Deposit Stability in Uncertain Times: Evidence from the 1918 Influenza Pandemic*

Haelim Anderson† Jin-Wook Chang‡ Adam Copeland§

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Abstract

The run on Silicon Valley Bank ignited a debate about potential banking reforms, including expanding the set of deposits which are FDIC-insured. But does expanding deposit insurance necessarily increase banks' deposit stability? We examine this question by analyzing deposit stability of NY banks during the 1918 influenza epidemic. At the time, banks accepted regular and preferred deposits, where the latter received priority in repayment during bankruptcy and was favored by institutional investors. Using a difference-in-differences approach, we estimate how the epidemic affected banks' capital structure and asset portfolio. A main finding is that although regular deposits were not withdrawn from banks during this crisis period, institutional investors withdrew their preferred deposits from banks that were most at risk from the epidemic's effects. Protections in bankruptcy, then, were not enough to stop institutional investors from withdrawing their deposits, a result that policymakers should consider when evaluating how different types of depositors today will value deposit insurance during times of stress.

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†Bank Policy Institute; e-mail: haelim.anderson@bpi.com.

‡(Corresponding author) Federal Reserve Board, 1801 K St, NW, Washington D.C. 20006; telephone: (202) 257-2792; email: jin-wook.chang@frb.gov.

§Federal Reserve Bank of New York; e-mail: adam.copeland@ny.frb.org

1 Introduction

The collapse of Silicon Valley Bank and other regional banks highlighted the continued importance of deposit stability. The tightening of monetary policy in 2022 and 2023 left some banks facing significant interest rate risk, which, in turn, triggered large outflows of uninsured deposits from a handful of banks. Regulators reacted to the bank runs in a number of ways, including pronouncements on the overall health of the banking system (Yellen, 2023) and the introduction of a new lending facility, the Bank Term Funding Program.[1] Further, the FDIC released an overview of its insurance program on May 1, 2023, in which the FDIC outlines various ways that deposit insurance could be extended to cover a larger set of deposits, with the goal of enabling the FDIC to better meet its goal of promoting banking stability.In addition, the FDIC introduced a proposal on long-term debt requirements to provide an extra layer of protection for uninsured deposits.[2]

The main mechanism behind these proposed reforms is that providing enhanced protection for a deposit decreases the probability that the deposit will be withdrawn from the bank during a time of stress, thereby increasing the stability of a bank's overall deposit base. Although this mechanism holds for household deposits, the benefits of insurance are less clear when depositors are more sophisticated investors. Indeed, the runs on the secured wholesale funding markets during the 2007-09 financial crisis are prominent instances where conservative investors withdrew funding from institutions facing increased solvency issues, even when these investors had strong protections in a bankruptcy event (Ball, 2018; Copeland et al., 2014; Krishnamurthy et al., 2014; Covitz et al., 2013; Gorton and Metrick, 2012; Ivashina and Scharfstein, 2010).

This paper examines the main mechanism behind the value of expanding the protection of deposits by analyzing the stability of deposits across different types of investors in a time of stress. This is accomplished by examining the impact of the 1918 influenza epidemic on banks in NY. This pandemic severely affected NY and had an uneven effect across the state, with some counties experiencing more than four times the mortality rate of other counties.

Crucially, the data capture two types of deposits, preferred and regular, which differ in their seniority in bankruptcy. Preferred deposits obtained seniority in case of default, meaning these

[1] For details on this new facility, see https://www.federalreserve.gov/newsevents/pressreleases/monetary20230312a.htm.

[2] For details, see https://www.fdic.gov/news/speeches/2023/spmay0123b.html. The FDIC also proposed additional supervisory measures to regulate uninsured depositors (see https://www.fdic.gov/news/speeches/2023/spaug1423.html)

depositors received repayment of the full value of their preferred deposits before regular depositors (there was not a deposit insurance program in NY during this time). In practice, this preference usually resulted in preferred depositors being made whole after a bank default, whereas regular depositors often regained access to their deposits only after those deposits had been discounted from their original face value. Preferred deposits, then, look similar to the insured deposits of today.

Offsetting their benefit in bankruptcy, preferred deposits received an interest rate fixed by law at a level below the market rate received by regular deposits. The selection of depositors into these two accounts was not random. Rather, ordinary households placed their cash into regular deposits, whereas sophisticated investors often placed their cash into preferred deposits. By comparing the behavior of preferred and regular depositors during the 1918 influenza epidemic, then, we are able to examine how much sophisticated investors valued protection in bankruptcy during times of stress.

For this study, we collect and construct a new data set that combines individual bank balance-sheet data, bank location data, and county-level statistics on mortality due to the 1918 influenza epidemic. We first construct a data set on quarterly balances sheets of all state-chartered commercial banks and trust companies in NY from 1915 to 1920. We exclude banks located in major financial centers (New York City, Albany, Buffalo, and Rochester) to arrive at a set of relatively homogeneous banks whose business model is to attract deposits from local households and businesses and to make loans to farmers and small businesses. These balance sheet data are detailed, allowing us to separately identify regular and preferred deposits, as well as a host of other important balance sheet variables such as short-term borrowing, various types of loans, holdings of securities, and reserves. We then merge in data on bank location and use this geographic information to link each bank to the relevant county-level influenza epidemic death rate. Combining these data sources allows us to exploit regional mortality variation to examine the relationship between the pandemic and the stability of banks.

We use a difference-in-differences approach to measure the impact of the pandemic on banks. Our first set of results focuses on measuring the pandemic's average effect on banks. We begin with a simple approach that estimates the average effect of the pandemic on the average bank. We find that in response to the pandemic, the growth rate of regular deposits increased by 3.4 percent, suggesting that households reacted to the pandemic by increasing their savings. In contrast, we find that growth rate of preferred deposits fell by 20.2 percent. This second result is hard to interpret, because it could be driven by liquidity demands of these investors, or by concerns over the solvency

of banks. Banks responded to the pandemic by decreasing loan growth and increasing the growth rate of their securities holdings, and so increasing the liquidity of their asset portfolio.

We then build upon this approach by allowing for the pandemic's effect to have a differential effect on banks based on influenza mortality rates in each county. Surprisingly, we do not find any differences in outcomes across counties, despite the large differences in severity of the pandemic across NY. We interpret this lack of an average effect to the pandemic having a differential effect across banks, which motivates our next set of results.

For our second set of results, we allow for a differential effect of the pandemic on banks that were members of the Federal Reserve System (member banks) compared with those that were not members (nonmember banks). A major difference between these two types of banks is that only the member banks were eligible to access the Federal Reserve discount window, a feature that is often valuable in a time of stress.

We continue to find that in the pandemic there is an average increase in the growth rate of regular deposits across all banks, although this estimate is now significantly larger at 8.6 percent. There are no differential effects across banks, neither in exposure to the severity of the pandemic nor by membership to the Federal Reserve System, supporting the idea that the increase in household deposits is precautionary. A more nuanced result is found for preferred deposits. For nonmember banks, the estimates imply there was large 58.2 percent decline in the average growth rate of these deposits. In contrast, the estimates imply that member banks in lightly effected counties saw no change in the growth rate of preferred deposits, whereas those member banks in severely effected counties experienced large declines of over 100 percent in growth rates.

