NBER WORKING PAPER SERIES

MONETARY POLICY TRANSMISSION THROUGH ONLINE BANKS

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Working Paper 31380
http://www.nber.org/papers/w31380

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
June 2023, Revised 2025

We are thankful to Marco Grotteria, Eduard Inozemtsev, Ralf Meisenzahl, Jungu Myung, Stefan Nagel, Friederike Niepmann, Lubos Pastor, Carolin Pflueger, Alp Simsek, Dominik Supera, Kandarp Srinivasan, Rene Stulz, Quentin Vandeweyer, Anne Villamil, Michael Weber, Yufeng Wu, Kairong Xiao, Yao Zeng, and Anthony Zhang as well as seminar participants at Baruch College, Berkeley, Chicago, Colorado Finance Summit, Delaware, Federal Reserve Board, Jackson Hole Finance Group Conference, Ohio State, SMU, the SFS Cavalcade, the New York Fed/NYU Stern Conference on Financial Intermediation, the UIC Finance Conference and the ECB's Inaugural Conference of the ChaMP Research Network for helpful comments. Yannelis gratefully acknowledges financial support from the Booth School of Business and the Fama Miller Center at the University of Chicago. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

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NBER Working Paper No. 31380
June 2023, Revised 2025
JEL No. E52, E58, G21, G23, G28

ABSTRACT

Financial technology has the potential to alter the transmission of monetary policy by lowering search costs and expanding banking markets. This paper studies the reaction of online banks to changes in the federal funds rate. We find that a 100 basis points increase in the federal funds rate leads to a 30 basis points larger increase in the deposit rates of online banks relative to traditional banks. Consistent with the rate movements, online bank deposits experience inflows, while traditional banks experience outflows. Results are similar across markets with differing competitiveness and demographics, but vary with the stickiness of depositors.

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1 Introduction

A large number of studies have found that monetary policy transmission is imperfect, and current empirical estimates of the effects of monetary policy include these frictions. In particular, market concentration in deposits (Drechsler et al., 2017), search costs (Duffie and Krishnamurthy, 2016), lender market power (Scharfstein and Sunderam, 2016), duration (Binsbergen and Grotteria, 2023), and human frictions (D'Acunto et al., 2021) have all been shown to affect how monetary policy is transmitted through market interest rates. Monetary policy is mainly transmitted through the regulated banking system. However, recent technological advances that have revolutionized traditional banking services have the potential to radically alter this transmission process. Individuals can now transfer funds via mobile devices and compare investments online, which dramatically lowers search costs, weakens banking relationships, and increases geographic scope and financial market competitiveness. How does this unprecedented growth in financial technology (FinTech) in banking impact monetary policy transmission?

Standard models predict that the increased reliance on financial technology in 21st century banking should dramatically impact how monetary policy is transmitted.[1] Consistent with increases in competition and lower search frictions, online banks offer significantly higher rates on deposits than traditional banks do through their branches. In this paper, we explore how the increasing share of online banks affects monetary policy transmission. Specifically, we study whether online banks' deposit rates respond differently relative to traditional brick-and-mortar banks. We exploit changes in the Federal Funds Rate (FFR) in the U.S., with a rapid increase from zero in March 2022 to 5 percent in April 2023. Our main finding is that a 100 basis point increase in the federal funds rate leads to an approximate 30 basis points larger increase in

[1] By 2023, online bank deposits constituted about 13 percent of the total deposits held by commercial banks in the US. While many regulated commercial banks in the US now start their operations almost exclusively online, offering online deposits and loans, we also observe many traditional banks switching from brick-and-mortar branches to online deposits. In other areas of the world, online banks have a larger market share. This is particularly true in Latin America, where 17% of individuals use digital banks as their primary financial institution. Demographics suggest that this share will continue to grow, as more than half (54%) of Latin American adults under the age of 35 prefer to use online banks as their primary financial institution.

deposit rates offered by online banks, relative to traditional brick-and-mortar lenders.

We begin by providing a stylized theoretical framework that follows Drechsler et al. (2017), where the key insight is that depositors of online banks adjust their deposit holdings in response to changes in interest rates, while depositors in traditional brick-and-mortar commercial banks are generally sticky.[2] Comparing rates at online banks to those at traditional banks, we see parallel trends prior and significant divergence following the 2022-2023 hikes in the FFR. Consistent with the deposit channel, we find that interest-rate passthrough is significantly larger for online banks relative to traditional brick-and-mortar banks. Using a difference-in-differences empirical design, we show a 17 to 36 basis points larger increase in rates of various types of deposits offered by online banks, compared with ones offered by traditional banks, due to a 100 basis points increase in the FFR.[3]

An implication of our framework is that, along with differential changes in deposit rates, there should be significant differences in levels of deposit flows between online banks and banks with brick-and-mortar branches. We show that deposits of online banks have been growing at a much faster rate (almost 40x) than that of traditional banks (under 10x) over the past two decades, with total deposits of online banks reaching about 13% of total banking deposits. Moreover, supporting our framework's predictions, this growth continued and got steeper after the rate hikes for online banks, while traditional banks experienced net deposit outflows. We also show that the increase in overall deposits for online banks during interest hikes is due to inflows to their interest-bearing deposits being larger for them than for traditional banks. Finally, online bank lending also increased relative to traditional bank lending.

Our paper's main contribution is to show that monetary policy transmission is distinct for online banks, which have been growing at an enormous pace. Therefore, going forward, policy

[2]This is not the only framework which can generate a spread between rates at online and traditional banks following monetary policy shocks. In section 2.2, we also discuss alternative channels, building on different theoretical frameworks, that lead to divergent rate adjustments for online banks.

[3]An important implication of our results is that online banks share features with Money Market Mutual Funds (MMMFs). MMMFs passed through Fed funds rate increases nearly one-for-one in 2022 and subsequently saw large investment inflows, similar to online banks. Even though online banks share a regulatory environment with traditional banks, their economic behavior may more closely resemble other types of investments.

rules and forward guidance may have different effects relative to policymakers' expectations. We argue that the key mechanism underlying our results is that online banks do not have physical bank branches. Bank branches foster long-run relationships with bank customers, advertise a variety of products, and attract a different clientele, such as customers who rely on in-person banking services. Drechsler et al. (2021) show that the deposit franchise creates market power for banks but also has high operating costs. Online banks avoid the expense of operating physical branches, but must pay higher and more variable rates as a result of their reduced market power. In our theoretical framework, differences in stickiness between brick-and-mortar and online depositors are the source of market power that results in higher passthrough at online banks. We provide evidence for the bank branch mechanism by showing that interest rate passthrough is higher at banks with a higher ratio of deposits to branches. Banks in the top decile of deposits-to-branches have a passthrough that is approximately 10 percentage points higher as compared to the median bank. This finding remains robust to excluding online banks from the sample. These findings complement research by Benmelech et al. (2023) who argue that branch density is associated with deposit flows.

By avoiding the cost of paying for bank branches, online banks reduce their operating expenses and are able to afford paying higher deposit rates. At the same time, their reduced market power requires them to pay higher rates, especially so when interest rates rise. Our findings are confirmed by bank executives' own statements about their business models. For example, Discover Bank CEO Roger Hochschild wrote that "Without the cost of branches, we can offer a high rate... I think a lot of the traditional banks have to adjust their models because people are focused on getting a good return for their money." The results raise the question of how online banks' assets differ from brick-and-mortar banks. We provide evidence that online banks invest in different types of assets than brick-and-mortar banks; around half are credit-card focused lenders. We show that online banks transmit monetary policy also to the loan market differently than brick-and-mortar banks do. To do so, we analyze rates on auto loans and mortgages for the subset of lenders for which data is available, which includes six online lenders. We find that the sensitivity of loan rates to the FFR is also larger for online banks relative to traditional brick and mortar banks.

We also discuss several potential reasons that online bank customers could be less "sticky" when they do not rely on physical branches. First we discuss financial technology, which reduces search costs, as a microfoundation for differences in customer stickiness (Choi and Rocheteau, 2023; Lieber and Syverson, 2012; Lu et al., 2024). Closely related to this is that online banks might specialize in particular products or do less cross-selling than traditional banks. Another natural reason for a less sticky customer base is that online banking customers have different demographics than brick-and-mortar customers (Xiao, 2020). In line with this hypothesis, data from the Survey of Consumer Finances shows that individuals who engage in online banking are younger and more educated, hence they may engage in more search. However, we provide evidence that demographics do not explain the entirety of the difference between online and brick-and-mortar banks by showing that differences persist even when we add controls for customer demographics. Specifically, we repeat our main regressions first with the addition of ZIP code level demographic controls, and interact these controls with changes in rates. We also match online banks to traditional banks that reside in ZIP codes with similar demographics. Our estimates remain remarkably similar when we control for demographics. With the caveat that regional data is an imperfect proxy for the characteristics of individual bank customers, these findings suggest that differences in demographics do not explain all our results.

We demonstrate that online banks behave qualitatively differently even compared to competitive brick-and-mortar banks. Drechsler et al. (2017) argue that the deposit channel of monetary policy exists due to market power of traditional banks over deposits. Hence, we repeat our tests using subsamples of bank branches in counties with high versus low banking concentration, in all banking markets or only in areas where online banks target their marketing efforts. Our finding of significantly larger transmission of policy through online banks holds with similar economic magnitudes when we exclude concentrated banking markets as well. This suggests that, even if increased competition is the underlying driver of differences between online and traditional banks, the fact that online banks operate in national markets leads to differences in interest-rate passthrough even relative to the most competitive brick and mortar banks.

Our paper mainly contributes to the extensive literature on monetary policy transmission. The existing literature has documented several channels of monetary policy passthrough to the supply of bank loans, namely, the bank lending channel (Bernanke and Blinder 1988, Kashyap and Stein 1994, Kashyap and Stein 1995),[4] the bank capital channel (Bolton and Freixas 2000, Van den Heuvel et al. 2002, Brunnermeier and Sannikov 2016), communication (Neuhierl and Weber, 2019; Coibion et al., 2022; Cieslak and Schrimpf, 2019), perceptions (Bauer et al., 2022), the deposit market power channel (Drechsler et al. 2017), and the loan market power channel (Scharfstein and Sunderam 2016). Using a structural model, Wang et al. (2022) quantify the relative importance of several channels on the sensitivity of bank lending to changes in the federal funds rate.[5] The authors show that the deposit market power channel is the most powerful one, explaining much of the transmission to bank borrowers. Focusing on the recent increases in the FFR, a contemporaneous paper by Greenwald et al. (2024) studies the effect of banks' securities holdings on monetary policy transmission. The authors show that banks that experienced larger losses on their securities holdings due to the rate hikes, contracted their commercial lending relatively more. Another related literature (e.g., Hannan and Berger 1991 and Neumark and Sharpe 1992) studies the rigidity of the banks' deposit rates against regulatory rate changes, especially in concentrated banking markets. Some recent papers such as Begenau and Stafford (2022), Granja and Paixao (2023), and d'Avernas et al. (2023), on the other hand, provide strong evidence on uniform deposit pricing across banking markets of especially large banks. Our contribution to this literature is to show that financial technology and the growing utilization of online services can have a dramatic impact on the transmission

[4]Federal Reserve's 2020 decision to completely eliminate reserve requirements ended the discussion on the lending channel based on reserve requirements, which had been also criticized to be too low to be effective.

[5]A related literature focuses on monetary policy and asset returns, for example Pflueger and Rinaldi (2022), Cieslak (2018) and d'Avernas and Vandeweyer (2023). See Cieslak and Pflueger (2023) for a recent review.

of monetary policy. As online banks expand, the passthrough of monetary policy to rates and loans may change, requiring updated models and policy guidance.

We also contribute to the literature on the growing role of FinTech in banking. The majority of this literature focuses on the increasing role of unregulated financial institutions in direct lending to small and medium-sized businesses, especially after the 2008 Financial Crisis and on how they expand access to finance for consumers.[6] Papers that focus on the role of FinTech in providing liquid claims, i.e., deposits, are rare, as providing deposits comes with regulation and FinTech lenders are typically shadow banks. Xiao (2020) builds a structural model incorporating the role of unregulated shadow banks in monetary policy transmission. He argues that deposit-like claim holders in shadow banks (e.g., money market mutual funds) are more sophisticated and hence more yield sensitive. His paper shows that monetary tightening drives more deposits into the uninsured shadow banking sector, which passes through rate hikes more to its rate-sensitive clientele. A recent paper by Gelman et al. (2024) focus on how universal banks, having access to a variety of funding sources, reduce the efficacy of the transmission of the monetary policy to the economy. To our knowledge, Abrams (2019) is the only paper on the growth of regulated online banks. In this paper, we also concentrate on regulated banks that utilize FinTech to operate almost exclusively online and compare them with traditional banks that operate mostly through their brick-and-mortar branches in terms of their interest rate passthrough. We find that the transmission of monetary policy on deposit rates is much more effective for online banks. This implies that the rapid growth in the utilization of financial technology may have important effects on policy.

Our paper is most related to a contemporaneous paper by Koont et al. (2023) who show that the introduction of digital platforms by brick-and-mortar banks has reduced their franchise value of deposits. They identify a bank as digital if it provides a mobile app with at least 300

[6] Research on business lending includes Buchak et al. (2018); Fuster et al. (2019); Stulz (2019); Chernenko et al. (2022); DeFusco et al. (2022); Gopal and Schnabl (2022). Papers about increasing financial access include Buchak and Jørring (2016), D'Acunto et al. (2019), Stein and Yannelis (2020), D'Acunto and Rossi (2023), Bartlett et al. (2022), Granja et al. (2022), Fuster et al. (2021), and Erel and Liebersohn (2022), among others. But, Ben-David et al. (2022) show that there is funding fragility for unregulated FinTech lenders during the COVID crisis.

reviews (see also Koont 2023). These digital banks are generally the largest banks (Haendler, 2023). Their main focus is on the deposit outflows from banks –i.e., how the digitization of traditional banks through these apps leads to faster deposit outflows in times of monetary tightening and how these outflows can affect the stability of the banking sector in general.[7] Our focus is on online banks, whose share has been growing in the U.S., and how deposit rates that they offer react to changes in federal funds rates. We find that online banks increase their rates significantly more than traditional banks do and do not experience deposit outflows, contrary to the findings of Koont et al. (2023) for traditional banks with a digital presence. Therefore, our papers are complementary and both findings should be incorporated in an equilibrium model of welfare effects of FinTech banking.

The remainder of this paper is organized as follows. Section 2 discusses institutional details and presents a motivating framework. Section 3 presents our main empirical strategy. Section 4 describes the main data sample used. Section 5 presents the main results while section 6 discusses the potential mechanisms. Section 7 includes robustness tests and tests on loan rates. Section 8 concludes.

2 Institutional Details and Motivating Framework

2.1 Online Banking

Internet banking has dramatically increased in importance over the past twenty years. Bhutta et al. (2020) show that nearly 80% of households used online banking services in 2019 and 45% used the internet for investment advice, a threefold increase since 2001.[8] In response to growing comfort with mobile and internet banking, a growing number of online banks have begun to compete with traditional brick-and-mortar banks. A major advantage of purely-online

[7] See, also, e.g., Caglio et al. (2023), Cookson et al. (2023), Drechsler et al. (2023), Jiang et al. (2023) and Benmelech et al. (2023) on the fragility of especially uninsured deposits, motivated by the recent failure of the Silicon Valley Bank.

[8] At the same time, 79% of households that used internet banking still visited a bank branch at some point in the year (Bhutta et al., 2020), indicating that many households use both physical and online services.

internet banks is that they do not have to maintain branches, lowering the cost of providing banking services. Moreover, they have to offer attractive rates as they cannot rely on relationships with customers and sticky depositors.

Figure 1 shows nominal deposit growth in online and brick-and-mortar banks indexed to 2001. The figure shows the rapid and large growth of online banks since 2001, growing by a factor of almost 40 during this time, quadrupling the deposit growth in brick-and-mortar banks. It is important to note that purely online banks are still a small share of total commercial banks as there are about 4,500 traditional banks in the U.S. However, the banks we identify as purely online represent about 13% of total system deposits as of March 2023. However, during the past two decades, the combined effects of rising mobile usage and new entry into the field of online banking have led to a dramatic increase since even ten years ago. Disruptions of the COVID-19 pandemic also accelerated demand for internet and mobile banking. According to the industry publication *American Banker*, the COVID-19 pandemic increased the share of households using mobile banking apps from 2019 to 2020. There seems to be little evidence of a slowdown, and if anything deposits at online banks appear to be growing at a faster rate relative to traditional banks. Online banks will thus likely be even more important in the future.

Even though our focus in this paper is on pure-play online banks, takeaways could also apply to traditional banks that shift towards digitization in general. However, online banks differ from brick-and-mortar banks, even with their growing online services presence, in several ways that affect their competitive landscape. Important differences include their reliance on technology in raising funds and the lack of personal relationships through bank branches, both of which could make their customers less sticky. The cost of comparing deposit rates with alternative investment options –such as mutual fund returns or rates offered by competitors– is lower when consumers can move their money at the click of a button. Therefore, improvements in outside investment opportunities are more likely to force online banks to raise rates when brick-and-mortar banks' rates remain low. Consumers of online banks may also be different from consumers of brick-and-mortar banks — for example, they may be younger, better educated, or simply more sophisticated investors. If these different demographics represent lower search costs for online banking consumers, this difference could also force online banks to compete more when outside opportunities improve. In the next section, we provide a theoretical framework which formalizes the intuition that customers of online banks are less sticky and that this affects interest rate passthrough.

