. Money Credit Bank.* 53 (4), 635–676.
- Kashyap, A.K., Siebert, C., 2020. Financial stability considerations and monetary policy. *Int. J. Central Bank.* 16 (1), 231–266.
- Kashyap, A.K., Stein, J.C., 2000. What do a million observations on banks say about the transmission of monetary policy? *Amer. Econ. Rev.* 90 (3), 407–428.
- Kreicher, L., McCauley, R.N., McGuire, P., 2013. The 2011 FDIC assessment on banks managed liabilities: interest rate and balance-sheet responses.
- Lim, J., Minton, B.A., Weisbach, M.S., 2014. Syndicated loan spreads and the composition of the syndicate. *J. Financ. Econ.* 111, 45–69.
- Morais, B., Peydró, J.-L., Roldán-Peña, J., Ruiz-Ortega, C., 2019. The international bank lending channel of monetary policy rates and QE: Credit supply, reach-for-yield, and real effects. *J. Finance* 74 (1), 55–90.
- Paligorova, T., Santos, J.A., 2017. Monetary policy and bank risk-taking: Evidence from the corporate loan market. *J. Financ. Intermediat.* 30, 35–49.
- Raz, A.F., McGowan, D., Zhao, T., 2022. The dark side of liquidity regulation: Bank opacity and funding liquidity risk. *J. Financ. Intermediat.* 52, 100990.
- Rezende, M., Styczynski, M.-F., Vojtech, C.M., 2021. The effects of liquidity regulation on bank demand in monetary policy operations. *J. Financ. Intermediat.* 46, 100860.
- Roberts, M.R., 2015. The role of dynamic renegotiation and asymmetric information in financial contracting. *J. Financ. Econ.* 116 (1), 61–81.
- Roberts, D.T., Sarkar, A., Shachar, O., 2023. Liquidity regulations, bank lending and fire-sale risk. *J. Bank. Financ.* 156, 107007.
- Rodnyansky, A., Darmouni, O.M., 2017. The effects of quantitative easing on bank lending behavior. *Rev. Financ. Stud.* 30 (11), 3858–3887.
- Smedley, B., 2010. FDIC proposal should lead to lower rates. *Bank Am. Merrill Lynch US Rates Wkly.* 12.
- Sufi, A., 2007. Information asymmetry and financing arrangements: Evidence from syndicated loans. *J. Finance* 62 (2), 629–668.
- Sundaresan, S.M., Xiao, K., 2018. Unintended consequences of post-crisis liquidity regulation. Available at SSRN 3400165.
- Whalen, R.C., 2011. What is a core deposit and why does it matter? Legislative and regulatory actions regarding FDIC-insured bank deposits pursuant to the dodd-frank act. *Netw. Financ. Inst. Work. Pap.* (2011-WP), 14.
- Woodford, M., 2016. Quantitative Easing and Financial Stability. Working Paper 22285, In: Working Paper Series, National Bureau of Economic Research.