Turning on the asset-side of banks' balance sheets, we see a similar pattern. Nonmember banks saw a decrease of 14.3 percent in loan growth regardless of the severity of the pandemic. In contrast, member banks in lightly effected counties experienced no change in the growth rate of loans, whereas loan growth for member banks in severely effected counties dramatically declined. Finally, all banks experienced a 24.2 percent increase in securities holdings and no change in the growth rate of reserves.

These results imply that the pandemic had the expected adverse effect on banks, best captured by the results of nonmember banks which saw a decline in growth rate of both preferred deposits and loans, and an increase in growth rate of securities holdings. Further, member banks in those counties most severely effected by the pandemic experienced the worst outcomes. We argue this

result is due to these member banks facing the highest risks of insolvency. Relative to nonmember banks, member banks often had higher risk profiles, likely reflecting member banks' access to the Federal Reserve's discount window. As a result, member banks in severely effected counties were less prepared to handle the economic shocks of the pandemic, which translated into solvency shocks for banks (e.g., loans not being repaid) rather than liquidity shocks. Indeed, during this period all banks dramatically increased their securities holdings, indicating that a banks could have easily liquidated their own portfolio of securities in case of a liquidity shock. An increased risk of insolvency explains why member banks in severely effected counties dramatically curtailed their loan growth and why the more sophisticated investors withdrew their (preferred) deposits from these banks.

Although the analysis presented here is specific to New York, the results are informative generally. First, NY banks were central to the U.S. banking system during this period and so understanding the stability of their deposit base during a time of stress is important for the U.S. banking system. Second, the NY banking system at this time was representative of the prevailing state banking systems throughout the U.S., and so lessons learned from examining NY banks are generally applicable.

This paper is relevant for today's modern banking system, as following the collapse of large regional banks in early 2023, policy makers have proposed to enhance the protection of uninsured deposits. An important implication from this paper's results is that sophisticated investors are still likely to withdraw deposits when there are increases to the risks of bankruptcy, even when these investors have seniority in bankruptcy, or similar types of guarantees. Although these investors value having protection in bankruptcy, as evidenced by their willingness to place cash into preferred deposits at below market rates, these investors prefer to withdraw their cash and invest elsewhere when the risks of bankruptcy escalate. This behavior by sophisticated investors could limit the value of enhancing protection of uninsured deposits such as providing seniority over long-term debt holders,[3] when this expansion is done to increase deposit stability during times of stress.

This paper contributes to the large literature on deposit stability. The first strand of this literature focuses on the role of information on deposit stability. These studies emphasize that depositors become more sensitive to information when macroeconomic conditions worsen because they cannot distinguish the quality of banks. Theoretically, Gorton (1985), Gorton and Pennacchi (1990),

[3]For example, see https://www.fdic.gov/news/financial-institution-letters/2023/fil23045.html.

Chari and Jagannathan (1988), Calomiris and Kahn (1991), and more recently Eisenbach (2017) and Dang et al. (2020), show how information affects bank funding stability. Empirically, Park (1991), Saunders and Wilson (1996), Calomiris and Mason (1997), and Chen et al. (2022) show that deposit flows are more sensitive to information about bank performance. In addition, Anderson and Copeland (2023) show that suppressing bank information helps banks manage deposit outflows during a time of financial stress. This paper adds to the empirical literature by demonstrating that sophisticated investors are sensitive to bank information during times of stress, even when they have priority in bankruptcy.

A second strand of the literature focuses on the relationship between the degree of depositor sophistication and deposit stability. Several studies find the level of depositor sophistication affects the behavior of uninsured depositors. Among uninsured depositors, the more sophisticated type monitor bank risk and react to increases in risk by withdrawing their deposits (Iyer et al., 2016; Martin et al., 2018; Imbierowicz et al., 2021; Chernykh and Mityakov, 2022).[4] Our study contributes to this literature by showing that sophisticated depositors will withdraw when bank risk rises, even in cases where these depositors have protections in bankruptcy. We argue these investors run from banks because they prefer to not be involved in the resolution process and often can easily place their deposits in other banks, a dynamic that was observed with the secured wholesale funding runs on Bear Stearns and Lehman Brothers during the 2007-09 financial crisis.[5]

This paper also adds to the literature examining the impact of the 1918 influenza epidemic, in particular the strand which studies the relationship between pandemics and economic outcomes (Brainerd and Siegler, 2003; Barro, Ursúa and Weng, 2020; Correia, Luck and Verner, 2022; Jordà, Singh and Taylor, 2022).[6] This paper stands apart from this existing literature because of our focus on the effect of a pandemic on financial stability, a question we are able to answer because of newly available micro-level balance sheet data during this period.

The remainder of this paper is organized as follows. Section 2 provides historical background.

[4] Anderson et al. (2023) study whether the behavior of depositors of different degrees of sophistication changed following the introduction of deposit insurance in New York.

[5] The bankruptcy trustee for Lehman Brothers reports that in the days before its acquisition by J.P. Morgan, Bear Stearns could not acquire funding even against U.S. Treasuries (Valukas, 2010). Copeland et al. (2014) argue that Lehman Brothers faced a similar run in days before it declared bankruptcy.

[6] Other strands of the literature which focus on the 1918 influenza epidemic focus on wages, demographic composition, or mortality differences across socioeconomic classes (Noymer and Garenne, 2000; Mamelund, 2006; Garrett, 2009) or health outcomes (Karlsson, Nilsson and Pichler, 2014; Clay, Lewis and Severnini, 2018; Keyfitz and Flieger, 1968; Almond, 2006).

Section 3 introduces the data and provides summary statistics. Section 4 describes the empirical specifications and presents results. Section 5 discusses policy implications for today's modern banking system and concludes.

2 Historical Background

This section begins with a description of the banking environment during the 1910s and ends with a summary of the impact of the 1918 influenza epidemic on New York.

2.1 New York's Banking System during the 1910s

In the early 1900s the U.S. banking system was a highly local affair. Regulations limited the ability of banks to open multiple branches, and as a result most banks operated an a unit bank. A main feature of being a unit bank is that the bank's retail deposit base is mainly local and banks loans were mainly with local farmers and small businesses. There are two main ways that banks were not solely local affairs.