Finally, online banks have different assets relative to traditional banks because they have poorer access to local lending markets which require a physical presence. Differences in investment opportunities between online and brick-and-mortar banks could lead to differences in deposit demand which are reflected in deposit rates.

2.2 Theoretical Framework

There are several non-mutually exclusive channels through which monetary policy transmission through interest rates may differ for online banks relative to traditional brick-and-mortar institutions. For example, the deposit channel, the costly search channel, or the shadow banking channel, building on different theoretical frameworks, all would predict differences in depositor behavior leading to divergent rate adjustments for online banks.

Our theory focuses on mechanisms linked to the lack of physical branches, which could reduce online banks' market power by reducing search costs or reducing the share of customers locked into a relationship with their bank. We think of our results as encompassing several channels whereby the presence of bank branches can change interest rate passthrough. The deposit channel of monetary policy (Drechsler et al. (2017)) is a very natural channel through which monetary policy transmission may differ for online and brick and mortar institutions. The relevant insight for our setting is that the spread s_{trad} between the FFR f and the deposit rates at traditional brick-and-mortar institutions is given by

$$s_{trad} = \delta^{\frac{\varepsilon}{\varepsilon-1}} \left[\frac{\mathscr{M} - \rho}{\varepsilon - \mathscr{M}} \right]^{\frac{1}{\varepsilon-1}} f \tag{1}$$

where ε is the elasticity of substitution between cash and deposits, ρ is the elasticity of substitution between bonds and deposits, δ is the liquidity of deposits relative to cash. $\mathscr{M}$ is the market power of the representative bank. The key difference between traditional and online banks is that $\mathscr{M}$, market power, would be much lower for online banks relative to traditional banks. This is because, for users of online banks markets are national and not local. It is frictionless to withdraw and transfer funds using apps. Traditional measures of local market power will not affect online banks. Online bank deposits are also not sticky, like traditional bank customers that might enjoy banking relationships.

From Equation (1), we know that spread on deposits increases with the FFR. Moreover, Drechsler et al. (2017) show that the sensitivity of spreads to the changes in the FFR is lower as $\mathscr{M}$ decreases. Since online banking is more competitive in terms of managing deposit funding relative to traditional banking, we would expect changes in deposit spreads due to changes in the FFR to be lower for online banks. In other words, online banks adjust their deposit rates more than traditional banks do, leading to larger (lower) changes in deposit rates (spreads) due to increases in the FFR.

A related channel is branch costs, which banks may need to pay to create market power. Drechsler et al. (2021) suggest that bank market power $\mathscr{M}$ is increasing in the cost of a deposit dollar. Physical branches require additional costs which online banks do not incur, such as the costs of property and salaries of employees to maintain retail offices. Drechsler et al. (2021) present a model under which banks incur costs to increase market power. Indeed, bank branches and in person contact can strengthen relationships with customers, advertise products, and attract stickier customers who rely on physical rather than digital banking services. Online banks do not face the costs of maintaining physical branches, but this comes at a cost of having less market power and being more sensitive to increases in deposit rates.[9] In the remainder of the paper, we test for differential passthrough of the Fed funds rate in rates for

[9]The cost of physical branches is noted by practitioners as affecting rates. For example the CEO of Discover Financial noted that "Without the cost of branches, we can offer a high rate."

online and traditional banks.[10] One reason why online banks may be more competitive than brick-and-mortar banks is that online banking customers are less likely to have an established relationship with their bank and can switch banks more easily.

Another channel is search costs, which can affect rates (Argyle et al., 2023). Argyle et al. (2023) demonstrate that local bank branches continue to be important and have real effects on rates through costly consumer search. Moving deposits is effectively frictionless at online banks, while visiting a bank branch incurs costs, primarily in terms of time. Search costs can lead to consumers accepting lower rates on deposits than they would otherwise. Costly search in traditional markets can also amplify rate passthrough in the online sector, as more rate-sensitive customers move towards online banks (Argyle et al., 2023).

A final channel through which passthrough may differ at online banks is the shadow banking channel, proposed by Xiao (2020). This channel operates through different demographics of customers at online banks. Contrary to traditional banks, the clientele of shadow banks, including online banks, are more sophisticated and, as a result are more yield-sensitive. Following the rise in the federal funds rate, traditional banks exploit the market power and yield-insensitivity of their depositors, restricting the passthrough of the interest rate shock to the deposit rates, leading to deposit outflow (Xiao, 2020). In contrast, shadow banks increase rates to keep their yield-sensitive clientele from switching to other markets. Our focus in this paper is on regulated financial institutions as monetary policy is mainly transmitted through them; however, depositor demographics of regulated online banks in our sample could resemble the clientele of shadow banks.

[10]While the framework above has unambiguous effects on rates, it is important to note that the effect of the transmission of the FFR to deposit rates can have ambiguous effects on the real economy. On the one hand, increasing rates may increase savings and reduce consumption. On the other hand, higher passthrough to rates may reduce transmission and bank lending through the deposit channel. Moreover, other frameworks may also generate our key empirical results — that there is greater passthrough of monetary policy to interest rates.

3 Empirical Strategy

We compare how interest rates evolve at online and brick-and-mortar banks during times of monetary tightening. Specifically, we exploit the difference in rates between online and brick-and-mortar banks following the increase in the Federal Funds Rate (FFR) beginning in March 2022. In early March 2022, the FFR was almost zero. On March 17, 2022 the Federal Reserve raised the benchmark rate by 25 basis points to 0.50%. This change was followed by even larger rate hikes in May and June, by 50 and 75 basis points respectively. By the end of our sample period in April 2023, the Fed raised rates nine times to 5%, with the last one being on March 22, 2023, by 25 basis points. This rapid increase over a year led to the highest FFR since 2007. We explore how lending and deposit rates changed following this historically quick increase in rates.[11]

More formally, we employ a difference-in-differences empirical strategy. For a given financial product, let i index banking institution and t index month-year. We model annual percentage yields, APY_{it}, as:

$$APY_{it} = \alpha_i + \alpha_t + \beta 1[Online]_i \times 1[PostMarch2022]_t + \varepsilon_{it}, \tag{2}$$

where $1[Online]_i$ is an indicator for whether institution i is classified as an online bank and $1[PostMarch2022]_t$ is an indicator for whether the month is March 2022 or later. The main coefficient of interest is β, which captures the spread in APY following the increase in interest rates. We include institution and time (month) fixed effects, α_i and α_t respectively. Time fixed effects α_t capture temporal shocks which affected online and traditional banks in a similar fashion. Institution fixed effects α_i capture time-invariant banks-specific factors. For example, some banks may provide better services and charge higher rates on average. We cluster standard errors at the institution level.[12] In some specifications we replace $1[PostMarch2022]_t$

[11] In Table A.1 we repeat our main results using the less dramatic increase in rates between 2015 and 2019 and find similar effects.

[12] An advantage of our strategy is that the policy occurs at a single point in time, and is not conditional on further covariates. Our analysis is thus robust to considerations regarding biases arising from staggered implementation of

with the FFR. The coefficient on this term captures the relative increase in spreads between online and traditional banks for a one percentage point increase in the FFR.

The key identifying assumption is parallel trends. That is, the strategy assumes that in the absence of federal funds rate changes the annual percentage yields of online and brick-and-mortar banks would have trended similarly. To establish pre-trends and visualize effects over time we estimate a dynamic difference-in-difference specification using the equation:

$$APY_{it} = \alpha_i + \alpha_t + \sum_t \beta_t Online_i + \nu_{it} \tag{3}$$

with the January 2022 coefficient normalized to zero. This specification is run separately for each financial product offered and uses each month between April 2021 and April 2023 inclusive. We additionally plot raw means of APY_{it} for online and traditional banks.

4 Data

4.1 Deposit and Rate Data

To create our analysis sample, we start with the set of online and brick-and-mortar banks that have Federal Financial Institutions Examination Council (FFIEC) Call Reports as of March 2021. Using the Call Reports data, we measure banks' total assets, total deposits, interest-bearing deposits and non-interest bearing deposits by quarter. We match the Call Reports data at the institution level to interest rate data from Ratewatch, a division of Standard & Poor's. Ratewatch collects data on deposit and loan interest rates on a regular basis (typically weekly) for a national sample of bank branches. Ratewatch is widely used in academic research on branch rates (e.g., Drechsler et al. 2017), but is also in industry by banks to stay informed about their competitors' rates.[13] In recent years, their coverage has expanded to include rates

policies, as two-way fixed effects estimators with heterogeneous treatment effects could lead to negative weights on treatment effects (de Chaisemartin and D'Haultfoeuille, 2020).

[13] Ratewatch does not survey *every* branch for any particular bank, but only a sample. Surveyed branches are denoted as "rate-setting branches" and other branches are assumed to follow nearby rate-setting branches.

from online banks and a variety of loan products.

We match Ratewatch data to data from Call Reports at the institution level, keeping only those banks whose rates are available consistently throughout our sample period. There are approximately 4,500 banks in the Call Reports during this period of which 3,916 have consistent RateWatch coverage. We then aggregate this data set to the month-by-institution level, taking the simple average of rates across each institution's branches. In robustness checks, we consider different specifications, for example using deposit quantity weights.

For each branch that Ratewatch surveys, data is collected on rates by product (e.g., checking, savings, or CD), amount and, if applicable, maturity. We study rates at $2,500 savings, $10,000 money market savings accounts, 6-month $10,000 certificates of deposit, 24-month and $10,000 certificates of deposit. We take these to be representative of the landscape of consumer deposits.[14] We further use data from the FDIC Summary of Deposits (SOD) database to calculate the location and deposits of brick-and-mortar bank branches. SOD data includes a unique branch identifier which is readily matched to Ratewatch data. We calculate county-level Herfindahl Indexes using deposits data from all the branches in each county. Local demographic information about ZIP code characteristics comes from the 2017-2021 American Community Survey. We match this survey data by ZIP code to the ZIP code of each bank branch.

4.2 Classifying Online Banks

To identify online banks we begin by considering all banks in Ratewatch and the March of 2021 FFIEC Call Reports that have less than five branches and more than $500 million in deposits. To this list we add all online banks identified by Abrams (2019). We then remove

Ratewatch conducts local market research to ensure that non-surveyed branches have rates that are very close to their assigned rate-setting branches.

[14] S&P acquired Ratewatch shortly before our sample begins and integrated the Ratewatch platform into their software in the middle of our sample. We discovered several missing data points in the middle of the sample that are the result of the integration, which reduced the number of banks and products we were able to consistently match between Call Reports and Ratewatch.

community banks and banks which do not offer commercial banking services.[15] This results in a sample of 41 banks which operate almost entirely online, 30 of which have consistent coverage in Ratewatch data.[16] The online 41 banks tend to be larger banks, and account for 13% of deposits and 16% of assets as of March 2023. These 30 banks with rate coverage comprise the online banks in our main analysis sample, and account for 9% of deposits and 12% of assets.

Table 1 shows the online banks in our main analysis sample. With few exceptions — e.g., Capital One and CIT Bank — the online banks have few branches. Most of them in fact operate fully online, with only one or two administrative branches. For example, Ally Bank, American Express National Bank, and Axos Bank are typical online banks with only one branch. Two of the online banks (CIT and E*Trade) were acquired in January, 2022, so we do not have data for them in 2023. In the appendix, we also show that our results are robust to excluding any particular online bank, excluding the banks from Abrams (2019), and using only online banks with a single branch (Tables A.2 and A.3). As an additional test, we increase the online bank sample size by manually collecting data from website histories of online banks which we identified in the Call Reports but are not covered by Ratewatch. For example, Charles Schwab Bank, which does not have sufficient RateWatch coverage during our sampling period, is in this extended sample. We show our results are robust to this extended sample in Table A.3 and discuss this sample in detail in section C.2.

We further use annual advertising data from Nielsen to identify our online bank's target markets. The Nielsen Ad$pender data set is comprised of advertising spending across various media platforms including television, radio, and digital at the zip code level. We identify 25 of our online banks in this data set and use the zip codes they advertise in to infer where their brick-and-mortar competitors are located. Additionally, we match local demographic

[15]This is done by hand checking each bank's website. Banks whose websites contain the key phrases "Locations & Hours" and "Community" are flagged as non-online institutions. See Appendix C for more details on data construction.

[16]All but one of these banks, Alliant Credit Union, files with the FFIEC. We collect similar deposit and asset data on Alliant using data from the National Credit Union Administration.

information from the 2017-2021 American Community Survey to these zip codes to estimate the demographics of the online bank's customers. The demographics of the online banks that are not found in the Nielsen data are supplemented using the individuals in the 2019 Survey of Consumer Finances who reported using online banking over the prior year.

Table 2 presents summary statistics for the main analysis sample, split by bank type. The Table shows cross-sectional means of annual percentage yields by product and bank type in March of 2021, before the Federal Reserve began rapid rate hikes. The top panel shows traditional brick-and-mortar banks, while the bottom panel shows online banks. Online banks tend to have higher rates on average, and they are also much larger, with an order of magnitude larger deposits and assets. For example, mean APY for 6-month (24-month) CDs was 19 (39) basis points for brick-and-mortar banks while it was 26 (47) basis points for online banks in April 2021 and total deposits of traditional banks were around \$3.9 billion while it was \$42.6 billion for online banks, on average.

4.3 Business Model of Online Banks

How does the business model of online banks differ from brick-and-mortar banks? By not relying on branches, online banks have liabilities with different properties than brick and mortar banks do; we would naturally expect their assets to be different as well. These differences could also mean that online banks passthrough interest rates to their assets differently, which we explore empirically in section 7.2.

Table 2 also shows further summary statistics of the asset and deposit composition of the online banks in our sample. They do not share a single business model, but several patterns emerge. Around half of online banks are banks that specialize in credit card lending, such as American Express and Synchrony being the largest and most important.[17] Since credit card loans pay floating rates closely linked to monetary policy, rate-sensitive liabilities are a natural way for these banks to hedge the rate sensitivity of their assets (Drechsler et al., 2024). Beyond

[17]Thanks to Dominik Supera (discussant) for pointing this out.

credit cards, online banks are more likely to make other types of personal loans. Overall, 33% of online bank assets are personal loans[18] including 13% credit card loans, as opposed to an average of 17% personal loans and 0% credit card loans for traditional banks. Other online banks invest their assets in securities, such as E*Trade, or use technology to manage their lending, such as LendingTree. Some have business models that are closer to traditional banks.

Higher deposit rates attract different sorts of depositors as well. Sixteen percent of online banks' loans are brokered deposits (which are more interest rate sensitive), as opposed to 2% for brick-and-mortar banks. The higher sensitivity of brokered deposits could make online banks' customers less "sticky", since interest rate changes are more salient for deposit brokers than for the general public. The share of time deposits is similar for online and brick-and-mortar banks at the start of the sample in 2021, but as we will show, funds flowed into online banks' time deposits when interest rates increased.

5 Main Results

5.1 Deposit Rates for Online and Traditional Banks

We begin by showing raw means over time in Figure 2. The top left panel shows the Federal Funds Rate (FFR) over time. The dashed vertical line indicates when the Federal Reserve began increasing interest rates in March of 2022. As was discussed in section 3, there is a sharp increase in the FFR starting in March 2022, from almost zero to five percent in April 2023. The remainder of the panels show APY for different product types broken down by online versus traditional brick-and-mortar banks. We examine rates on savings accounts (regular passbook savings and money market deposit accounts) as well as 6 and 24-month Certificates of Deposits (CDs). The solid lines show rates for online banks, while the dashed lines show rates for traditional banks.

For all products, we see a similar pattern of change starting in March 2022. For both online

[18] We define personal loans as credit cards, mortgages, auto loans, and other personal revolving lines of credit.

and traditional banks, rates trend similarly while the FFR is at the zero lower bound. Following the increase in the FFR, rates rise for both types of banks. However, the rise is much faster and sharper for online banks. By the end of the sample period, there is a much larger spread between rates at online and traditional banks. This is most evident for Savings and Money Market Deposit Accounts, while the spread is smaller for CDs. For savings accounts, rates for online banks reach to 150-250 basis points while they stay at or below 50 basis points for brick-and-mortar banks by April 2023. For 6-month or 24-month CDs, the interest gap rises to about 150 basis points, with rates for online banks exceeding 250-300 basis points. Note that banks raise rates on time deposits, which are typically higher, more in response to a higher Fed funds rate (Kang-Landsberg et al., 2023).[19] In Appendix Figure A.1, where we present similar graphs weighted by each bank's total deposits, the difference in rates is much larger, with the rate for 6-month and 24-month CDs, for example, reaching 300-400 basis points while remaining under 100 basis points for traditional banks.