The first way is through the U.S. system of reserves, which had a pyramid structure. Regulations dictated that rural banks hold their reserves at banks in regional financial centers. Further, banks in these regional centers had to hold their reserves in banks in national financial centers, such as New York City (Mitchener and Richardson, 2015). This network of inter-bank deposits created links among banks across the U.S. As detailed in section 3, our analysis focuses on rural banks only, which downplays the role of this connection as rural banks only made inter-bank deposits, and did not receive them.[7]

The second way banks were not solely local institutions is through preferred deposits, a service which attracted sophisticated institutional investors from outside their local area. During this time, banks offered two types of deposits: preferred and regular. The benefit of preferred deposits over regular is that in the case of a bank failure, preferred deposits have senior status in bankruptcy and so received repayment first. The cost is that preferred deposits receive a rate of interest below those offered on regular deposits. Further, regulators often placed a cap on the interest rate offered on

[7] In contrast, banks in reserve cities could face liquidity crunches if their inter-bank deposits where pulled (Mitchener and Richardson, 2019).

preferred deposits.[8]

Most depositors could choose between preferred or regular deposits. Households overwhelmingly chose regular deposits, and as a result regular deposits make up a dominant share of total deposits.[9] In contrast, institutional investors, who are often both financially sophisticated and fairly risk averse, were more likely to choose preferred deposits. In addition, at this time in NY, the law required some types of investors to use preferred deposits. This group included custodians of funds, such as lawyers overseeing trusts; New York state chartered savings banks and savings and loans; credit unions; land banks; the government of the State of New York and its business entities; and municipal and county governments. Bankers considered preferred deposits to be a stable source of funding because they offered safety (Bankers' Magazine, 1909).[10]

The Federal Reserve System was established at the beginning of the sample period. It was created by the passage of the Federal Reserve Act of 1913 and went into operation on November 16, 1915. Not all banks became members of the Federal Reserve System. National-charter banks, which were regulated by the Office of the Comptroller of the Currency (OCC), were required to become members of their local Federal Reserve Bank. State-charter banks, which were regulated by their state's banking regulator, had the option of becoming members.

A main value of being a member was gaining direct access to the discount window. During this period, the Federal Reserve conducted monetary policy exclusively through discount window lending (Chabot, 2017).[11] The Fed's founders had not considered monetary policy in the modern sense, so liquidity provision by the Federal Reserve was passive. Each Federal Reserve Bank set a discount rate, but Federal Reserve credit was provided at the initiative of banks who came to the discount window to borrow reserves (Wheelock, 2013). In contrast to later years, during the early years of the Federal Reserve System, banks did not suffer from stigma when they accessed the discount window (Gorton and Metrick, 2013).

State-chartered banks were eligible for membership in the Federal Reserve System if they met certain criteria. Upon becoming a member, state-charter banks became subject to federal banking regulations and supervision, which were sometimes more strict than those of the relevant state bank-

[8] For details, see Morgan and Parker (1915).

[9] As discussed in the following section, for NY rural banks in the sample period, regular deposits made up more than 90 percent of the total deposits.

[10] See p.69 of the *Bankers Magazine* for detailed discussions.

[11] Until 1922, there were no open market operations to conduct monetary policy. Open market purchases were conducted only to support Treasury issuance or raise revenue of the Federal Reserve Banks.

ing regulator.[12] At the same time, a state-chartered bank could still enjoy the benefit of the Federal Reserve's discount window by establishing a correspondent relationship with a bank that was a member (Anderson et al., 2018). As a result, few state-charter banks joined the Federal Reserve System when it was first established. In 1917, the Federal Reserve introduced major reforms to the membership process for state-charter banks to make membership more appealing. As a result, there was an uptick in the number of state-charter banks becoming members of Federal Reserve System in 1917 and through the end of the sample period.[13]

2.2 1918 Influenza Pandemic

An outbreak of influenza spread across the world in three waves over 1918 and 1919. This epidemic was severe, with about 500 million people infected globally (a quarter of the world's population) and at least 50 million people killed. The 1918 pandemic did not spare the United States, where over half a million deaths are attributed to the epidemic (Crosby, 1989).[14]

New York provides a useful laboratory to study the effects of the 1918 influenza as the pandemic had a large effect on the state. In the pandemic, monthly influenza and pneumonia death rates spiked up in NY from below 0.5 deaths per 1000 people to almost 3 deaths per 1000 in October 1918 (see Appendix Figure A1). Further, there was a large amount of variation in the severity of the pandemic across counties in NY, with some counties experiencing almost four times the mortality rate than others (see Figure 1).

The drivers behind the variation in mortality rates across counties is not well understood. Although researchers have suggested possible explanations, including the demobilization of troops after WWI, there is little consensus on the underlying causes (Report of the Committee on the Atmosphere and Man, 1923; Crosby, 1989; Brainerd and Siegler, 2003; Kolata, 2011). Examining the impact of the 1918 influenza across the U.S., Brainerd and Siegler (2003, p. 7-8) reports that the statistical evidence "supports the notion of influenza mortality as an exogenous shock to the

[12] Another cost was that banks which were members of the Federal Reserve System were required to hold their required reserves at a Federal Reserve Bank where these reserves did not earn interest. In contrast, non-members held their required reserves at other banks and earned an interest rate.

[13] In appendix figure D2 the number of NY state-charter banks which are members of the Federal Reserve System is illustrated alongside the equivalent nationwide number. This comparison shows that the evolution in the number of state-charter banks becoming members of the Federal Reserve System in NY mirrors what has happening in the U.S.

[14] Similar to the COVID-19 virus, the 1918 influenza itself did not often cause death. Instead, secondary infections such as bacterial pneumonia, were typically the direct cause of death.

population." Furthermore, the mortality rates "appear to be randomly distributed and do not seem to be related to the level of economic development, climate or geography." Based on these results from the existing literature, we consider the cross-county distribution of the 1918 influenza to be exogenous to our object of interest, which are the balance sheet variables of NY state-charter banks.

3 Data and Summary Statistics

To study how the influenza pandemic affected deposit flows and other balance sheet variables, we combine information on state-charter banks and trust companies with flu mortality statistics. To construct this novel dataset, we begin by collecting the quarterly balance sheets of all NY state-chartered banks and trust companies from the Annual Report of the Superintendent of Banks for the period 1915 to 1920. Further, we identify which state-charter banks were members of the Federal Reserve using the Annual Report of the Federal Reserve Board.

Given that New York City was the financial capital of the US in this sample period, this set of banks captured entities which followed different business operations. In particular, banks in large financial centers, and especially in New York City, held a large share of deposits due to other banks. To arrive at a set of comparable banks, we eliminate banks from such financial centers–the reserve cities of New York City, Albany, Buffalo, and Rochester–to arrive at a set of relatively homogeneous banks whose business model was to attract deposits from local households and businesses, and make loans to farmers and small businesses. Our final data set includes a total of 249 state-chartered banks and trust companies every quarter from 1915 to 1920. After 1917, the number of these banks which are members of the Federal Reserve System steadily grows until by the end of the sample period they account of 22 percent of all banks in the sample. The geographic distribution of banks across NY is fairly uniform, as illustrated in Figure 1.

To these balance sheet data, we add information on the mortality rates due to influenza and pneumonia in NY. These mortality rates, which are the ratio of deaths due to influenza and pneumonia over total deaths, are our measure of the severity of the 1918 influenza outbreak.[15] These data come from the Annual Report of State Department of Health of New York, from which we collect information on population and deaths from influenza and pneumonia for each county from

[15] Use of mortality rates to measure severity of the pandemic is common in the literature, as in Garrett (2009); Barro, Ursúa and Weng (2020) to name a few.

1915 through 1920 on a yearly basis. We merge this county-level information to the balance sheet data, using the geographic information of the bank's branch available from the Annual Report of the Superintendent of Banks.[16]

We also collect and merge in monthly data on deaths from influenza and pneumonia for the entire state of New York on a monthly basis. This second aggregate series is used to interpolate the annual county-level data to a quarterly frequency. This interpolation assumes the pattern of flu mortality in each county resembles what was observed at the state level, a reasonable assertion because flu-related deaths exhibit seasonal patterns. Finally, we merge in the mortality statistics with a lag so that deaths from influenza and pneumonia in a particular quarter are a beginning-of-period measure, whereas our balance sheet measures are an end-of-period measure.

For a general sense of how the pandemic effected banks, in Table 1 we report balance sheet ratios over the sample period, from the first quarter of 1915 to the fourth quarter of 1920. These ratios are further reported for three sub-periods: Pre-pandemic, Pandemic, and Post-pandemic. In NY, the 1918 influenza was most widespread at the end of 1918 and the beginning of 1919 (see Section 2.2). In our analysis, we use the quarterly growth rates of balance sheet variables, and as such, we define the pandemic period as the first quarter of 1919 in order to capture the effect of the flu on the banking system. Accordingly, the Pre-pandemic period is defined as the first quarter of 1915 through the fourth quarter of 1918 and the Post-pandemic period is defined as the second quarter of 1919 through the fourth quarter of 1920. In addition to reporting averages across all banks, a breakdown is provided for banks which are members of the Federal Reserve System (member banks) and those which are not (nonmember banks).

We start by examining the portfolio of assets held by banks, where all variables are normalized by total assets, to make for a more meaningful comparison across banks of different sizes. We find that Securities and Total Loans are the largest asset categories, accounting for one-third and one-half of total deposits, respectively (see Table 1). The most liquid assets held by banks are vault and interbank reserves. We label the sum of both types as reserves and find this measure accounts for about 18 percent of total assets. Looking at member versus nonmember banks, we see that member banks hold less reserves (as a share of total assets) than nonmember banks, likely reflecting member bank's access to the discount window.

Turning next to the capital structure of banks, we consider equity capital, deposits, and short-

[16] In this period, the U.S. had a unit banking system which meant that most banks (and all the small rural banks in the sample analyzed here) operated from a single branch.

term borrowing as shares of total liabilities. Not surprisingly, deposits make up the lion's share of liabilities at 80 percent (see Table 1). Equity capital is a distant second at 16 percent, and short-term borrowings is about 1.6 percent of total liabilities. Once again, member banks present a riskier profile with an average lower equity ratios of 14.3 percent versus 17.1 percent for nonmember banks.

Finally, we look at regular and preferred deposits, which are presented as shares of total deposits. regular deposits make up over nine-tenths of deposits, as expected for these rural banks outside of NY's financial centers. There are, however, differences across member and nonmember banks, where member banks have a larger share of preferred deposits on their balance sheet, on average. Furthermore, larger share of their preferred deposits come from institutional investors, around 4 percent of total deposits for member banks versus around 2 percent for nonmember banks.

4 Empirical Approach

In this section, we detail our empirical approach and results. The main focus is estimating the immediate impact of the pandemic on the balance sheet on banks. We first describe how we implement a difference-in-differences approach and discuss identification. We then present the results and our interpretation of the estimates. Finally, we end with a longer-term analysis which examines whether the pandemic had a persistent effect on banks.

4.1 The difference-in-differences approach and identification

We assess how the 1918 influenza pandemic affected banks using a difference-in-differences approach that combines bank-level responses with cross-county differences in the severity of the pandemic. The key identifying assumption for our analysis is that both the timing of the outbreak in NY and the differences in exposure across the state represent an exogenous shock. Further, bank behavior would have been similar across counties in the absence of the pandemic. With this approach, we both estimate the average effect of the pandemic on NY banks as well as compare the responses of banks in more affected versus less affected counties, as measured by pandemic-related mortality rates.

Our statistical analysis uses a classic fixed-effects linear regression relating an indicator for the pandemic to various aspects of bank behavior (conditional on a set of bank-level controls as well

as a variety of fixed effects). We begin with a basic specification where the pandemic is captured with an indicator variable, P_t, which is equal to 1 for the first quarter of 1919.[17] This specification estimates an average effect of the pandemic across all banks. Then, following the specification used in Barro et al. (2020), we estimate the effect of the pandemic on bank behavior using both P_t and an interaction between P_t and county-level flu mortality rates. This second specification allows for a differential impact of the pandemic based on local, county-level conditions. Formally, our basic specifications are:

$$\Delta Y_{i,t} = \alpha + \beta_1 P_t + Z'_{i,t-1}\gamma + \eta_i + \lambda_t + \varepsilon_{i,t}, \tag{1}$$

$$\Delta Y_{i,t} = \alpha + \beta_1 P_t + \beta_2 P_t \cdot x_{i,t} + Z'_{i,t-1}\gamma + \eta_i + \lambda_t + \varepsilon_{i,t}, \tag{2}$$

where i and t represent bank and time, respectively; Y is the dependent variable of interest; $\Delta Y_{i,t} = \ln(Y_{i,t}) - \ln(Y_{i,t-1})$ is the growth rate of the dependent variable. The variable $x_{i,t}$ is the mortality rate at the beginning of quarter t in the county in which bank i is located, Z is a vector of bank-level controls, and (η_i, λ_t) are bank and year fixed effects, respectively. The bank-level controls are liquid assets over total assets, equity capital over total liabilities, a measure of loan quality (amount secured over total loans), and the log of total assets. ε is a mean-zero, possibly heteroskedastic and autocorrelated within-bank error term.

The next specification differentiates between banks which are members of the Federal Reserve System and those which are not. This distinction could be important as investor may value placing their money at a bank which has access to the discount window. Letting $M_{i,t}$ be an indicator variable equal to 1 if a bank i is a member of the Federal Reserve System in period t, the specification accounting for differences in membership to the Federal Reserve System is

$$\Delta Y_{i,t} = \alpha + \beta_1 P_t + \beta_2 M_{i,t} + \beta_3 P_t \cdot x_{i,t} + \beta_4 P_t \cdot M_{i,t} + \beta_5 P_t \cdot M_{i,t} \cdot x_{i,t} + Z'_{i,t-1}\gamma + \eta_i + \lambda_t + \varepsilon_{i,t}. \tag{3}$$

The key coefficients of interest in equations (1) and (2) are $\{\beta_1, \beta_2\}$, which capture the average effect of the pandemic and the differential cross-county effect during the pandemic, respectively. We are able to cleanly estimate both coefficients because the impact of the 1918 influenza across

[17] Banks reported their balance sheets for 1918:Q4 before or during the peak of the influenza pandemic in NY. Given the focus on growth rates, it is the growth rate of first quarter of 1919, the rate of change between the fourth quarter of 1918 and the first quarter of 1919, which captures the effect of the pandemic correctly.

NY is arbitrary and random, as characterized by the existing literature (see details in section 2.2). As such, it is reasonable to consider the spread and severity of the 1918 influenza as exogenous to banking activity.[18]

Given the wide variety of banks chartered in NY, a concern is that the results may be driven by unobserved differences across bank business models. This concern is allayed because the sample is restricted to banks outside of New York City and outside of the reserve cities of Albany, Buffalo, and Rochester (see section 3). As a result, the analysis is focused on a relatively homogeneous set of "rural" banks. These one-branch banks accept deposits and issue loans in local markets, where these local markets are similar to one another in terms of population density or economic activity.