Table 3 makes this graphical evidence more explicit. The top panel of the Table shows estimates of equation 2, specifically of the main interaction coefficient β, which captures the spread in APY between online and traditional banks. For all products studied, we see significant effects, with a difference in APY which is significant at the 1% level or higher. The bottom panel of Table 3 replaces the indicator of a time period being post March 2022 with the Fed funds rate (FFR). The coefficient on this interaction can be interpreted as the differential passthrough of the FFR for online relative to traditional banks. Across various products, we see an approximate 17 to 36 basis point relative increase in rates for online banks.

Figure 3 presents the results of a dynamic difference-in-difference estimator. The figure plots coefficients from equation 3, along with a 95% confidence interval. Consistent with the raw means, we see no difference between online and traditional banks prior to the increase in rates. This evidence is consistent with the identifying parallel trends assumption. Following

[19] We only observe banks for one year after the rate increase, and ultimately, they may raise rates to be closer to rates offered by online banks. This would be consistent with Neumark and Sharpe (1992), who show that market power leads to delayed deposit passthrough, not just lower passthrough.

March 2022, we see a sharp increase in rates for online banks relative to traditional brick-and-mortar institutions. By the end of the sample period, there is a 100 basis point spread for 6-month CDs and Money Market Deposit Accounts, and an approximate 150 basis point spread for 24-month CDs and Savings. In Appendix Figure A.2, where we present similar graphs, deposit weighted, the difference exceeds 200 basis points for savings accounts or 6-month CDs and 250 basis points for 24-month CDs.

5.2 Deposit Growth at Online and Traditional Banks

An implication of our framework is that deposit growth at online banks is also expected to be larger as their depositors are more rate sensitive and we see larger rate changes for them than for traditional banks. Figure 1 presents total deposit growth for both types of banks since March 2001.[20] The dashed vertical line in the figure indicates March of 2022 which is when the Federal Reserve began the rate hikes to tighten its monetary policy. There are two important facts we learn from this figure. The first is that online banks' deposits grew at a much faster rate than that of traditional banks over the last decade. Second, confirming the implication of our framework discussed above, this deposit growth continued for online banks after the Fed started increasing the Fed funds rate targets in March 2022, at even a steeper rate. For traditional banks, though, we see a contraction in their deposits.

This decline (increase) in deposits due to the rate hikes is also evident in Figure 4, where we present the deposit quantities, rather than the growth, for both types of banks. We observe a steady increase in the total deposits of traditional banks until the first quarter of 2022. Their deposits totaled over $15 trillion dollars, almost $1 trillion of which left by the third quarter of 2023. Online banks' deposits increased by about $150 billion — similar in magnitude to the change over the previous decade.

We estimate the following difference-in-differences specification to show the effect on de-

[20] As our deposit quantities data source is the Call Reports, we provide quarter-over-quarter changes in the figure.

posit levels more formally. For a given financial product, letting i index banking institutions and t index month-years, we estimate:

$$Deposits_{it} = \alpha_i + \alpha_t + \beta 1[Online]_i \times 1[PostMarch2022]_t + \varepsilon_{it}, \tag{4}$$

where $1[Online]_i$ is an indicator for if institution i is classified as an online bank and $1[PostMarch2022]_t$ is an indicator for if the month is March 2022 or later. As above, standard errors are corrected for clustering of observations at the bank level. We run this specification for total deposits first and present the results in Column 1 of Table 4. The coefficient on the interaction of the online and post dummy is positive and significant, showing about $6 billion of larger net deposit inflows to online banks. Figure 5 plots the results of a dynamic difference-in-difference estimator.

In columns (2) and (3) of Table 4, we present results of the same difference-in-differences estimation for interest-bearing and non-interest bearing deposits separately.[21] For both types of banks, we would expect a shift from the latter to the former due to increases in rates in general. But we would also expect the shift to be larger for online banks as their response to rate hikes in terms of raising their deposit rates is larger. Findings are consistent with our prediction that inflows to interest-bearing deposits are larger for online banks than for traditional banks. There is no difference for non-interest bearing deposits. See also Appendix Figure A.3 showing the evolution of quantities for interest-bearing and non-interest-bearing deposits. For both types of banks, we see an outflow of non-interest bearing deposits while inflows of interest bearing ones happen at a much larger scale for online banks.[22]

[21] A natural comparison group to online banks is Money Market Mutual Funds (MMMFs). Online banks share a regulatory environment with brick-and-mortar banks but our findings show that they respond to monetary policy differently. Instead of traditional banks, a better comparison group may be MMMFs. MMMFs passthrough interest rates nearly one-for-one, making them attractive to customers of brick-and-mortar banks. Figure A.4 shows that MMMFs experienced inflows following rate increases, somewhat more slowly relative to online banks.

[22] Note that interest bearing deposits were 91.3% of total deposits for online banks while it was 67.5% for traditional banks, as of 2021Q1.

6 Mechanisms

The preceding analysis shows that interest rate passthrough at online banks is higher. The mechanism our framework builds on is that customers of online banks are not as sticky as the customers of brick-and-mortar banks. Here, we provide evidence that the lack of stickiness is linked to differences in online banks' deposit franchise. Lower market power raises the rates online banks must pay, while at the same time the lack of branches could lower their operating costs, in line with the mechanism described by Drechsler et al. (2021). To provide evidence for the role of physical branches, this section first provides direct evidence that banks with a high ratio of deposits to branches have higher passthrough of monetary policy, even when we exclude online banks.

Several non-mutually exclusive reasons micro-found the link between market power and physical bank branches. Search costs are one possibility, since online banks' market power is reduced since their clientele can easily leave when deposit rates are unattractive. Beyond this, online banks' customers might also behave differently because younger and more tech-savvy customers are attracted to online banks, who might be more financially sophisticated as well.

There is substantial evidence from the marketing literature that online markets have lower search costs than offline markets (Lieber and Syverson, 2012). In the context of the deposit market, Lu et al. (2024) provide evidence for the effects of technology on search. Choi and Rocheteau (2023) show using a money search model that high interest rate passthrough is precisely what we should expect if new technology leads to lower search costs. In their micro-founded model of consumer search, they show that interest rate passthrough will approach 100% as FinTech banks increasingly dominate the loan market.

Further evidence for differences in depositor stickiness comes from the difference in online and brick-and-mortar banks' business model. Online banks have a higher share of brokered deposits which are more sensitive to rates (16% versus 2% for brick-and-mortar banks). Several large online banks are divisions of major credit card companies — a form of arms-length consumer lending not reliant on traditional "relationships" (credit cards make up an average of

13% of online banks' assets versus about 0% for brick-and-mortar banks). Some online banks, such as E*Trade and Schwab, operate primarily as brokerages, which may further reduce search costs by making yields on other savings instruments more salient for customers.

While technological differences can be important reasons for differences in stickiness, we also explore the role of demographics, as online and brick-and-mortar banks may serve a different clientele. We show that more educated and younger individuals use online banking services more. Since more educated borrowers may be more sophisticated and younger borrowers may have a less-committed relationship with their bank, demographics could also explain the difference in customer stickiness. At the same time, we provide evidence that demographic differences do not explain all the difference between the two groups.

Other possible explanations concern local banking market concentration. If online banks mostly compete with offline banks in markets with many physical branches, it could lead to lower search costs, but with different implications for the future of online banking. In particular, if results are driven by online banks operating in more competitive brick-and-mortar markets, then as the share of individuals using online banks increases, they may start to behave more like brick-and-mortar banks.

6.1 Role of Bank Branches

Figure 6 explores the role of bank branches for deposit rate passthrough. Physical bank branches have multiple effects on banks' business model. On the one hand, they require operating expenses, such as employee salaries, land and maintenance costs. On the other hand, they can help create market power for banks by fostering relationships with customers and attracting a distinct clientele. How does the availability of branches affect interest rate passthrough?

We answer this question by comparing passthrough at each bank, splitting banks by their reliance on physical branches. We measure branch reliance using deposits per branch and split banks into deciles. In Table A.4 we present results separately including and excluding online banks from the sample. Importantly, banks with a high ratio of deposits per branch could be traditional banks that nonetheless have a clientele or business model that more closely resembles online banks. Therefore, in addition to confirming our mechanism, these results show the implications of our results for the banking system more broadly.

The availability of bank branches has a strong effect on interest rate passthrough. This is especially true for banks in the highest and second-highest decile of deposits per branch. Excluding online banks, savings rates in the top decile increased by 0.05 percentage points more than the median bank, with a similar difference for 6-month CDs. Money market and 24-month CDs rates increased by 0.1 percentage points more. We thus conclude that the availability of branches is an important mechanism for the transmission of monetary policy. This finding is consistent with Drechsler et al. (2021), as banks may need to incur fixed costs to increase market power. Traditional branches require costs which online banks do not, such as building rents and employee salaries. Reducing these fixed costs ultimately increases monetary policy transmission.

6.2 Passthrough and Demographics

New technology and branch costs are not the only differences between online and brick-and-mortar banks. Another difference is that the types of people who use online banks are different from those who use brick-and-mortar banks. Anenberg et al. (2018) show that younger and higher-income people engage in more online banking. Lieber and Syverson (2012) show that they are also more likely to purchase financial products online, as well as a variety of other goods. If the users of online banks are more financially sophisticated, they might have an easier time moving their money or finding the best rates. Therefore, demographic differences between the customers of online banks and brick-and-mortar banks could affect their rates, in a fashion similar to technology.

Previous research has shown that differences in clientele can indeed lead to differences in customer behavior (Xiao, 2020; Daniel et al., 2021). Table B.1 in the Appendix shows average SCF demographics among online bank users. Young, high-income and educated individuals use online services to the greatest extent. Given the differences in demographics we observe, clientele effects may be an important explanation for the differences in passthrough between online and brick-and-mortar banks.

Do demographics explain *all* of the difference between online and brick-and-mortar banks? To explore this, we repeat our main regression with the addition of interactions with the ZIP code level demographic controls. Table 5 presents these results. The results in Table 5 are quite similar to our main results, and the coefficients are statistically indistinguishable from those presented in our main tables. This suggests that differences between online and brick-and-mortar branches are not entirely to demographics, providing a role for other channels such as the sticky deposit channel or decreased search costs. There is likely to be within-ZIP code selection to online banking which we cannot control for.[23] Nonetheless, as long as ZIP code demographics are at least partially correlated with the demographics of each bank's customers, the results are informative.

We conduct further tests, in which we generate pseudo-online banks, assigning a 'pseudo online' indicator to branches in ZIP codes that are most similar to depositors of online banking. To find similar branches we run nearest neighbor matching using ZIP code averages of having a computer in the home, access to Internet, being older than 65, having a college degree, minority status, and having low income status (i.e., having household income of below $30,000). We again have the annual percentage yield offered as our dependent variable of interest and the interaction of post dummy and the pseudo-online indicator as the main explanatory variable of interest. The results, presented in Table 6, are generally insignificant at conventional levels; they even have a negative sign. Overall, these results provide suggestive evidence that the differences in passthrough are not entirely explained by demographics.

[23] We discuss these points in more detail in Appendix C. In addition to the results in the main text, we run our main regression using only traditional banks that reside in ZIP codes with demographics similar to users of online banking. We use Nearest Neighbor Matching to assign zip codes with similar demographics. In both cases the effect of being an online bank remains large and significant.

6.3 Passthrough and Concentration

One potential channel for the difference in passthrough by online banks is the difference in competitiveness of the banking markets for online and traditional banks. Hence, we repeat our tests using bank branches in counties with high versus low banking competition using the median Hirfindahl-Hirschman Index (HHI).[24] Table 7 presents results, where we create splits based on the HHI at the branch level. Panels A and B split branches below and above the sample's median HHI, while Panels C and D restrict these same splits to the zipcodes where online banks advertise. The results are similar for both splits. In unreported robustness tests, we run similar subsamples to the ones in Panels A and B using bank level HHI rather than branch level and also find similar results. Our finding of significantly larger transmission of policy on rates through online banks holds, with similar economic magnitudes, even when we exclude concentrated banking markets.

This finding provides strong evidence that greater transmission of monetary policy through online banks is qualitatively different than brick-and-mortar banking markets, even ones in less-concentrated markets. However, this result does not rule out the important role of competition for online banks– indeed it is possible that competition affects all of our results, and that no traditional markets are as competitive as the online, possibly national market. Indeed, concentration may no longer be the primary determinant of bank branch competitiveness. While there is some evidence that physical branches still matter for competition (Nguyen, 2019; Liebersohn, 2024), our paper shows that banks can be competitive even absent physical branches. What Table 7 shows is that, at the very least, even the most competitive traditional banks, with branch networks and reliance on banking relationships, differ from online banks in their interest-rate passthrough.

[24]HHI for branches is calculated at the county level. For each county we calculate the HHI as $HHI = \sum_{i=1}^{N} S_i^2$ where i indexes the N branches in each county and S_i is the share of total county deposits held by branch i.

7 Additional Tests

7.1 Robustness Tests

Online banks are yet small in number but not in size. As presented in Table 2, the average online bank has about $42 billion in assets, more than ten times as large as the average brick-and-mortar bank in our sample. To alleviate the concern that our findings are due to size differences between two types of banks in our sample, in Panel A of Table 8, we use only large traditional banks with total assets of $40 billion or over in our sample. The findings remain similar in terms of both economic and statistical significance. Moreover, in Panel B of Table 8, we alternatively run our main tests using the deposits of branches to weigh bank level rates.[25] Results largely remain similar to our baseline estimates.

Additional robustness tests are presented in the Appendix. For example, we test whether our results are driven by one particular online bank in Appendix Table A.2. Presented in this table are estimates from our main difference-in-differences specification in each case with a sub-sample leaving out one of the online banks. We see that betas remain significant and similar to each other across almost twenty sub-samples, indicating that our results are not driven by any particular online institution. We also test if our findings are due to online banks being younger – i.e., using only 657 banks established after 2000 as our sample of brick-and-mortar banks. Additionally, we also consider subset of traditional banks that offer higher rates –i.e., offering rates greater than the 75th percentile prior to March 2022 (see Kundu et al. (2024) studying differences between high-rate and low-rate banks). Appendix Table A.5 repeats our main analysis using only these young banks (Panel A) and banks offering high interest rates prior to March of 2022 (Panel B). If online banks were to be similar to young brick-and-mortar banks, which are eager to gain new customers, we would expect effects to decrease significantly. In general, our estimation provides no evidence of a decrease in effects. On the contrary,

[25] This is done using branch level SOD data. Because some banks book deposits at their headquarters location we exclude branches with deposits above $10 billion. We then average annual percentage yields at the bank-month level weighted by the total deposits at each rate setting branch and repeat our main tests.

coefficients for almost all products remain both statistically and economically significant.

Finally, we also implement matching techniques to select a subset of brick-and-mortar banks that resemble online banks in terms of their balance sheet characteristics. Given that online banks' business model differs from brick-and-mortar banks in some ways, a natural question is whether passthrough is more similar when the two types of banks are matched based on their asset composition. Results presented in Table 9 include online banks with the matched traditional banks identified using nearest neighbor matching (with the smallest Euclidean distance). We match by the share of credit card lending, share of personal loans, share of time deposits, share of brokered deposits and deposits per branch. The estimates are largely unchanged when we match on each of these characteristics with the exception of deposits per branch. When we match to brick-and-mortar banks with a similar level of deposits per branch, the estimated coefficient drops to 0.66. The latter finding supports our argument that deposits per branch is an important reason for the difference between online and brick-and-mortar banks. Finally, we match jointly on establishment year, total assets, and each of the balance sheet characteristics previously mentioned. We continue finding highly significant results.

7.2 Comparison to the Lending Market

Online banks are a growing presence in the retail loan market as well. In Table 10, we investigate whether deposit inflows to online banks have an effect on their lending behavior. The main effect on total lending is shown in Column 1. We estimate that total lending increased by an average of $6.6bn for online banks relative to their brick-and-mortar counterparts. Comparing the estimated effect on lending to the effect on deposit quantities shown in Table 4, each additional dollar of deposit funding is associated with about one dollar of additional lending. Column 2 shows the effect on personal loans. Net deposit inflows to personal loans are about $4.6bn, representing most of the increase in total lending.

The online loan market is similar to the online deposit market in some ways since accounts can be opened electronically and search frictions may be lower. However, effects of lowering search frictions on lending rates are more ambiguous. On the one hand, more competition should push down rates if consumers search more. On the other hand, increased search for higher deposit yields and higher costs of funds may push up lenders' costs, leading to higher rates. Finally, if online banks try to match the interest rate sensitivity of their assets to their liabilities, then we would expect their loan rates to be more sensitive to rates than brick-and-mortar banks in both markets.

To understand the implications of online banking for the passthrough of monetary policy to loans, we repeat our main analysis for loan rates. We study two markets where Ratewatch data is available for online banks: the auto loan market and the mortgage market. We look at rates for 5-year new auto loans, 2-year used auto loans, 15-year mortgages and 30-year mortgages, where sufficient data is available. The main results are shown in Table 10 and dynamic difference-in-difference estimates are plotted in Figure A.5. The estimates are noisy, but consistently positive, suggesting that increases in deposit rates and costs of funds pass on to higher lending rates. The elasticity of auto loan rates with respect to the Fed funds rate is larger for online banks by about 0.13-0.17, and the elasticity of mortgage rates for online banks is larger by between 0.3-0.4. The greater elasticity suggests that online lenders price loans closer to marginal cost, as we would expect from a more competitive market.