Although our empirical approach enables us to accurately estimate $\{\beta_1, \beta_2\}$, a potential confounding factor is that our sample includes banks which are members of the Federal Reserve System as well as those which are not. This difference could be important for our analysis because the Federal Reserve acts as a lender-of-last-resort, a service that is likely to be valuable during a stress event such as a pandemic.

Using equation (3), we analyze whether member banks were able to manage deposit outflows better than nonmember banks. With this specification, the key coefficients of interest are $\{\beta_1, \beta_3, \beta_5\}$. One possible concern is that banks strategically select Federal Reserve member status in light of the pandemic, a feature that could bias the estimates.[19] This possibility seems remote however. At this time, the Federal Reserve System took about six months to process state-charter banks' applications and approve their membership requests. Given how quickly the 1918 influenza pandemic arrived and then dissipated in NY, there was not enough time for state-charter banks to respond to the pandemic by becoming members of the Federal Reserve System.

4.2 Empirical results

We begin by examining the immediate impact of the pandemic on banks' balance sheets. On the liabilities side, we focus on deposits and short term borrowing, and on the assets side we focus

[18] As a check on this exogeneity assumption, we provide summary statistics on our objects of interest (growth rates of various balance sheet variables) in the pre-pandemic period, based on pandemic-related mortality rates. The results are shown in Appendix B and demonstrate that there are not any systematic differences across banks with different exposures to the pandemic.

[19] Anderson et al. (2018) demonstrate that banks chose to become member of the Federal Reserve System to have better access to the discount window.

on loans, securities holdings, and reserves. As detailed in equations (1) and (2), we consider the difference in the log of the dependent variable. All regressions are estimated by ordinary least squares and standard errors are clustered at the county level.

The estimated coefficients imply that the pandemic did not impact total deposit growth or short term borrowing growth at banks (see the top panel of table 2). This overall measure of deposits, however, hides offsetting effects in two types of bank deposits: preferred and regular. Looking at each deposit-type separately, we find that regular deposits increased by 3.4 percent for all banks whereas preferred deposits decreased by 20.2 percent for all banks (see the bottom panel of table 2).

Turning to the asset side of the balance sheet, the estimates imply that banks shifted their asset portfolios towards more liquid assets. There was a significant decline of 8.9 percent in loan growth during the pandemic, coupled with significant increases in the growth of securities holdings. The growth rate of reserves, in contrast, was not impacted.

Given the 1918 influenza pandemic likely had a broad impact on economic conditions, it is hard to definitely interpret these results. Overall, households, in reaction to the pandemic, increased their holdings on liquid assets by placing more money at banks. The decline in the growth rate of loans might be due to decline in the demand for loans by businesses, as well as the unwillingness of banks to make loans given the uncertainty around economic conditions. On net, banks reacted to the pandemic by shifting their portfolio of assets towards liquid financial securities.

The results in table 2 are surprising as there are not any differences in outcomes across counties, despite the large differences in severity of the pandemic across NY. This lack of an aggregate effect is in part because the pandemic effected banks heterogeneously. As shown below, the pandemic had a different effect on state-charter banks which were members of the Federal Reserve System (member banks) compared to state-charter banks which were not members (nonmember banks).

Using equation (3), we analyze whether the pandemic had differential effects on member and nonmember banks, focusing on the same balance sheet variables examined above. As before, we find that in the pandemic there is an average increase in the growth rate of regular deposits across all banks, although this estimate is now significantly larger at 8.6 percent (see the first column of table 3). There are no differential effects across banks, neither in exposure to the severity of the pandemic or by membership to the Federal Reserve System.

A more nuanced result is found for preferred deposits. For nonmember banks, the estimates imply there was large 58.2 percent decline in the average growth rate of these deposits (see the

second column of table 3). In contrast, the estimates imply both a positive average effect on the growth rate of preferred deposits for member banks as well as negative relationship between these deposits and pandemic-related deaths.[20]

We illustrate the estimates of the growth rate of preferred deposits for banks in counties with pandemic-level flu mortality rates equal to the 1st, 10th, 25th, 50th, 75th, 90th, and 99th percentiles, in figures 2a and 2b. The results imply that a member bank in a county with the median rate of pandemic-flu deaths saw a statistically significant decline in preferred deposit growth rates of 54 percent, in line with those experienced by all nonmember banks. For member banks in less severely effects counties, the estimated coefficients do not imply a statistically significant result, whereas member banks in the most severely effected counties saw the growth rate of preferred deposits decline by over 100 percent.

Turning to short-term borrowing, the estimates imply that non-member banks did not experience a significant change in the growth rate of borrowing over the pandemic (see the third column of table 3). In contrast, member banks experienced a positive average effect on short-term borrowing, where this effect decreases in the severity of the pandemic. Combining these estimates with the pandemic-flu mortality rates, we find that member banks in a county with a median rate of pandemic flu mortality increased their short-term borrowing by 58 percent. For member banks in more severely effected counties there was no significant change in borrowing, whereas in counties that were less significantly effected, the increase in short-term borrowing is significant and large.[21]

Turning to the asset-side of the balance sheet, the estimated coefficients imply that nonmembers saw an average 14.3 percent decline in the growth rate of loans, regardless of the severity of the pandemic in their county. In contrast, the estimates imply that member banks experienced an increase in average loan growth, but this growth rate is negatively related to the severity of the pandemic.

As with preferred deposits, we illustrate the estimated effect on the growth rate of loans for banks in counties with various levels of pandemic-level flu mortality rates in figures 2c and 2d. For a member bank in a county with a median pandemic-flu mortality rate, there is not a significant effect of the pandemic on loan growth. Similarly, there is not an effect on loan growth for member banks in counties which were less severely by the pandemic. For those in more severely effect counties, however, loan growth is estimated to have declined and these declines are large. Member

[20]The average effect on the growth rate of preferred deposits for member banks is 1.109 = -0.582 + 1.691. The negative relationship is determined by the estimated coefficient -396.6 and the actual county-level flu death rates.

[21]At the 25th percentile of the pandemic-flu mortality rate, the estimated effect on the growth rate is 87.5 percent.

banks in counties with pandemic-flu mortality rates at the 90th and 99th percentiles, for example, are estimated to have experienced declines of 29 and 45 percent, respectively.

We dig further into this result on loans by considering the effect of the pandemic on the four main types of loans: loans secured by bonds and real estate, mortgages, loans secured by other collateral, and unsecured loans. The results are collected in table 4. They illustrate that nonmember banks reacted to the crisis by decreasing the growth rate of unsecured loans by 14 percent, arguable the riskiest loan type. These results continue to show that member banks in less severely affected counties did not change the growth rate of their loans, while, in contrast, member banks in counties which were severely effected did see decreased loan growth. These particular banks experienced decreased growth rates in unsecured loans, as well as loans secured by bonds and real estate. For example, member banks in the counties exposed to pandemic-flu mortality rates at the 90th percentile are estimated to decrease the growth rate of both unsecured loans and loans secured bonds and real estate by 26 percent.

Finally, the estimates imply that all banks saw a 24.2 percent increase in the growth of securities holdings and further, there are no significant effects on the growth rate of reserves. Both these results are roughly inline with earlier results presented in table 2 and table 3.

This set of results continues to highlight that households, on net, reacted to the pandemic by increasing deposits at banks. This behavior was not associated with the actual severity of the pandemic, suggesting that households may have been acting in a precautionary manner. The results on preferred deposits and loans suggest that member banks in severely affected counties faced substantial credit risk concerns. These concerns lead these member banks to experience the largest decreases in the loan growth and drove investors to shift their preferred deposits from these banks to member banks in counties with minimal exposure to the pandemic.

That the adverse effect of the pandemic is concentrated on member banks is not surprising given these banks often have a higher risk profile than nonmember banks, likely reflecting member banks' access to the discount window. Indeed, member banks equity to total liabilities ratio is 2.8 percentage points below that of nonmember banks (14.3 to 17.1 percent).[22] Further, although being a member of the Federal Reserve System has benefits when faced with a crisis of liquidity, there is little evidence that the 1918 influenza outbreak was such a crisis. All banks were increasing their holdings of securities in the pandemic, suggesting that any bank facing liquidity pressures would

[22] See Table 1 for further statistics on the differences across member and nonmember banks.

be able to easily sell its securities if needed. Rather, the results point to concerns over asset performance, such as whether loans would continue to be repaid. Evidence in support of this argument are the results on short-term borrowing. Member banks in severely affected counties did not increase their borrowing (from the Federal Reserve Banks or from private investors), the expected outcome from a liquidity crisis. Furthermore, nonmember banks, which experienced a uniform decrease in loan growth, also did not increase their short term borrowing during the pandemic.

The decrease in the growth rate of preferred deposits is striking because bankers at the time considered preferred deposits to be a stable source of funding, especially given that these deposits had priority in case of bankruptcy. The fleeing of these deposits from member banks in severely-affected counties undermines this idea; the results imply that these conservative investors would rather move their deposits to a similar account at another, observably safer, bank, than handle an increased risk of having to deal with an insolvency. Similarly dynamics were observed in the U.S. money markets over the 2007-09 financial crisis, when conservative investors stopped entering into overnight Treasury repos with securities dealers experiencing stress, despite the fact that these investments were quite safe given their overnight maturity, backed by highly liquid securities, and bankruptcy-remote (Ball, 2018; Copeland et al., 2014; Krishnamurthy et al., 2014; Gorton and Metrick, 2012; Ivashina and Scharfstein, 2010).

4.3 Long-term results

We now turn our attention to whether the effects of the pandemic persisted over time. Our approach is to re-estimate the regression specified in equation (3) on annual basis, using only data from the fourth quarter of each year. The annual analysis is valuable because it allows us to estimate longer-lived effects and investigate whether there was a more secular change in bank behavior as a result of the pandemic. In addition, this analysis more closely aligns with approaches taken in previous work on the effects of pandemics on economic growth such as Barro et al. (2020) and Correia et al. (2022). Hence, the analysis provides a useful way to compare our results of the effects of the pandemic on economic growth through bank lending to those through the government intervention in the literature.

Building on our results above, we consider the longer-run effects of the pandemic on deposits, borrowing, loans, securities holdings, and reserves, collecting the results in table 5. These results demonstrate that the immediate effects of the pandemic on deposits estimated previously, persisted

over time. In particular, there was an increase in the growth rate of regular deposits at all banks and a decrease in the growth rate of preferred deposits at member banks located in counties which were severely effected by the pandemic. Finally, on the asset-side, the results indicate the immediate effect of decreased loan growth is overturned in the longer run, as there is an increase in loan growth for all banks with this specification. Nevertheless, member banks in severely-affected counties continued to have slower loan growth relative to member banks other counties. Finally, all banks experienced a stronger growth rate in securities holdings in the longer term.

5 Discussion and Conclusion

This paper examines the impact of the 1918 influenza epidemic on state-charter banks in NY, with a focus on the stability of deposits across different types of investors. We find that 1918 influenza epidemic had the expected adverse effect on banks, best captured by the results of nonmember banks which saw a decline in growth rate of both preferred deposits and loans, and an increase in growth rate of securities holdings.[23] Further, member banks in those counties most severely effected by the pandemic experienced the worst outcomes. We argue this result is due to these member banks facing the highest risks of insolvency. This increased risk explains why member banks in counties severely effected by the epidemic dramatically curtailed their loan growth and faced the extremely large withdrawals of preferred deposits by sophisticated investors. Strikingly, regular deposits increased across all banks, indicating that households increased their savings as a precautionary measure in the face of the epidemic.

This difference in behavior across deposits is a main result of the paper. It demonstrates that sophisticated investors are likely to withdraw deposits from a bank with an increased risk of solvency, even when those investors have protection in bankruptcy. Furthermore, these investors withdrew even though there was not regular run on the bank.

This study has important implications for policy today. Following the collapse of three large regional banks in early 2023 due to runs by uninsured deposits, policymakers have issued proposals to stabilize and regulate uninsured deposits. In particular, in May 2023 the FDIC proposed several changes to enhance deposit stability, with the preferred option at that time of raising the insurance cap for business payment accounts, while leaving the $250,000 limit in place for others,

[23] Member banks are those which are members of the Federal Reserve System.

to best balance the risk of moral hazard.[24] More recently, FDIC proposed to impose long-term debt requirements on more banks to reduce the incentives for uninsured depositors to run.[25]

The main mechanism behind these proposed reforms is that providing enhanced protection for a deposit decreases the probability that the deposit will be withdrawn from the bank during a time of stress, thereby increasing the stability of a bank's overall deposit base. Although this mechanism holds for household deposits, the benefits of insurance are less clear when depositors are more sophisticated investors. Indeed, a main result from this work is that sophisticated investors will withdraw deposits from a bank facing an increase in solvency risk, even when these investors have protection in bankruptcy.

We argue this is occurs because these investors want to avoid the bankruptcy process and can easily move their deposits elsewhere. Consequently, when evaluating the benefits of expanding deposit insurance, it is important for regulators to understand the types of depositors that will be covered with an expansion of deposit insurance, and how these depositors will behave when their bank becomes stressed. Similarly, proposals to strengthen the bankruptcy protections of deposits help by sophisticated investors may not persuade these investors to keep their deposits in a bank facing an increased risk of solvency.

[24]For details, see https://www.fdic.gov/news/speeches/2023/spmay0123b.html.

[25]For the transcript, see https://www.federalreserve.gov/newsevents/pressreleases/bcreg20230829a.htm.