Our findings also show that monetary policy passthrough is greater among online banks in *both* the loan and the deposit markets. Online banks passthrough cost shocks from borrowers to savers to a greater extent than brick-and-mortar banks. This fact potentially has important distributional consequences, both in terms of age and wealth. Since savers are older and wealthier than borrowers on average (Doepke and Schneider, 2006), redistribution from savers to borrowers is potentially regressive. Effectively high rates transfer to older and wealthier savers, and away from younger and poorer borrowers.

8 Concluding Remarks

An increasing share of lending is done by online institutions, and the increasing use of financial technology may have important implications for policy transmission. This has the potential to massively alter the transmission of monetary policy to deposit rates, as banking markets become national and search frictions dissipate. In this paper, we study how monetary policy is transmitted through online versus traditional brick-and-mortar institutions. We find that monetary policy transmission on rates is significantly greater for online banks. A 100 basis point increase in the Fed funds rate leads to between a 17 and 36 basis point larger increase in annual percentage yields for online banks relative to traditional institutions.

The growing utilization of online banks, and financial technology in general, will likely change the efficacy of central bank policy in the future. We show increased interest rate passthrough for online bank deposits. But the long-term effect of interest rate hikes on online bank lending is unclear, given larger deposit inflows that come at higher cost, with relatively higher deposit rates offered. We further provide evidence that monetary policy passthrough is also greater for online bank loan rates. But, overall, there remains much important work to be done in exploring how financial technology will shape policy in the future. In particular, old policy rules and forward guidance may have different effects on lending, growth, and employment than policymakers' expectations. Additionally, the transmission of monetary policy into deposit rates may in theory have ambiguous effects on the real economy. The theoretical channels affecting monetary policy transmission may also change in the future, if financial technology leads to less bank market power.

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Table 1: Online Banks

Institution Name	Branches	Total Deposits	Abrams 2019
Alliant Credit Union	2	11.69	No
Ally Bank	1	141.94	Yes
American Bank	1	0.60	No
American Express National Bank	1	91.05	Yes
Axos Bank	1	11.77	Yes
Bancorp Bank	1	7.02	No
Barclays Bank Delaware	1	22.12	No
CIT Bank	92	42.63	Yes
Capital One, National Association	446	306.69	Yes
Colorado Federal Savings Bank	1	1.71	No
Comenity Direct	1	6.56	No
Cross River Bank	2	4.73	No
Discover Bank	2	79.42	Yes
E*Trade Bank	1	72.56	Yes
Farm Bureau Bank, FSB	2	0.65	No
First Command Bank*	1	0.93	No
First Internet Bank of Indiana	1	3.25	Yes
LendingClub Bank, National Association	1	2.41	No
Live Oak Banking Company	1	6.33	No
Marcus by Goldman Sachs	5	225.77	Yes
NBKC Bank	4	0.98	No
Nano Banc	2	1.08	No
NexBank	3	7.57	No
Quontic Bank*	3	0.51	No
Sallie Mae Bank	1	23.77	No
Silvergate Bank*	2	7.02	No
Synchrony Bank	3	65.27	Yes
TAB Bank	1	0.80	No
TIAA, FSB*	12	27.48	Yes
USAA Federal Savings Bank	1	102.46	No

Notes: This table displays information on the 30 online banks we identify in our study. Deposits are reported in billions and are sourced from the March 2021 FDIC Summary of Deposits. Banks with an asterisk are classified as savings and loans institutions. Alliant is a credit union and all other intuitions are classified by RateWatch as banks. Source: RateWatch & FFIEC

Table 2: Summary Statistics

	Mean	SD	Max	Min	Median
Bank Type: Brick and Mortar					
6 Month CD APY	0.19	0.11	0.83	0.01	0.15
24 Month CD APY	0.39	0.18	1.26	0.01	0.35
10K MM APY	0.11	0.09	0.80	0.01	0.10
2.5K Savings APY	0.09	0.08	0.75	0.00	0.07
Total Deposits (Billions)	3.90	52.84	1986.41	0.00	0.30
Total Assets (Billions)	5.19	76.56	3207.52	0.01	0.35
Share of Assets Credit Card Loans	0.00	0.01	0.40	0.00	0.00
Share of Assets Personal Loans	0.17	0.13	0.88	0.00	0.15
Share of Deposits that are Brokerage	0.02	0.05	0.85	0.00	0.00
Share of Deposits that are Time Deposits	0.22	0.13	0.97	0.00	0.20
Deposits per Branch (Billions)	0.09	0.15	4.34	0.00	0.06
Employees per Branch	15.66	26.07	1130.00	2.40	12.00
Number of Institutions	3,916				
Bank Type: Online					
6 Month CD APY	0.26	0.14	0.60	0.05	0.25
24 Month CD APY	0.47	0.19	0.75	0.10	0.50
10K MM APY	0.26	0.17	0.60	0.01	0.28
2.5K Savings APY	0.37	0.18	0.61	0.03	0.40
Total Deposits (Billions)	42.56	71.83	306.69	0.51	7.30
Total Assets (Billions)	53.83	88.94	369.91	0.77	11.04
Share of Assets Credit Card Loans	0.13	0.27	0.86	0.00	0.00
Share of Assets Personal Loans	0.33	0.26	0.87	0.00	0.32
Share of Deposits that are Brokerage	0.16	0.20	0.89	0.00	0.10
Share of Deposits that are Time Deposits	0.22	0.18	0.59	0.00	0.20
Deposits per Branch (Billions)	20.84	36.02	142.29	0.18	3.23
Employees per Branch	1545.48	3399.96	16073.00	30.00	222.50
Number of Institutions	30				

Notes: This table displays cross-sectional summary statistics of annual percentage yields and balance sheet characteristics by bank type in March of 2021. Total assets and deposits are reported in billions. Personal loans are defined as credit cards, mortgages, auto loans, and other personal revolving lines of credit. Source: RateWatch & FFIEC

Table 3: Main Results

	(1) Savings, 2.5K	(2) Money Market, 10K	(3) 6-Month CD, 10K	(4) 24-Month CD, 10K
Panel A: Post Interaction				
Online × Post March 2022	0.927***	0.442***	0.639***	1.137***
	(0.151)	(0.154)	(0.183)	(0.172)
Panel B: FFR Interaction				
Online × FFR	0.357***	0.174***	0.245***	0.358***
	(0.058)	(0.059)	(0.069)	(0.055)
Observations	98125	92209	96447	95373
Bank FE	✓	✓	✓	✓
Month FE	✓	✓	✓	✓

Notes: This table presents estimates of β from the OLS regression $APY_{it} = \alpha_i + \alpha_t + \beta 1[Online]_i \times 1[PostMarch2022]_t + \epsilon_{it}$ for the four products listed in each column. APY_{it} is the annual percentage yield offered by institution i at time t. $1[Online]_i$ is an indicator for if institution i is an online bank and $1[PostMarch2022]_t$ is an indicator for time period t being after the rate increases in March of 2022. α_i and α_t are institution and time fixed effects. Standard errors are in parentheses and are clustered at the institution level. Panel B replaces $1[PostMarch2022]_t$ with the actual federal funds rate at time t.

* $p < .1$, ** $p < .05$, *** $p < .01$

Table 4: Deposits

	(1) Total Deposits	(2) Interest Deposits	(3) Non-Interest Deposits
Panel A: Post Interaction			
Online × Post March 2022	5.809**	5.960**	-0.150
	(2.635)	(2.641)	(0.145)
Panel B: FFR Interaction			
Online × FFR	1.703**	1.809***	-0.106
	(0.686)	(0.693)	(0.078)
Bank FE	✓	✓	✓
Quarter FE	✓	✓	✓
Observations	36096	36096	36096

Notes: This table presents estimates of β from the OLS regression $Deposits_{it} = \alpha_i + \alpha_t + \beta 1[Online]_i \times 1[PostMarch2022]_t + \varepsilon_{it}$ where $1[Online]_i$ is an indicator for if institution i is classified as an online bank and $1[PostMarch2022]_t$ is an indicator for if the month is March 2022 or later. Deposits are reported in billions. Standard errors are in parentheses and are clustered at the institution level. Panel B replaces $1[PostMarch2022]_t$ with the actual federal funds rate at time t. $^{*}p < .1$, $^{**}p < .05$, $^{***}p < .01$

Table 5: Demographics and Rates

	(1) Savings, 2.5K	(2) Money Market, 10K	(3) 6-Month CD, 10K	(4) 24-Month CD, 10K
Online × Post March 2022	1.064***	0.473***	0.817***	1.397***
	(0.153)	(0.155)	(0.183)	(0.186)
Observations	120102	111420	118084	117128
× Has Computer	✓	✓	✓	✓
× Internet Access	✓	✓	✓	✓
× Age 65+	✓	✓	✓	✓
× College Degree	✓	✓	✓	✓
× Minority	✓	✓	✓	✓
× Low Income	✓	✓	✓	✓
Bank FE	✓	✓	✓	✓
Month FE	✓	✓	✓	✓

Notes: This table presents estimates from the OLS regression $APY_{it} = \alpha_i + \alpha_t + \beta 1[Online]_i \times 1[PostMarch2022]_t + \sum_j \delta_j Demographic_{ji} \times 1[PostMarch2022] + \epsilon_{it}$ for the four products listed in each column where j indexes population averages of having a computer at home, access to Internet, being older than 65, having a college degree, minority status, and having low income status (with below $30,000 household income) within the ZIP code for which branch i resides. APY_{it} is the annual percentage yield offered by branch i at time t. $1[Online]_i$ is an indicator for if branch i is an online bank and $1[PostMarch2022]_t$ is an indicator for time period t being after the rate increases in March of 2022. α_i and α_t are institution and time fixed effects. Standard errors are in parentheses and are clustered at the institution level. Demographic averages for online banks are calculated using averages from the SCF. * $p < .1$, ** $p < .05$, *** $p < .01$

Table 6: Zip Codes with Demographics Similar to Online Banks

	(1) Savings, 2.5K	(2) Money Market, 10K	(3) 6-Month CD, 10K	(4) 24-Month CD, 10K
Pseudo-Online × Post March 2022	-0.008	0.022	0.004	0.047
	(0.015)	(0.028)	(0.049)	(0.064)
Observations	119302	110920	117385	116353
Branch FE	✓	✓	✓	✓
Month FE	✓	✓	✓	✓

Notes: This table presents estimates of β from the OLS regression $APY_{it} = \alpha_i + \alpha_t + \beta 1[PseudoOnline]_i \times 1[PostMarch2022]_t + \epsilon_{it}$ for the four products listed in each column. The 'pseudo online' indicator is assigned to branches that reside in ZIP codes that are most similar to the users of online banking. Selection of similar banks is done using nearest neighbor matching (with the smallest Euclidean distance) on ZIP code averages of having a computer in the home, access to internet, being older than 65, having a college degree, minority status, and being low income status (below $30,000 household income). APY_{it} is the annual percentage yield offered by institution i at time t. $1[PostMarch2022]_t$ is an indicator for time period t being after the rate increases in March of 2022. α_i and α_t are institution and time fixed effects. Standard errors are in parentheses and are clustered at the institution level. *$p < .1$, ** $p < .05$, *** $p < .01$

Table 7: Passthrough and Competition

	(1) Savings, 2.5K	(2) Money Market, 10K	(3) 6-Month CD, 10K	(4) 24-Month CD, 10K
Panel A: Low Competition Branches				
Online × Post March 2022	1.050***	0.466***	0.772***	1.346***
	(0.135)	(0.155)	(0.158)	(0.153)
Observations	60545	56243	59406	59014
Panel B: High Competition Branches				
Online × Post March 2022	1.073***	0.481***	0.861***	1.457***
	(0.135)	(0.155)	(0.158)	(0.154)
Observations	60109	55479	59079	58591
Panel D: Low Competition Branches (In Advertised Zip Code)				
Online × Post March 2022	1.061***	0.476***	0.786***	1.368***
	(0.135)	(0.155)	(0.158)	(0.154)
Observations	44130	40807	43343	43070
Panel E: High Competition Branches (In Advertised Zip Code)				
Online × Post March 2022	1.073***	0.479***	0.854***	1.447***
	(0.135)	(0.155)	(0.158)	(0.154)
Observations	49573	45866	48720	48452
Branch FE	✓	✓	✓	✓
Month FE	✓	✓	✓	✓

Notes: This table presents estimates of β from the OLS regression $APY_{it} = \alpha_i + \alpha_t + \beta 1[Online]_i \times 1[PostMarch2022]_t + \epsilon_{it}$ for the four products listed in each column. APY_{it} is the annual percentage yield offered by institution i at time t. $1[Online]_i$ is an indicator for if institution i is an online bank and $1[PostMarch2022]_t$ is an indicator for time period t being after the rate increases in March of 2022. α_i and α_t are institution and time fixed effects. The top two panels split branches by median county HHI and the bottom two panels restrict these splits to the zip codes where online banks advertise. Standard errors are in parentheses and are clustered at the institution level. $^{*}p < .1$, ** $p < .05$, *** $p < .01$

Table 8: Robustness Checks

	(1) Savings, 2.5K	(2) Money Market, 10K	(3) 6-Month CD, 10K	(4) 24-Month CD, 10K
Panel A: Large Banks Only				
Online × Post March 2022	0.946***	0.504***	0.708***	1.262***
	(0.155)	(0.158)	(0.204)	(0.208)
Observations	1950	1745	1824	1900
Panel B: Deposit Weighted				
Online × Post March 2022	0.927***	0.442***	0.638***	1.137***
	(0.151)	(0.154)	(0.183)	(0.172)
Observations	97695	91754	96021	94918
Bank FE	✓	✓	✓	✓
Month FE	✓	✓	✓	✓

Notes: This table presents estimates of β from the OLS regression $APY_{it} = \alpha_i + \alpha_t + \beta 1[Online]_i \times 1[PostMarch2022]_t + \epsilon_{it}$ for the four products listed in each column. APY_{it} is the annual percentage yield offered by institution i at time t. $1[Online]_i$ is an indicator for if institution i is an online bank and $1[PostMarch2022]_t$ is an indicator for time period t being after the rate increases in March of 2022. α_i and α_t are institution and time fixed effects. Standard errors are in parentheses and are clustered at the institution level. Panel A restricts brick-and-mortar banks to those with total assets worth at least 40 billion (58 total banks). Panel B weights average bank rates by the total deposits under each rate setting branch. $^*p < .1$, $^{**}\ p < .05$, $^{***}\ p < .01$

Table 9: Banks Matched on Business Model Characteristics

	(1) Savings, 2.5K	(2) Money Market, 10K	(3) 6-Month CD, 10K	(4) 24-Month CD, 10K
Panel A: Share Credit Cards				
Online × Post March 2022	0.968***	0.503***	0.777***	1.198***
	(0.154)	(0.158)	(0.195)	(0.191)
Panel B: Share Personal Loans				
Online × Post March 2022	0.942***	0.469***	0.686***	1.266***
	(0.154)	(0.159)	(0.201)	(0.193)
Panel C: Share Time Deposits				
Online × Post March 2022	0.961***	0.450***	0.725***	1.268***
	(0.154)	(0.164)	(0.195)	(0.189)
Panel D: Share Brokered Deposits				
Online × Post March 2022	0.890***	0.455***	0.716***	1.219***
	(0.157)	(0.161)	(0.202)	(0.202)
Panel E: Deposits per Branch				
Online × Post March 2022	0.642***	0.100	0.347	0.750***
	(0.185)	(0.198)	(0.233)	(0.244)
Panel F: All Characteristics				
Online × Post March 2022	0.888***	0.363**	0.586***	0.938***
	(0.156)	(0.166)	(0.203)	(0.198)
Observations	2321	1895	2124	2275
Bank FE	✓	✓	✓	✓
Month FE	✓	✓	✓	✓