Table 1: Balance Sheet Ratios, by Period

	All			Member			Nonmember		
	Pre-Pandemic	Pandemic	Post-Pandemic	Pre-Pandemic	Pandemic	Post-Pandemic	Pre-Pandemic	Pandemic	Post-Pandemic
Liquid assets	0.185	0.173	0.153	0.168	0.140	0.137	0.191	0.184	0.159
	(0.0687)	(0.0774)	(0.0606)	(0.0664)	(0.0600)	(0.0509)	(0.0684)	(0.0796)	(0.0619)
Securities	0.270	0.336	0.320	0.311	0.365	0.310	0.256	0.327	0.323
	(0.154)	(0.153)	(0.142)	(0.133)	(0.110)	(0.123)	(0.158)	(0.165)	(0.147)
Total loans	0.548	0.477	0.524	0.514	0.470	0.539	0.559	0.479	0.519
	(0.152)	(0.140)	(0.143)	(0.130)	(0.112)	(0.125)	(0.157)	(0.149)	(0.148)
Loans Secured by Bonds	0.0388	0.0292	0.0257	0.0298	0.0194	0.0182	0.0417	0.0326	0.0284
	(0.0393)	(0.0329)	(0.0283)	(0.0337)	(0.0241)	(0.0236)	(0.0405)	(0.0348)	(0.0294)
Loans Secured by Mortgage	0.0798	0.0661	0.0606	0.0981	0.0799	0.0699	0.0738	0.0614	0.0573
	(0.0706)	(0.0557)	(0.0510)	(0.0717)	(0.0579)	(0.0516)	(0.0692)	(0.0543)	(0.0504)
Loans Secured by Other	0.112	0.124	0.157	0.125	0.152	0.185	0.107	0.114	0.148
	(0.0895)	(0.0964)	(0.113)	(0.0840)	(0.0937)	(0.101)	(0.0908)	(0.0957)	(0.115)
Loans Unsecured	0.318	0.257	0.281	0.261	0.218	0.266	0.337	0.271	0.286
	(0.142)	(0.127)	(0.128)	(0.114)	(0.0988)	(0.129)	(0.145)	(0.133)	(0.127)
Equity	0.164	0.136	0.129	0.143	0.116	0.122	0.171	0.143	0.131
	(0.0748)	(0.0718)	(0.0692)	(0.0500)	(0.0385)	(0.0587)	(0.0800)	(0.0790)	(0.0680)
Deposits	0.804	0.795	0.829	0.815	0.775	0.804	0.800	0.803	0.839
	(0.0856)	(0.0991)	(0.0866)	(0.0762)	(0.110)	(0.0985)	(0.0880)	(0.0945)	(0.0762)
Borrowing	0.0159	0.0401	0.0260	0.0217	0.0764	0.0547	0.0140	0.0279	0.0157
	(0.0386)	(0.0645)	(0.0507)	(0.0488)	(0.0855)	(0.0746)	(0.0343)	(0.0505)	(0.0333)
Regular deposits	0.928	0.908	0.944	0.920	0.881	0.939	0.930	0.917	0.947
	(0.0892)	(0.0724)	(0.0852)	(0.0519)	(0.0869)	(0.0463)	(0.0984)	(0.0647)	(0.0909)
Preferred deposits	0.0722	0.0919	0.0557	0.0803	0.119	0.0613	0.0696	0.0827	0.0529
	(0.0892)	(0.0724)	(0.0852)	(0.0519)	(0.0869)	(0.0463)	(0.0984)	(0.0647)	(0.0909)
Non-institutional preferred deposits	0.0242	0.0659	0.0492	0.0239	0.0733	0.0271	0.0244	0.0635	0.0572
	(0.121)	(0.210)	(0.184)	(0.106)	(0.212)	(0.104)	(0.125)	(0.209)	(0.205)

Note: Cell entries are means, with standard deviations in parenthesis. The Pre-Pandemic period is from the first quarter of 1915 to the fourth quarter of 1918. The Pandemic period is the first quarter of 1919. The Post-Pandemic period is the second quarter of 1919 through the fourth quarter of 1920. All variables are shares of total assets, except for regular and preferred deposits, which are shares of total deposits.

Source: *Annual Report of the Superintendent of Banks* and authors' calculations.

Table 2: The Effect of the 1918 Pandemic on State-Charter NY Banks

	Deposits		Short Term Borrowing		Loans		Securities Holdings		Reserves	
Pandemic	0.00558	0.0866	0.0180	-0.0856	−0.0889**	-0.0502	0.169**	0.270**	-0.0140	0.0587
	(0.0137)	(0.256)	(0.158)	(0.423)	(0.0126)	(0.0638)	(0.0271)	(0.0841)	(0.0344)	(0.127)
Pandemic x Flu		-19.26		22.97		-9.190		-24.05		-17.29
		(12.43)		(85.64)		(13.76)		(19.25)		(26.40)
Constant	1.897**	1.888**	1.437	1.501	0.555	0.551	2.482**	2.471**	5.093**	5.085**
	(0.299)	(0.300)	(1.686)	(1.711)	(0.482)	(0.480)	(0.576)	(0.579)	(1.107)	(1.111)
Obs	4734	4734	909	909	4737	4737	4737	4737	4737	4737

	Regular Deposits		Preferred Deposits	
Pandemic	0.0344*	0.109	-0.202**	-0.219
	(0.0165)	(0.0582)	(0.0658)	(0.256)
Pandemic x Flu		-17.73		3.962
		(11.93)		(58.47)
Constant	1.987**	1.979**	2.546**	2.549**
	(0.384)	(0.384)	(0.922)	(0.931)
Obs	4709	4709	3782	3782

Note: Pandemic is an indicator variable equal to 1 in the first quarter of 1919 and Flu are the county-level flu death rates measured at the start of the first quarter of 1919. Standard errors, which are clustered at the county-level are reported in parenthesis beneath the estimated coefficients. All regressions contain bank controls as well as fixed effects for banks, years, and quarters.

* denotes a p-value less than 0.05, ** denotes a p-value less than 0.01.

Table 3: The Effect of the 1918 Pandemic on State-Charter Member versus Nonmember NY Banks

	Regular Deposits	Preferred Deposits	Short Term Borrowing	Loans	Securities Holdings	Reserves
Member	-0.00170	-0.0195	-0.142	-0.000773	-0.00998	0.0253
	(0.00976)	(0.0200)	(0.111)	(0.0155)	(0.0142)	(0.0278)
Pandemic	0.0860*	-0.582*	-0.778	-0.143**	0.242**	0.0135
	(0.0410)	(0.221)	(0.395)	(0.0284)	(0.0724)	(0.0985)
Member x Pandemic	0.0380	1.691**	2.008**	0.544**	0.183	0.267
	(0.138)	(0.588)	(0.488)	(0.185)	(0.240)	(0.281)
Pandemic x Flu	-15.12	88.26	129.8	9.142	-16.54	-6.016
	(9.023)	(50.14)	(86.34)	(5.760)	(18.02)	(20.83)
Member x Pandemic x Flu	-1.550	-396.6**	-343.0**	-112.3**	-47.66	-67.59
	(29.94)	(134.1)	(108.5)	(41.18)	(53.97)	(60.91)
Constant	1.754**	2.361*	2.82	0.537	2.430**	5.132**
	(0.278)	(0.969)	(1.76)	(0.475)	(0.584)	(1.085)
Observations	4708	3781	843	4736	4736	4736

Note: Pandemic is an indicator variable equal to 1 in the first quarter of 1919, Member is an indicator variable equal to 1 if the bank is a member of the Federal Reserve System, and Flu are the county-level flu death rates measured at the start of the first quarter of 1919. Standard errors, which are clustered at the county-level, are reported in parenthesis beneath the estimated coefficients. All regressions contain bank controls as well as fixed effects for banks, years, and quarters.