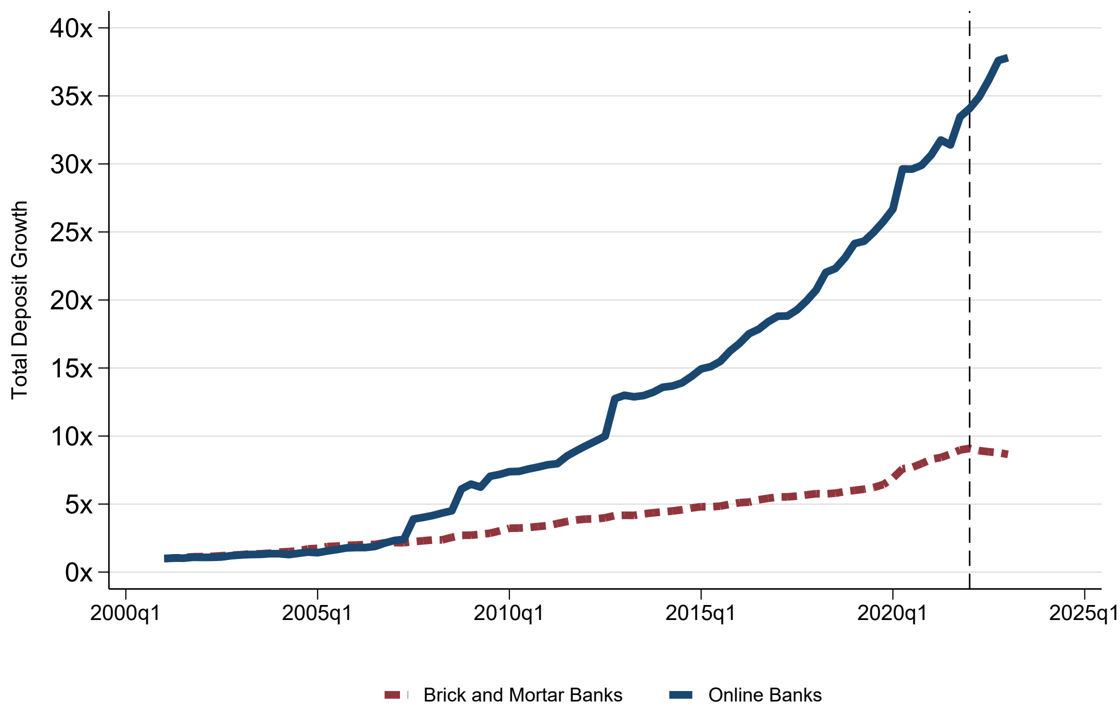
Notes: This table presents estimates of β from the OLS regression $APY_{it} = \alpha_i + \alpha_t + \beta 1[Online]_i \times 1[PostMarch2022]_t + \epsilon_{it}$ for the four products listed in each column. APY_{it} is the annual percentage yield offered by institution i at time t. $1[Online]_i$ is an indicator for if institution i is an online bank and $1[PostMarch2022]_t$ is an indicator for time period t being after the rate increases in March of 2022. α_i and α_t are institution and time fixed effects. Standard errors are in parentheses and are clustered at the institution level. The sample is restricted to brick-and-mortar banks that match to online banks using nearest neighbor matching (with the smallest Euclidean distance). For each online bank we use the three nearest neighbors. Panels A-E match on the share of assets that are credit card loans, share of assets that are personal loans, share of deposits that are time deposits, share of deposits that brokered deposits, and the number of deposits per branch. Panel F matches on all of these characteristics plus total assets and establish year. $^{*}p < .1$, $^{**}p < .05$, $^{***}p < .01$

Table 10: Loans

	Quantities		Rates			
	(1)	(2)	(3)	(4)	(5)	(6)
	Total Loans	Personal Loans	5-Year Auto, New	5-Year Auto, Used	15-Year Mortgage	30-Year Mortgage
Panel A: Post Interaction						
Online × Post March 2022	6.614**	4.601**	0.464***	0.316**	1.434***	1.260***
	(2.901)	(1.851)	(0.138)	(0.156)	(0.051)	(0.104)
Panel B: FFR Interaction						
Online × FFR	2.163**	1.608**	0.171***	0.125	0.407***	0.368***
	(1.051)	(0.776)	(0.060)	(0.086)	(0.018)	(0.055)
Observations	36096	36096	46637	42572	22673	19759
Bank FE	✓	✓	✓	✓	✓	✓
Quarter FE	✓	✓				
Month FE			✓	✓	✓	✓

Notes: This table presents estimates of β from the OLS regression $Y_{it} = \alpha_i + \alpha_t + \beta 1[Online]_i \times 1[PostMarch2022]_t + \epsilon_{it}$. In columns 1-2, Y_{it} is the quantity of loans in billions of institution i at time t as reported in the Call Reports. In columns 3-6, Y_{it} is the annual percentage rate offered by institution i at time t on the products labeld above each column. $1[Online]_i$ is an indicator for if institution i is an online bank and $1[PostMarch2022]_t$ is an indicator for time period t being after the rate increases in March of 2022. α_i and α_t are institution and time fixed effects. Standard errors are in parentheses and are clustered at the institution level. Panel B replaces $1[PostMarch2022]_t$ with the actual federal funds rate at time t. Personal loans are defined as credit cards, mortgages, auto loans, and other personal revolving lines of credit. $^*p < .1$, $^{**}\ p < .05$, $^{***}\ p < .01$

Figure 1: Total Deposit Growth

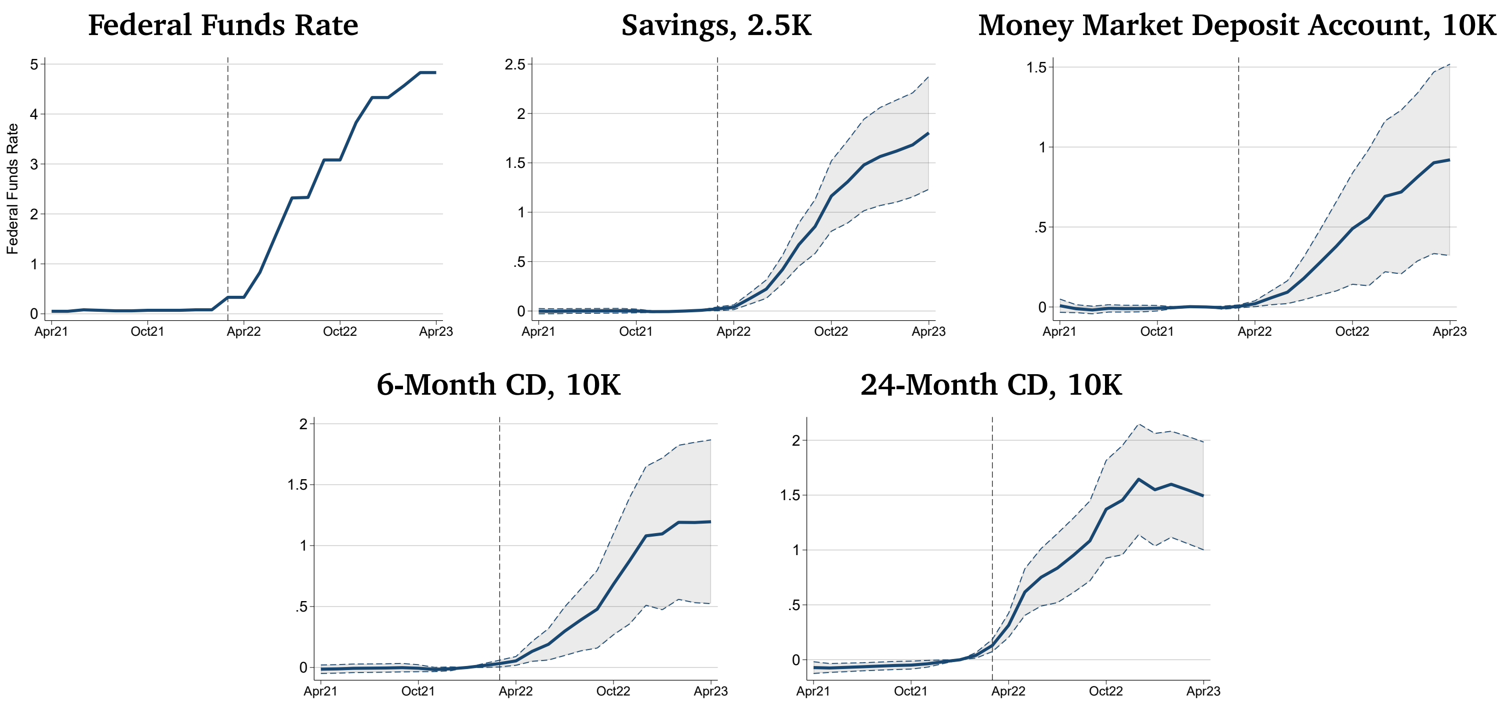


Notes: This figure shows total deposit growth since March 2001 by bank type. The dashed vertical line indicates when the federal reserve began increasing rates in March of 2022. The online banks that are included are listed in Table 1. CIT Bank and E*Trade were both acquired in 2022 and have been excluded. In 2007 Capital One acquired North Fork bank and in 2012 they acquired ING bank nearly doubling their total deposits each time. For this graph North Fork bank and ING bank deposits prior to their acquisitions have been included in Capital One's deposits. Deposits for banks regulated by Office of Thrift Supervision (OTS) prior to 2011 have been linearly interpolated from annual Summary of Deposits data. Source: FFIEC & FDIC

Figure 2: Levels for Rates

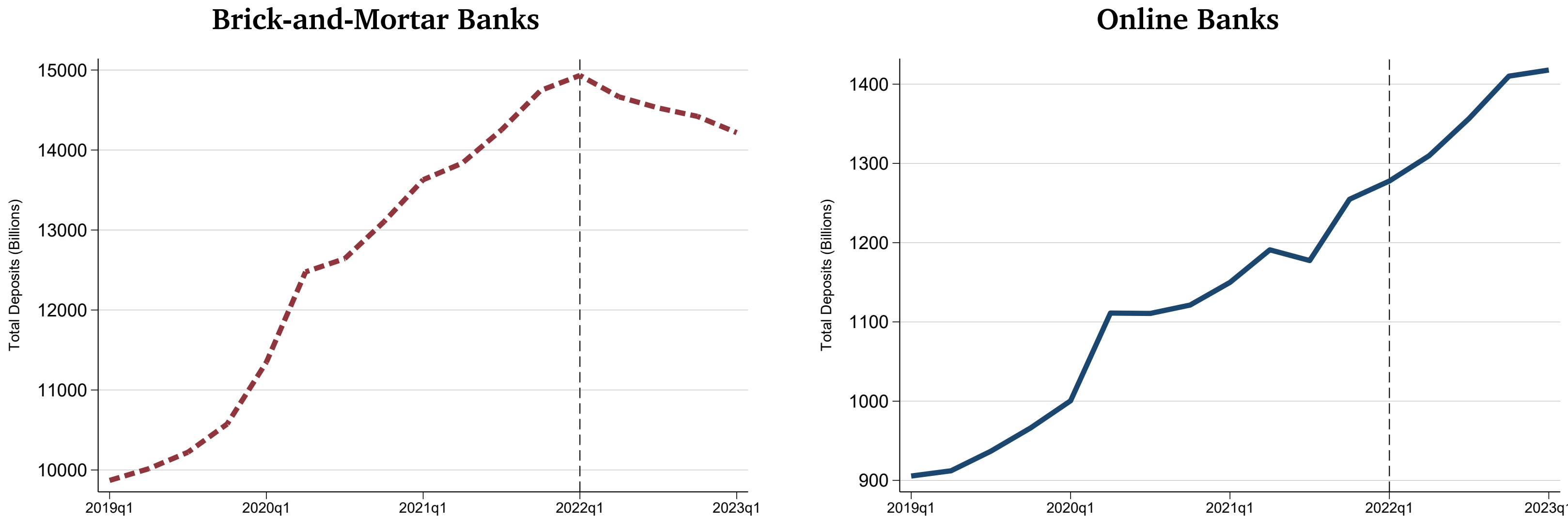
Notes: This figure plots the average annual percentage yield for each product broken down by online banks and brick-and-mortar banks. The solid blue lines show the average APY for online banks and the dashed red lines show average APY for brick-and-mortar banks. The dashed vertical line indicates when the Federal Reserve began increasing interest rates in March of 2022. Source: RateWatch & FRED

Figure 3: Deposit Rates



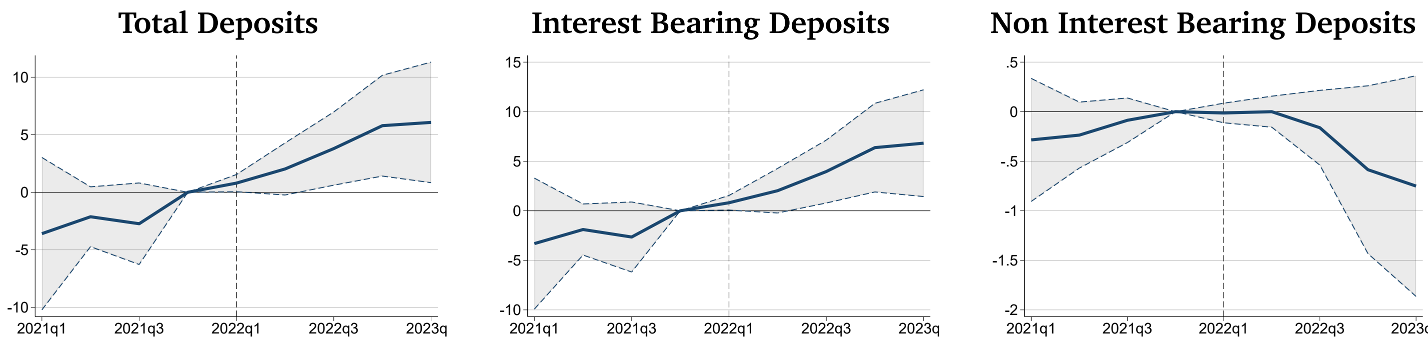
Notes: This figure plots β_t from the OLS regression $APY_{it} = \alpha_i + \alpha_t + \sum_t \beta_t Online_i + \nu_{it}$ along with a 95% confidence interval. APY_{it} is the annual percentage yield offered by institution i at time t. $Online_i$ is an indicator for if institution i is an online bank. α_i and α_t are institution and time fixed effects. Standard errors are clustered at the institution level. The dashed vertical line indicates when the Federal Reserve began increasing interest rates in March of 2022. Source: RateWatch

Figure 4: Total Deposit Levels



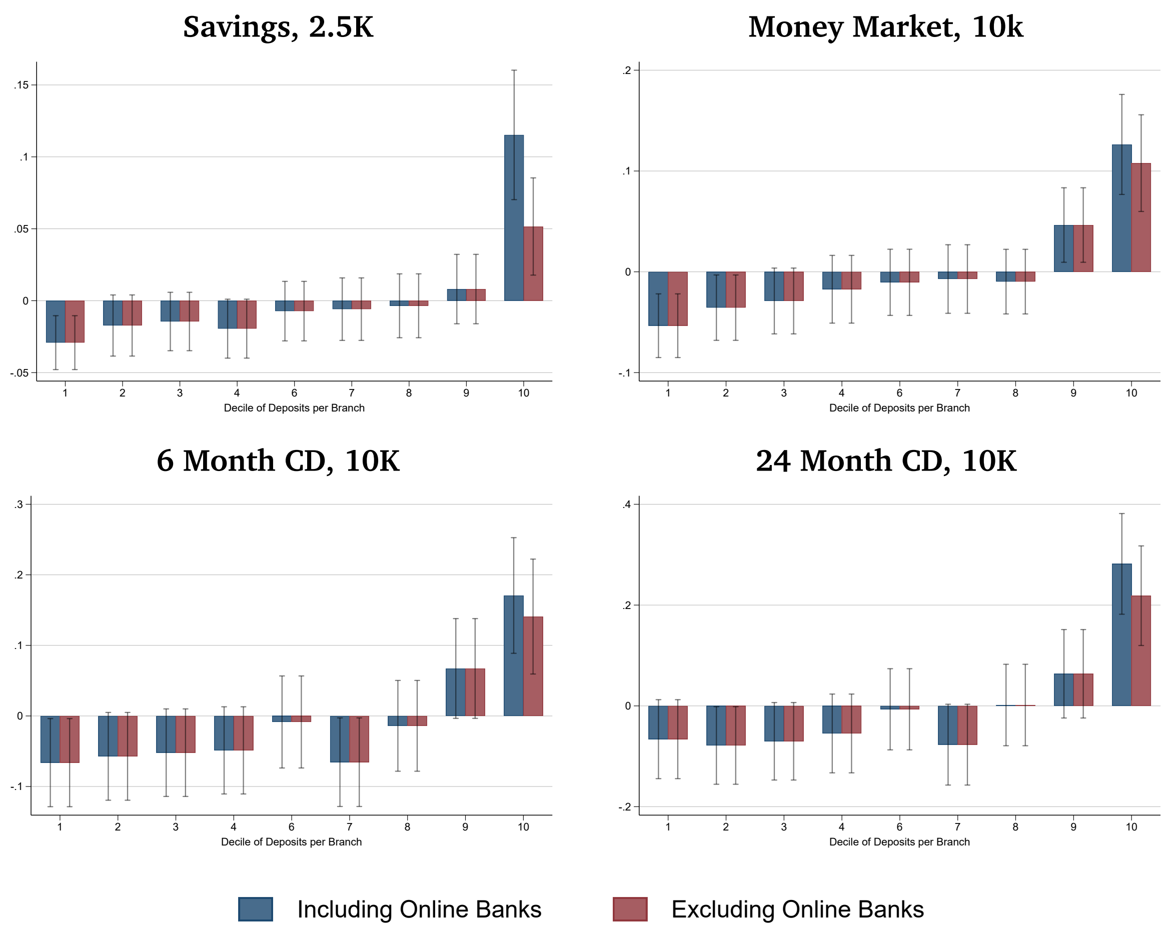
Notes: This figure shows total deposits by bank type. The dashed vertical line indicates when the federal reserve began increasing rates in March of 2022. The online banks that are included are listed in Table 1. CIT Bank and E*Trade were both acquired in 2022 and have been excluded. Source: FFIEC

Figure 5: Total Deposits



Notes: This figure plots β_t from the OLS regression $Deposits_{it} = \alpha_i + \alpha_t + \sum_t \beta_t Online_i + \nu_{it}$ along with a 95% confidence interval. $Deposits_{it}$ is respectively the total deposits, interest bearing deposits and non interest bearing deposits held by institution i at time t in billions. $Online_i$ is an indicator for if institution i is an online bank. α_i and α_t are institution and time fixed effects. Standard errors are clustered at the institution level. The dashed vertical line indicates when the federal reserve began increasing interest rates in March of 2022. Source: FFIEC

Figure 6: Sensitivity by Deposits Per Branch



Notes: This figure presents estimates of β from the OLS regression $APY_{it} = \alpha_i + \alpha_t + \beta D_i \times 1[PostMarch2022]_t + \epsilon_{it}$ for the four products listed above each panel. APY_{it} is the annual percentage yield offered by institution i at time t. D_i is a vector of indicators for institution i's decile of deposits per branch and $1[PostMarch2022]_t$ is an indicator for time period t being after the rate increases in March of 2022. α_i and α_t are institution and time fixed effects. Standard errors are clustered at the institution level. The blue bars use all banks and the red bars exclude online banks. See Table A.4 for individual coefficients and standard errors.

Appendix

A Additional Tables and Figures

Table A.1: Main Results Using 2015-2019 Rate Hikes

	(1) Savings, 2.5K	(2) Money Market, 10K	(3) 6-Month CD, 10K	(4) 24-Month CD, 10K
Panel A: Post Interaction				
Online × Post December 2016	0.317***	0.109*	0.124*	0.291***
	(0.065)	(0.060)	(0.075)	(0.091)
Panel B: FFR Interaction				
Online × FFR	0.297***	0.115**	0.102	0.257***
	(0.061)	(0.057)	(0.065)	(0.087)
Observations	97532	91242	96496	93869
Bank FE	✓	✓	✓	✓
Month FE	✓	✓	✓	✓

Notes: This table presents estimates of β from the OLS regression $APY_{it} = \alpha_i + \alpha_t + \beta 1[Online]_i \times 1[PostDecember2016]_t + \epsilon_{it}$ for the four products listed in each column. APY_{it} is the annual percentage yield offered by institution i at time t. $1[Online]_i$ is an indicator for if institution i is an online bank and $1[PostDecember2016]_t$ is an indicator for time period t being after the rate increases in December of 2016. α_i and α_t are institution and time fixed effects. Standard errors are in parentheses and are clustered at the institution level. Panel B replaces $1[PostDecember2016]_t$ with the actual federal funds rate at time t. $^{*}p < .1$, $^{**}\, p < .05$, $^{***}\, p < .01$

Table A.2: Results Dropping Individual Banks

	(1) Savings, 2.5K	(2) Money Market, 10K	(3) 6-Month CD, 10K	(4) 24-Month CD, 10K
Alliant Credit Union				
Online × Post March 2022	0.912***	0.442***	0.639***	1.107***
	(0.156)	(0.154)	(0.183)	(0.176)
Observations	98100	92209	96447	95348
Ally Bank				
Online × Post March 2022	0.905***	0.389**	0.613***	1.133***
	(0.156)	(0.153)	(0.190)	(0.179)
Observations	98100	92184	96422	95348
American Bank				
Online × Post March 2022	0.961***	0.464***	0.672***	1.188***
	(0.153)	(0.160)	(0.188)	(0.171)
Observations	98075	92159	96397	95323
American Express National Bank				
Online × Post March 2022	0.902***	0.442***	0.639***	1.108***
	(0.155)	(0.154)	(0.183)	(0.176)
Observations	98100	92209	96447	95348
Axos Bank				
Online × Post March 2022	0.966***	0.476***	0.688***	1.208***
	(0.152)	(0.158)	(0.185)	(0.163)
Observations	98100	92184	96422	95348
Bancorp Bank				
Online × Post March 2022	0.969***	0.453***	0.639***	1.137***
	(0.151)	(0.162)	(0.183)	(0.172)
Observations	98100	92184	96447	95373
Barclays Bank Delaware				
Online × Post March 2022	0.901***	0.442***	0.684***	1.100***
	(0.155)	(0.154)	(0.185)	(0.175)
Observations	98100	92209	96423	95348
CIT Bank				
Online × Post March 2022	0.965***	0.474***	0.688***	1.208***
	(0.152)	(0.159)	(0.185)	(0.163)
Observations	98100	92184	96422	95348
Capital One, National Association				
Online × Post March 2022	0.903***	0.442***	0.608***	1.101***
	(0.155)	(0.154)	(0.189)	(0.175)
Observations	98100	92209	96422	95348
Colorado Federal Savings Bank				
Online × Post March 2022	0.910***	0.442***	0.599***	1.109***
	(0.156)	(0.154)	(0.187)	(0.176)
Observations	98100	92209	96422	95348

Table A.2: Results Dropping Individual Banks (Continued)

	(1) Savings, 2.5K	(2) Money Market, 10K	(3) 6-Month CD, 10K	(4) 24-Month CD, 10K
Comenity Direct				
Online × Post March 2022	0.931***	0.442***	0.639***	1.155***
	(0.157)	(0.154)	(0.183)	(0.178)
Observations	98100	92209	96447	95348
Cross River Bank				
Online × Post March 2022	0.920***	0.474***	0.666***	1.166***
	(0.157)	(0.159)	(0.189)	(0.176)
Observations	98100	92184	96422	95348
Discover Bank				
Online × Post March 2022	0.901***	0.386**	0.623***	1.108***
	(0.155)	(0.151)	(0.191)	(0.176)
Observations	98100	92184	96422	95348
E*Trade Bank				
Online × Post March 2022	0.966***	0.442***	0.639***	1.137***
	(0.152)	(0.154)	(0.183)	(0.172)
Observations	98100	92209	96447	95373
Farm Bureau Bank, FSB				
Online × Post March 2022	0.927***	0.474***	0.662***	1.175***
	(0.151)	(0.159)	(0.190)	(0.174)
Observations	98125	92184	96422	95348
First Command Bank				
Online × Post March 2022	0.927***	0.465***	0.665***	1.186***
	(0.151)	(0.160)	(0.189)	(0.172)
Observations	98125	92184	96422	95348
First Internet Bank of Indiana				
Online × Post March 2022	0.952***	0.385**	0.590***	1.105***
	(0.155)	(0.151)	(0.185)	(0.176)
Observations	98100	92184	96422	95348
LendingClub Bank, National Association				
Online × Post March 2022	0.891***	0.442***	0.639***	1.099***
	(0.153)	(0.154)	(0.183)	(0.174)
Observations	98100	92209	96447	95348
Live Oak Banking Company				
Online × Post March 2022	0.896***	0.442***	0.572***	1.167***
	(0.154)	(0.154)	(0.179)	(0.176)
Observations	98100	92209	96422	95348
Marcus by Goldman Sachs				
Online × Post March 2022	0.904***	0.442***	0.596***	1.107***
	(0.155)	(0.154)	(0.186)	(0.176)
Observations	98100	92209	96422	95348
NBKC Bank				
Online × Post March 2022	0.927***	0.429***	0.688***	1.149***
	(0.151)	(0.161)	(0.185)	(0.178)
Observations	98125	92184	96422	95348

Table A.2: Results Dropping Individual Banks (Continued)

	(1) Savings, 2.5K	(2) Money Market, 10K	(3) 6-Month CD, 10K	(4) 24-Month CD, 10K
Nano Banc				
Online × Post March 2022	0.973***	0.477***	0.698***	1.137***
	(0.150)	(0.158)	(0.182)	(0.172)
Observations	98100	92184	96422	95373
NexBank				
Online × Post March 2022	0.960***	0.444***	0.638***	1.154***
	(0.154)	(0.162)	(0.191)	(0.178)
Observations	98100	92184	96422	95348
Quontic Bank				
Online × Post March 2022	0.898***	0.389**	0.616***	1.116***
	(0.154)	(0.152)	(0.190)	(0.177)
Observations	98100	92184	96422	95348
Sallie Mae Bank				
Online × Post March 2022	0.897***	0.379**	0.602***	1.104***
	(0.154)	(0.149)	(0.188)	(0.176)
Observations	98100	92184	96422	95348
Silvergate Bank				
Online × Post March 2022	0.965***	0.474***	0.639***	1.137***
	(0.152)	(0.159)	(0.183)	(0.172)
Observations	98100	92184	96447	95373
Synchrony Bank				
Online × Post March 2022	0.895***	0.417***	0.590***	1.107***
	(0.154)	(0.160)	(0.185)	(0.176)
Observations	98100	92184	96422	95348
TAB Bank				
Online × Post March 2022	0.890***	0.474***	0.598***	1.113***
	(0.153)	(0.159)	(0.187)	(0.177)
Observations	98100	92184	96422	95348
TIAA, FSB				
Online × Post March 2022	0.933***	0.444***	0.650***	1.157***
	(0.157)	(0.162)	(0.191)	(0.178)
Observations	98100	92184	96422	95348
USAA Federal Savings Bank				
Online × Post March 2022	0.966***	0.472***	0.688***	1.131***
	(0.152)	(0.159)	(0.185)	(0.179)
Observations	98100	92184	96422	95348
Bank FE	✓	✓	✓	✓
Month FE	✓	✓	✓	✓

Notes: This table presents estimates of β from the OLS regression $APY_{it} = \alpha_i + \alpha_t + \beta 1[Online]_i \times 1[PostMarch2022]_t + \epsilon_{it}$ for the four products listed in each column. In each row one online bank is excluded from the regression as indicated in the top left corner. Standard errors are in parentheses and are clustered at the institution level.$*p < .1$, ** $p < .05$, *** $p < .01$

Table A.3: Sample Variation Checks

	(1) Savings, 2.5K	(2) Money Market, 10K	(3) 6-Month CD, 10K	(4) 24-Month CD, 10K
Panel A: Including Hand Collected Rates				
Online × Post March 2022	0.877***	0.428***	0.765***	1.155***
	(0.145)	(0.147)	(0.190)	(0.166)
Observations	98175	92234	96497	95398
Panel B: Excluding Abrams 2019 Banks				
Online × Post March 2022	0.924***	0.477***	0.623***	1.165***
	(0.168)	(0.167)	(0.205)	(0.177)
Observations	98025	92159	96347	95273
Panel C: Single Branch Online Banks				
Online × Post March 2022	0.935***	0.483*	0.752***	1.158***
	(0.209)	(0.251)	(0.287)	(0.243)
Observations	97825	91934	96147	95073
Bank FE	✓	✓	✓	✓
Month FE	✓	✓	✓	✓

Notes: This table presents estimates of β from the OLS regression $APY_{it} = \alpha_i + \alpha_t + \beta 1[Online]_i \times 1[PostMarch2022]_t + \epsilon_{it}$ for the four products listed in each column. APY_{it} is the annual percentage yield offered by institution i at time t. $1[Online]_i$ is an indicator for if institution i is an online bank and $1[PostMarch2022]_t$ is an indicator for time period t being after the rate increases in March of 2022. α_i and α_t are institution and time fixed effects. Standard errors are in parentheses and are clustered at the institution level. Panel A extends the sample using the hand collected rates discussed in section C.2. Panel B removes banks that have more than 4 branches but are included because they were identified as online banks in Abrams (2019). Panel C restricts the online banks sample to only online banks with one branch. $*p < .1$, $**\ p < .05$, $***\ p < .01$

Table A.4: Deposits Per Branch

	Including Online Banks				Excluding Online Banks			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Savings, 2.5K	Money Market, 10K	6-Month CD, 10K	24-Month CD, 10K	Savings, 2.5K	Money Market, 10K	6-Month CD, 10K	24-Month CD, 10K
Decile 1	-0.029***	-0.053***	-0.066**	-0.066*	-0.029***	-0.053***	-0.066**	-0.066*
	(0.010)	(0.016)	(0.032)	(0.040)	(0.010)	(0.016)	(0.032)	(0.040)
Decile 2	-0.017	-0.036**	-0.057*	-0.079**	-0.017	-0.036**	-0.057*	-0.079**
	(0.011)	(0.017)	(0.032)	(0.039)	(0.011)	(0.017)	(0.032)	(0.039)
Decile 3	-0.014	-0.029*	-0.052	-0.070*	-0.014	-0.029*	-0.052	-0.070*
	(0.010)	(0.017)	(0.032)	(0.039)	(0.010)	(0.017)	(0.032)	(0.039)
Decile 4	-0.019*	-0.017	-0.049	-0.055	-0.019*	-0.017	-0.049	-0.055
	(0.010)	(0.017)	(0.032)	(0.040)	(0.010)	(0.017)	(0.032)	(0.040)
Decile 6	-0.007	-0.010	-0.009	-0.007	-0.007	-0.010	-0.009	-0.007
	(0.011)	(0.017)	(0.033)	(0.041)	(0.011)	(0.017)	(0.033)	(0.041)
Decile 7	-0.006	-0.007	-0.066**	-0.077*	-0.006	-0.007	-0.066**	-0.077*
	(0.011)	(0.017)	(0.032)	(0.041)	(0.011)	(0.017)	(0.032)	(0.041)
Decile 8	-0.004	-0.010	-0.014	0.002	-0.004	-0.010	-0.014	0.002
	(0.011)	(0.016)	(0.033)	(0.041)	(0.011)	(0.016)	(0.033)	(0.041)
Decile 9	0.008	0.046**	0.067*	0.064	0.008	0.046**	0.067*	0.064
	(0.012)	(0.019)	(0.036)	(0.045)	(0.012)	(0.019)	(0.036)	(0.045)
Decile 10	0.115***	0.126***	0.171***	0.282***	0.052***	0.108***	0.141***	0.219***
	(0.023)	(0.025)	(0.042)	(0.051)	(0.017)	(0.024)	(0.042)	(0.050)
Bank FE	✓	✓	✓	✓	✓	✓	✓	✓
Month FE	✓	✓	✓	✓	✓	✓	✓	✓
Observations	98125	92209	96447	95373	97450	91709	95873	94723

Notes: This table presents estimates of β from the OLS regression $APY_{it} = \alpha_i + \alpha_t + \beta D_i \times 1[PostMarch2022]_t + \epsilon_{it}$ for the four products listed in each column. APY_{it} is the annual percentage yield offered by institution i at time t. D_i is a vector of indicators for institution i's decile of deposits per branch and $1[PostMarch2022]_t$ is an indicator for time period t being after the rate increases in March of 2022. α_i and α_t are institution and time fixed effects. Standard errors are clustered at the institution level. $^{*}p < .1$, ** $p < .05$, *** $p < .01$

Table A.5: Additional Robustness

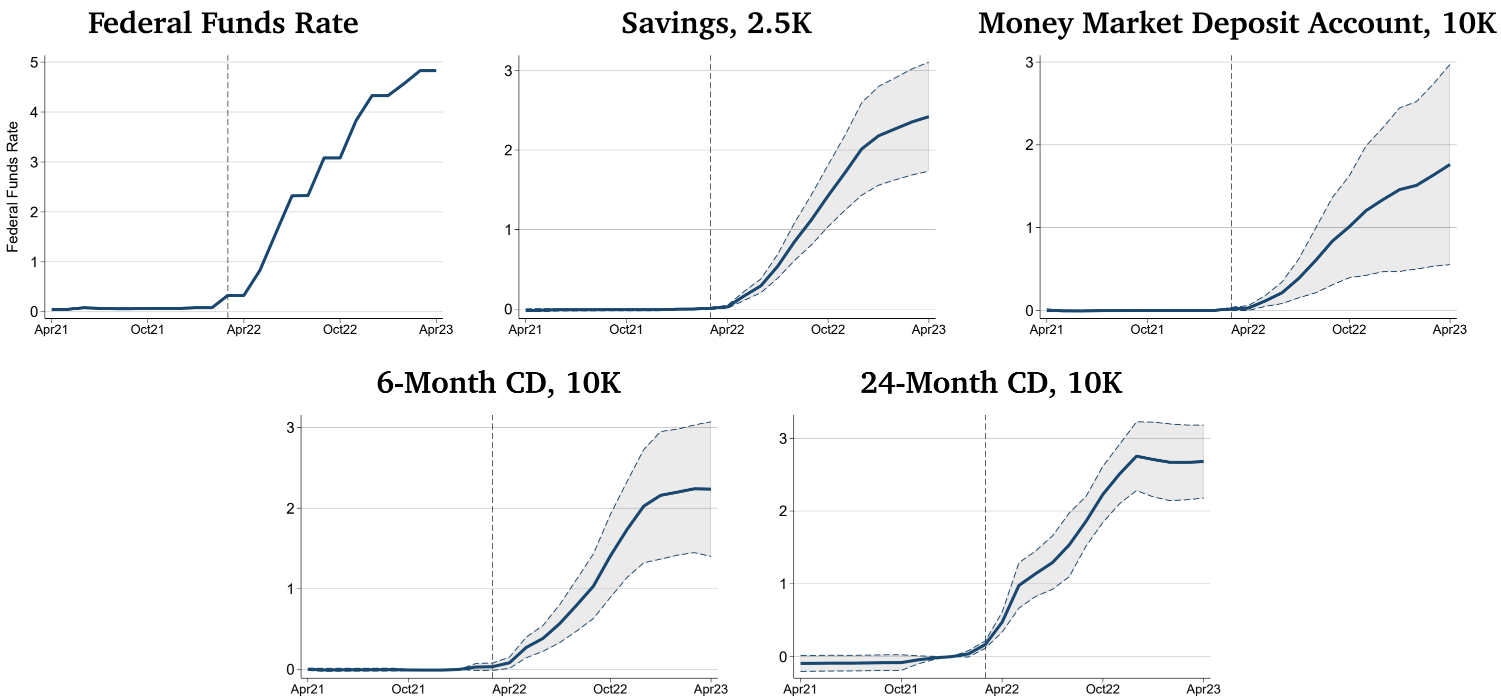
	(1) Savings, 2.5K	(2) Money Market, 10K	(3) 6-Month CD, 10K	(4) 24-Month CD, 10K
Panel A: Young Banks Only				
Online × Post March 2022	0.905***	0.400***	0.560***	1.032***
	(0.152)	(0.155)	(0.185)	(0.174)
Observations	12487	12289	12285	12434
Panel B: High Rate Banks Only				
Online × Post March 2022	0.910***	0.382**	0.439**	0.927***
	(0.151)	(0.154)	(0.184)	(0.173)
Observations	41461	24082	24394	24166
Bank FE	✓	✓	✓	✓
Month FE	✓	✓	✓	✓

Notes: This table presents estimates of β from the OLS regression $APY_{it} = \alpha_i + \alpha_t + \beta 1[Online]_i \times 1[PostMarch2022]_t + \epsilon_{it}$ for the four products listed in each column. APY_{it} is the annual percentage yield offered by institution i at time t. $1[Online]_i$ is an indicator for if institution i is an online bank and $1[PostMarch2022]_t$ is an indicator for time period t being after the rate increases in March of 2022. α_i and α_t are institution and time fixed effects. Standard errors are in parentheses and are clustered at the institution level. Panel A restricts brick-and-mortar banks to those established after 2000 (657 banks). Panel B uses only brick-and-mortar banks offering rates greater than or equal to the 75th percentile of rates prior to March 2022. $*p < .1$, $**\ p < .05$, $***\ p < .01$

Figure A.1: Levels Raw Means - Total Deposits Weighted

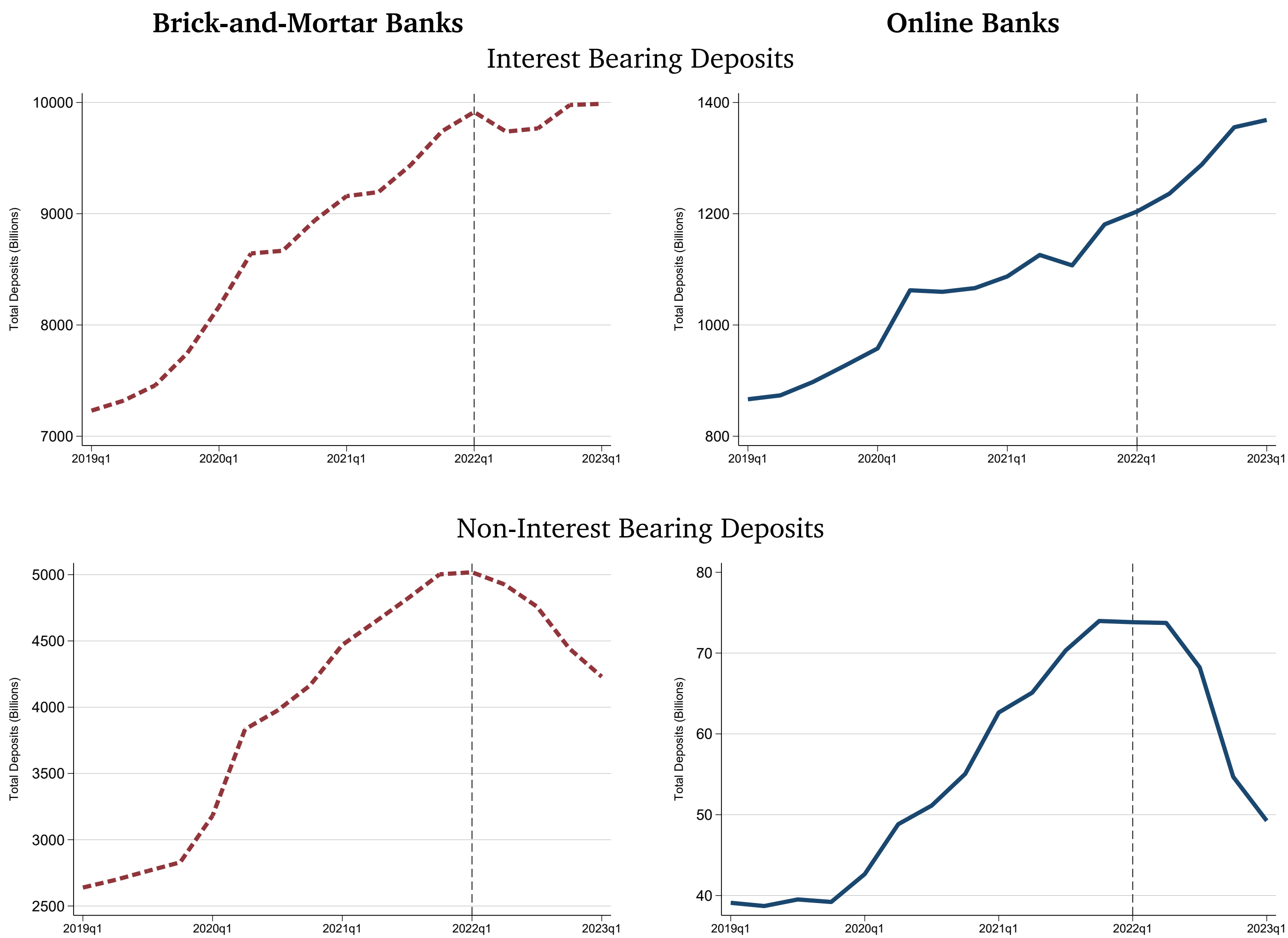
Notes: This figure plots the average annual percentage yield for each product broken down by online banks and brick-and-mortar banks, weighted using each bank's total deposits. The solid blue lines show the average APY for online banks and the dashed red lines show average APY for brick-and-mortar banks. The dashed vertical line indicates when the Federal Reserve began increasing interest rates in March of 2022. Source: RateWatch & FRED

Figure A.2: Event Studies - Total Deposits Weighted



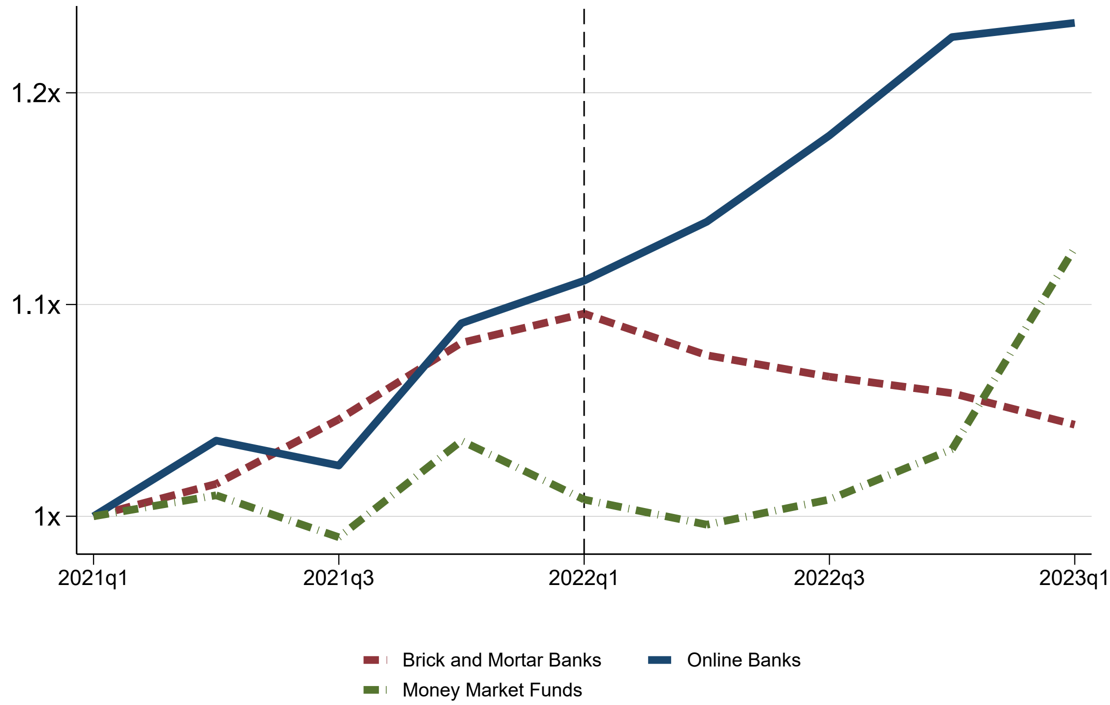
Notes: This figure plots β_t from the OLS regression $APY_{it} = \alpha_i + \alpha_t + \sum_t \beta_t Online_i + \nu_{it}$, weighted using each bank's total deposits, along with a 95% confidence interval. APY_{it} is the annual percentage yield offered by institution i at time t. $Online_i$ is an indicator for if institution i is an online bank. α_i and α_t are institution and time fixed effects. Standard errors are clustered at the institution level. The dashed vertical line indicates when the Federal Reserve began increasing interest rates in March of 2022. Source: RateWatch

Figure A.3: Deposit Type Breakdown



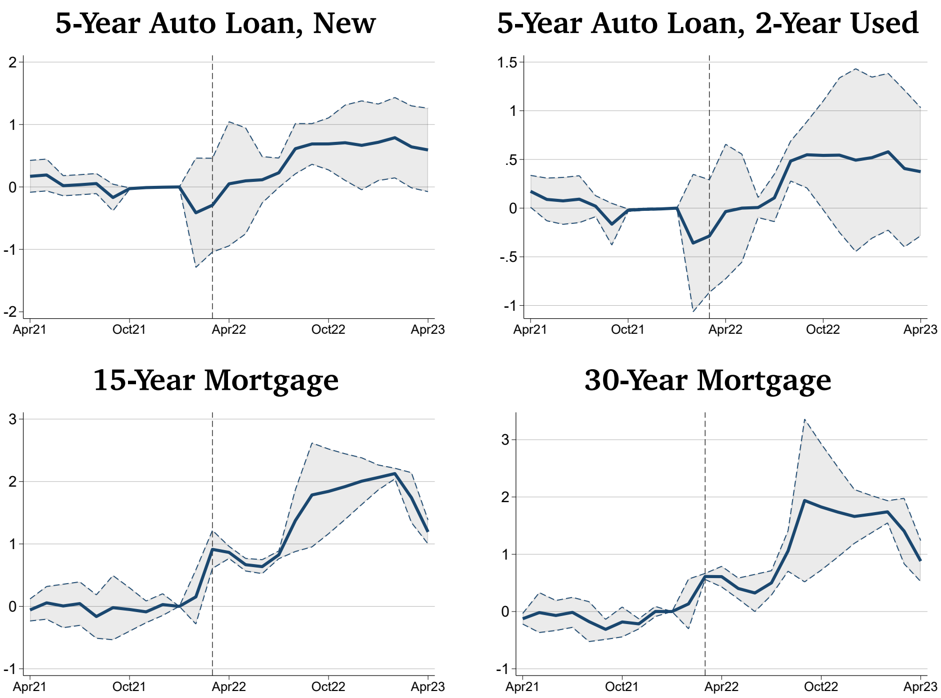
Notes: This figure shows total deposits since March 2019 by bank type and deposit type. The dashed vertical line indicates when the Federal Reserve began increasing rates in March of 2022. The online banks that are included are listed in table 1. CIT Bank and E*Trade were both acquired in 2022 and have been excluded. Source: FFIEC

Figure A.4: Money Market Fund Growth



Notes: This figure plots brick-and-mortar bank deposits, online bank deposits, and money market fund growth indexed at quarter 1 of 2021. Source: FFIEC & financialresearch.gov

Figure A.5: Loan Event Studies



Notes: This figure plots β_t from the OLS regression $APR_{it} = \alpha_i + \alpha_t + \sum_t \beta_t Online_i + \nu_{it}$ along with a 95% confidence interval. APR_{it} is the annual percentage rate offered by institution i at time t. $Online_i$ is an indicator for if institution i is an online bank. α_i and α_t are institution and time fixed effects. Standard errors are clustered at the institution level. The dashed vertical line indicates when the Federal Reserve began increasing interest rates in March of 2022. Source: RateWatch

B Demographics and Passthrough

To study the role of demographics, we use household-level data from the Survey of Consumer Finances (SCF). Note that the SCF does not ask whether individuals use an online-only bank, but rather whether they use online or mobile banking services, regardless of whether their bank also has physical branches. Nonetheless this question is also informative about the types of households that are likely to use purely online banking.

Using the provided population weights we calculate averages across four key demographics: an older than 65 indicator, having a college degree, being a minority, and being low income status (below $30,000 household income). Table B.1 shows the statistics. The SCF averages suggest that users of online banking services tend to be younger, more educated, and have a higher income. Additionally, minorities use online banking services less than non-minority individuals.

The ideal way to study the effect of these demographics on deposit rates would require data about the demographic composition of each bank. Given such data, we could match brick-and-mortar banks with very similar customers as online banks. If demographically-similar brick-and-mortar banks offer rates that are similar to the rates of online banks, we could conclude that demographics play an important role. But if their deposit rates are more similar to the rates at other brick-and-mortar banks, it would imply that demographics are not very important.

Data about the demographics of different banks' customers is not available. We therefore take a second-best approach and use data on the demographic composition of the ZIP codes where bank branches are located. If demographics are important for interest rates, we might expect that branches in higher-income, younger and more educated areas are more sensitive to the federal funds rate. To study this, we use ZIP code level demographic data from the 2015-2019 ACS. Similar to our SCF estimates, we use data on average household income, minority share, age distribution, and average education levels. We also look at variables measuring computer use and internet availability.

For each product we re-estimate our main results adding in demographics controls using the following specification:

$$\text{APY}_{it} = \alpha_i + \alpha_t + \beta 1[Online]_i \times 1[PostMarch2022]_t + \sum_j \delta_j Demographic_{ji} \times 1[PostMarch2022] + \epsilon_{it} \quad (5)$$

where j indexes population averages of having a computer in the home, access to internet, being older than 65, having a college degree, minority status, and being low income status (below \$30,000 household income) within the ZIP code for which branch i resides. Standard errors are clustered at the bank level.

Results are shown in Table 5. If the demographics of users explain online bank's passthrough we would expect the addition of demographics controls to decrease the magnitude and significance of the coefficient of interest β. We find no such decrease in magnitude or significance with the addition of demographics controls leading us to believe that demographics do not drive online bank passthrough. As an additional test we repeat our main regression using only traditional banks that reside in ZIP codes similar to users of online banks. Results are shown in Table C.2. Estimates again remain large and significant.

Table B.1: Online Banking Demographics

	Mean	SD	Max	Min	Median	Obs
SCF: Never Used Online Banking						
Age 65+	0.46	0.50	1.00	0.00	0.00	5492
College Degree	0.14	0.35	1.00	0.00	0.00	5492
Minority	0.41	0.49	1.00	0.00	0.00	5492
Low Income	0.52	0.50	1.00	0.00	1.00	5492
SCF: Used Online Banking						
Age 65+	0.19	0.39	1.00	0.00	0.00	23393
College Degree	0.43	0.49	1.00	0.00	0.00	23393
Minority	0.29	0.46	1.00	0.00	0.00	23393
Low Income	0.17	0.37	1.00	0.00	0.00	23393
Online Bank Sample						
Age 65+	0.18	0.01	0.20	0.16	0.19	30
College Degree	0.35	0.08	0.44	0.21	0.37	30
Minority	0.24	0.07	0.32	0.09	0.26	30
Low Income	0.20	0.04	0.30	0.16	0.19	30
Matched Brick-and-Mortar Branches						
Age 65+	0.18	0.02	0.24	0.12	0.17	96
College Degree	0.30	0.08	0.48	0.19	0.29	96
Minority	0.21	0.08	0.35	0.08	0.23	96
Low Income	0.22	0.05	0.33	0.11	0.22	96

Notes: The first two panels of this table present SCF summary statistics split by those who use online banking and those who do not use online banking. Statistics are calculated using the provided population weights. Low income status is defined as having a household income below $30,000. The third panel presents the summary statistics of online bank users using the demographics of the zip codes in which they advertise as proxies for user demographics. The fourth panel presents the summary statistics of the nearest neighbour (with the smallest Euclidean distance) matched brick-and-mortar branches using the demographics of their zip codes as proxies for user demographics.. Source: 2019 SCF & ACS

C Detailed Data Construction

C.1 Main Sample

To create our analysis sample, we start with the set of online and brick-and-mortar banks that have Federal Financial Institutions Examination Council (FFIEC) Call Reports as of March 2021. We excluded any institutions with less than $50 million in assets.[26] Using the Call Reports data, we measure banks' total assets, total deposits, interest-bearing deposits and non-interest bearing deposits by quarter. We match Ratewatch data to data from Call Reports at the institution level. We then aggregate this data set to the month-by-institution level, taking the simple average of rates across each institution's branches. To identify online banks we begin by considering all banks in RateWatch and the March of 2021 FFIEC Call Reports that have less than five branches and more than $500 million in deposits. To this list we add all online banks identified by Abrams (2019). We then remove community banks and banks which do not offer commercial banking services by hand checking each bank's website. Banks whose websites contain the key phrases "Locations & Hours" and "Community" are flagged as non-online institutions. This results in a sample of 41 banks which operate almost entirely online. All but one of these banks, Alliant Credit Union, files with the FFIEC. We collect similar Call Report data on Alliant using data from the National Credit Union Administration.

Next we identify products that allow us to compare rates between online banks and brick-and-mortar banks. The criteria for these products is that they must be consistently reported in RateWatch by at least 10 online banks between April 2021 and April 2023. To enforce consistent coverage, we remove all banks's products that have less than 19 months of coverage during this 25 month period. Missing gaps in banks' reported annual percentage yields are then linearly interpolated. The products with consistent RateWatch coverage which we study rates are $2,500 savings, $10,000 money market savings accounts, 6-month $10,000 certificates of deposit, 24-month and $10,000 certificates of deposit. Of the 41 identified online banks 30

[26] Figures C.1 and C.2 repeat our main analysis including these banks.

have consistent coverage in Ratewatch data.[27] These 30 banks comprise the online banks in our main analysis sample and all other banks with consistent Ratewatch coverage comprise of the brick and mortar banks in our analysis.

C.2 Online Bank Sample Extension

Due to the limitations of the RateWatch surveys we are not able to include every online bank in our main sample. However, online banks often list deposit rates on their websites. Using the Internet Archive 'Wayback Machine' we hand collect the rates of the online banks which were excluded from our main sample due to lack of coverage by RateWatch.

We begin with the the 11 online banks listed in Table C.1 which we identified in the Call Reports but did not have RateWatch coverage and check each bank's website for the deposit rates offered on the four products in our analysis. We then use the Internet Archive to obtain snap shots of these web pages in each month between April 2021 and April 2023 and record historical rates by hand. Banks and products that do not have Internet Archive coverage prior to March 2022, when the rate hike occurred, are removed. For banks with gaps in Internet Archive coverage we linearly interpolated missing rate observations. Through this process we add an additional 2 online banks to our sample, Charles Schwab and Raymond James Bank.

Using this extended sample we repeat our main analysis. Results are presented in Table A.3. The results using the extended sample are very similar to those using the main sample and even appear to be stronger for money market accounts and CDs.

C.3 Matched Demographics

In Table C.2 we restrict the brick-and-mortar sample to branches that reside in zip codes who's demographics are similar to online banks. This is done through nearest neighbor matching (with the smallest Euclidean distance) on zip code level demographics data. Because online

[27] Figures C.3 and C.4 plot the deposit growth and level of the online and brick-and-mortar banks without the RateWatch coverage restriction

banks do not have physical locations we use the average demographics of the zip codes in which each online bank advertises. To calculate the distance of each brick-and-mortar branch's zip code demographics to the demographics of a single online bank we calculate the euclidean distance across demographic averages using the following formula:

$$d_i = \sqrt{\sum_j (q_j - p_{ij})^2} \tag{6}$$

where j indexes across the demographic averages of having a computer in the home, access to internet, being older than 65, having a college degree, minority status, and being low income status (below $30,000 household income). q_j is the demographic average of the online bank that branch i is being compared against. p_{ij} is the demographic average of the zip code in which branch i resides. Once distances have been calculated, we consider the eight nearest branches to each online bank 'similar' branches [28]. The summary statistics of these 'similar' branch's demographics are reported in Table B.1.

[28]There are 80 unique 'similar' branches due to overlap between matched branches across different online banks.

Table C.1: Online Banks Not Covered by RateWatch

Bank	Website	Internet Archive Coverage
Avidbank	www.avidbank.com	No
Charles Schwab Bank	www.schwab.com	Yes
Fieldpoint Private Bank & Trust	www.fieldpointprivate.com	No
Lead Bank	www.lead.bank	No
Merrick Bank	www.merrickbank.com	No
Metabank	www.pathward.com	No
Modern Bank	www.modernbank.com	No
Morgan Stanley Bank	www.morganstanley.com	No
Raymond James Bank	www.raymondjamesbank.com	Yes
Silicon Valley Bank	www.svb.com	No
The Federal Savings Bank	www.thefederalsavingsbank.com	No

Notes: This table displays the online banks identified in the call reports that do not have sufficient RateWatch coverage to use. Banks flagged 'Yes' in the third column are those that have Internet Archive coverage prior to April 2022 and no gaps in coverage longer than 6 months after April 2022. These banks are included in the extended online bank sample. Source: FDIC & archive.org

Table C.2: Matched ZIP Codes Similar to Online Users

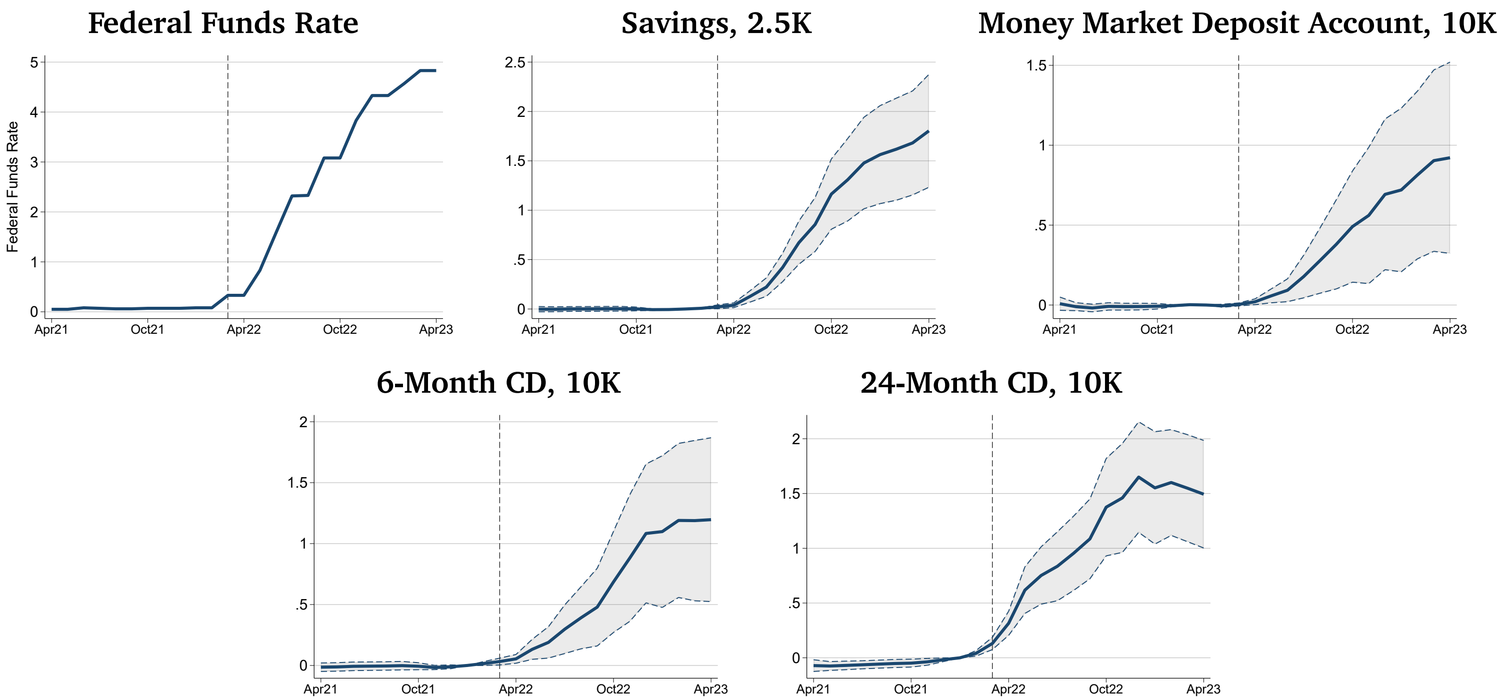
	(1) Savings, 2.5K	(2) Money Market, 10K	(3) 6-Month CD, 10K	(4) 24-Month CD, 10K
Online × Post March 2022	1.071***	0.453***	0.819***	1.362***
	(0.137)	(0.159)	(0.166)	(0.167)
Observations	3150	2750	3074	3125
Branch FE	✓	✓	✓	✓
Month FE	✓	✓	✓	✓

Notes: This table presents estimates of β from the OLS regression $APY_{it} = \alpha_i + \alpha_t + \beta 1[Online]_i \times 1[PostMarch2022]_t + \epsilon_{it}$ for the four products listed in each column using only traditional banks that reside in ZIP codes with demographics similar to users of online banking. Selection of similar banks is done using Nearest Neighbour Matching using ZIP code averages of having a computer in the home, access to internet, being older than 65, having a college degree, minority status, and being low income status (below $30,000 household income). APY_{it} is the annual percentage yield offered by institution i at time t. $1[Online]_i$ is an indicator for if institution i is an online bank and $1[PostMarch2022]_t$ is an indicator for time period t being after the rate increases in March of 2022. α_i and α_t are institution and time fixed effects. Standard errors are in parentheses and are clustered at the institution level. $^{*}p < .1$, $^{**}\ p < .05$, $^{***}\ p < .01$

Figure C.1: Levels Raw Means - No Asset Threshold

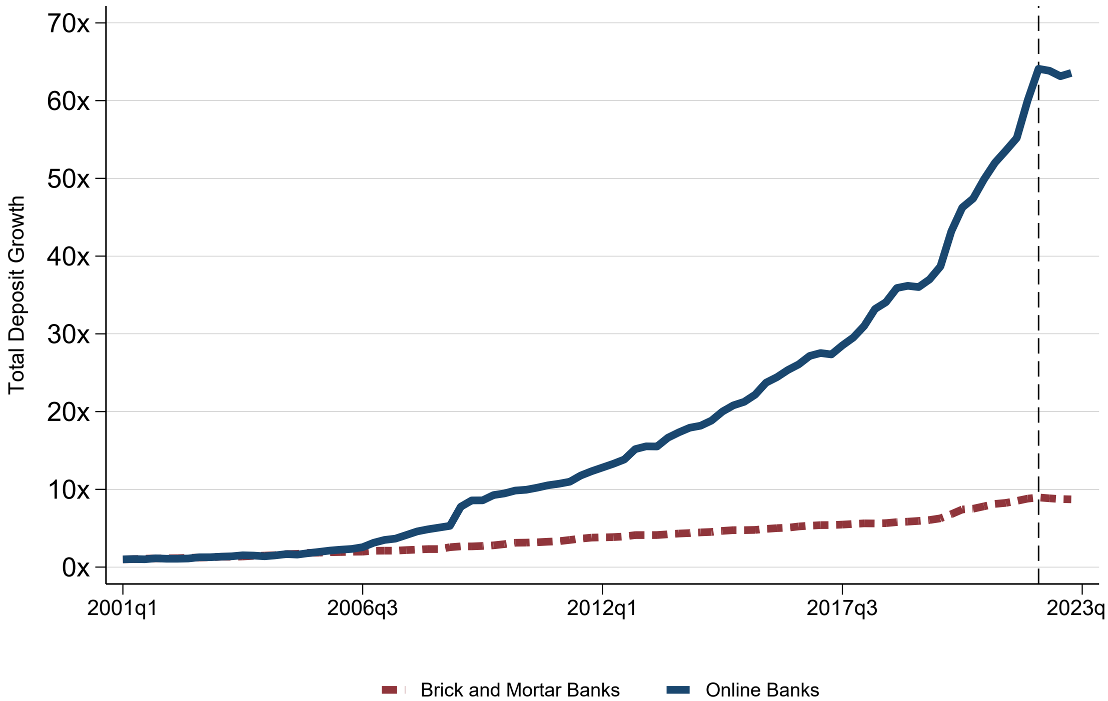
Notes: This figure plots the average annual percentage yield for each product broken down by online banks and brick-and-mortar banks. The solid blue lines show the average APY for online banks and the dashed red lines show average APY for brick-and-mortar banks. The dashed vertical line indicates when the Federal Reserve began increasing interest rates in March of 2022. Source: RateWatch & FRED

Figure C.2: Event Studies - No Asset Threshold



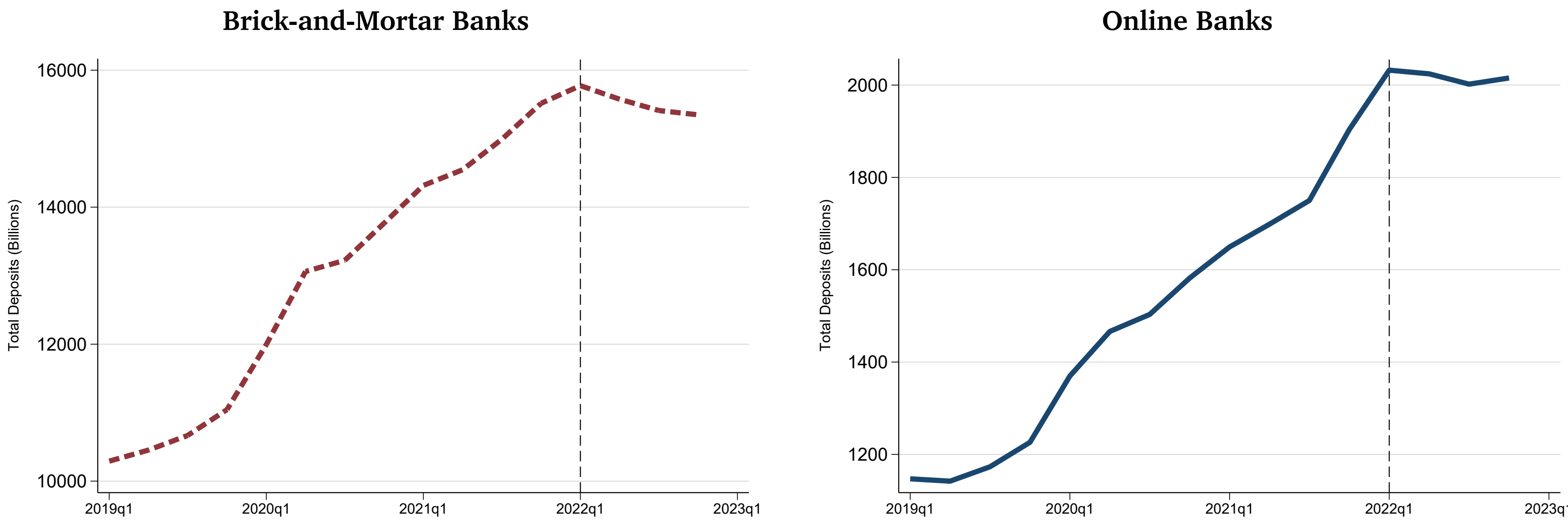
Notes: This figure plots β_t from the OLS regression $APY_{it} = \alpha_i + \alpha_t + \sum_t \beta_t Online_i + \nu_{it}$ along with a 95% confidence interval. APY_{it} is the annual percentage yield offered by institution i at time t. $Online_i$ is an indicator for if institution i is an online bank. α_i and α_t are institution and time fixed effects. Standard errors are clustered at the institution level. The dashed vertical line indicates when the Federal Reserve began increasing interest rates in March of 2022. Source: RateWatch

Figure C.3: Total Deposit Growth (No RateWatch Coverage Restriction)



Notes: This figure shows total deposit growth since March 2001 by bank type using all available banks in the FFIEC Call Reports (not just those with RateWatch coverage). The dashed vertical line indicates when the Federal Reserve began increasing rates in March of 2022. The online banks that are included are listed in Table 1. CIT Bank and E*Trade were both acquired in 2022 and have been excluded. Deposits for banks regulated by OTS prior to 2011 have been linearly interpolated from annual Summary of Deposits data. Source: FFIEC & FDIC

Figure C.4: Total Deposit Levels (No RateWatch Coverage Restriction)



Notes: This figure shows total deposits since March 2019 by bank type using all available banks in the FFIEC Call Reports (not just those with RateWatch coverage). The dashed vertical line indicates when the Federal Reserve began increasing rates in March of 2022. CIT Bank and E*Trade were both acquired in 2022 and have been excluded. Source: FFIEC & FDIC