* denotes a p-value less than 0.05, ** denotes a p-value less than 0.01.

Table 4: The Effect on Loan Portfolios

	Loans secured by bonds	Mortgages	Loans secured by other assets	Loans unsecured
Member	0.00796	-0.0192	-0.0182	0.00492
	(0.0222)	(0.0198)	(0.0239)	(0.0211)
Pandemic	-0.0893	-0.0452	-0.208	-0.140**
	(0.0715)	(0.0348)	(0.125)	(0.0458)
Member x Pandemic	0.689*	0.441	0.619	0.470*
	(0.289)	(0.304)	(0.32)	(0.209)
Pandemic x Flu	17.48	5.522	-0.539	21.55
	(17.95)	(7.409)	(27.15)	(11.85)
Member x Pandemic x Flu	-155.4*	-91.27	-123.6	-96.63*
	(59.26)	(63.14)	(69.62)	(45.04)
Constant	0.909	0.23	1.843*	-0.208
	(0.551)	(0.653)	(0.787)	(0.44)
Observations	4286	4266	4584	4693

Note: Pandemic is an indicator variable equal to 1 in the first quarter of 1919, Member is an indicator variable equal to 1 if the bank is a member of the Federal Reserve System, and Flu are the county-level flu death rates measured at the start of the first quarter of 1919. Standard errors, which are clustered at the county-level, are reported in parenthesis beneath the estimated coefficients. All regressions contain bank controls as well as fixed effects for banks, years, and quarters.

* denotes a p-value less than 0.05, ** denotes a p-value less than 0.01.

Table 5: The Long-term Effect of the 1918 Pandemic on State-Charter Member versus Nonmember NY Banks, annual, end-1915 to end-1920

	Deposits	Regular Deposits	Preferred Deposits	Short Term Borrowing	Loans	Securities Holdings	Reserves
Member	-0.00177	-0.00295	0.0858	-0.417	-0.0440	0.0264	0.201*
	(0.0183)	(0.0205)	(0.137)	(0.764)	(0.0380)	(0.0487)	(0.0768)
Pandemic	0.290**	0.310**	-0.540	1.035	0.235**	0.478**	0.215
	(0.0405)	(0.0552)	(0.450)	(1.191)	(0.0690)	(0.151)	(0.191)
Member x Pandemic	0.197	-0.00446	1.731	1.445	0.621*	-0.105	0.0846
	(0.153)	(0.129)	(0.972)	(1.550)	(0.250)	(0.348)	(0.532)
Pandemic x Flu	-0.00712	-0.00810	0.0856	-0.201	0.0102	-0.0428	-0.000203
	(0.00637)	(0.00818)	(0.0730)	(0.185)	(0.0138)	(0.0228)	(0.0325)
Member x Pandemic x Flu	-0.0309	0.0172	-0.363*	-0.122	-0.0965*	0.0113	0.00192
	(0.0284)	(0.0247)	(0.170)	(0.282)	(0.0447)	(0.0604)	(0.0866)
Constant	7.158**	6.760**	8.559*	18.09	3.977**	10.44**	12.55**
	(0.812)	(0.896)	(3.975)	(15.85)	(0.932)	(1.389)	(1.976)
Observations	1021	1015	811	132	1021	1021	1021

Note: Pandemic is an indicator variable equal to 1 in 1919, Member is an indicator variable equal to 1 if the bank is a member of the Federal Reserve System, and Flu are the county-level flu death rates measured at the fourth quarter of 1918. Standard errors, which are clustered at the county-level, are reported in parenthesis beneath the estimated coefficients. All regressions contain bank controls.
* denotes a p-value less than 0.05, ** denotes a p-value less than 0.01.

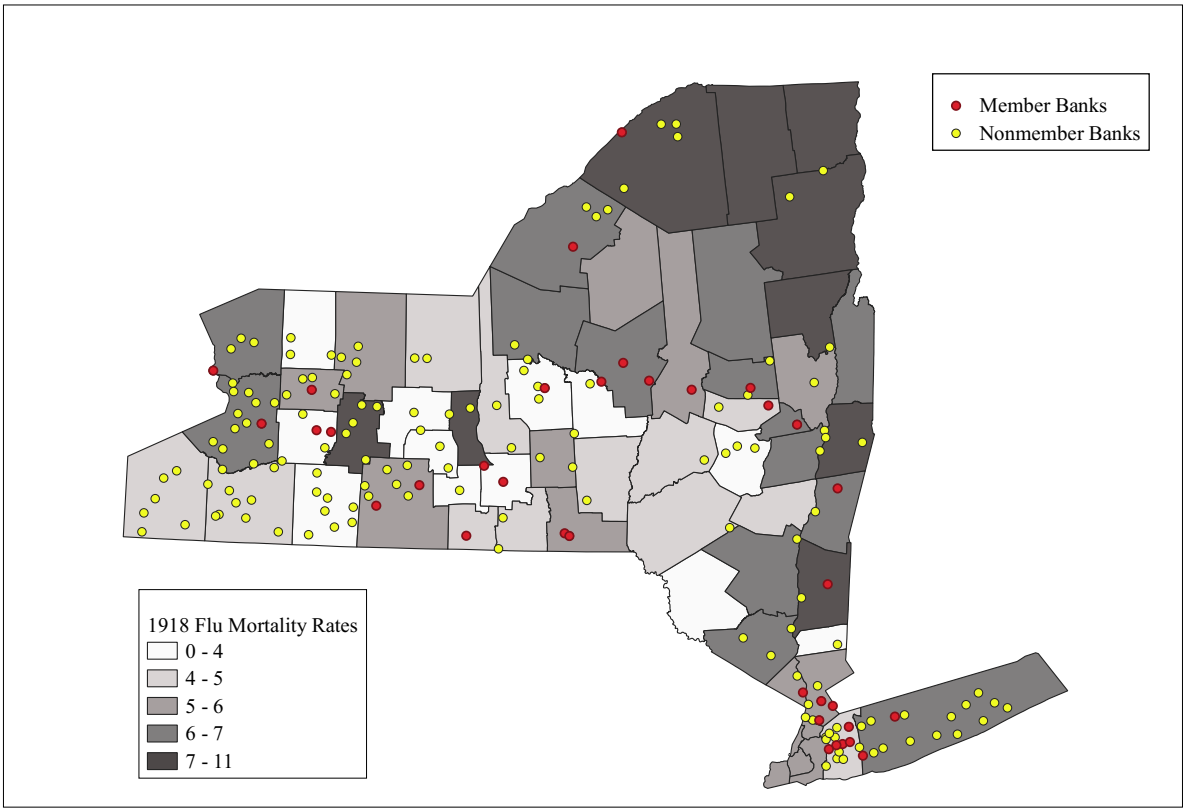
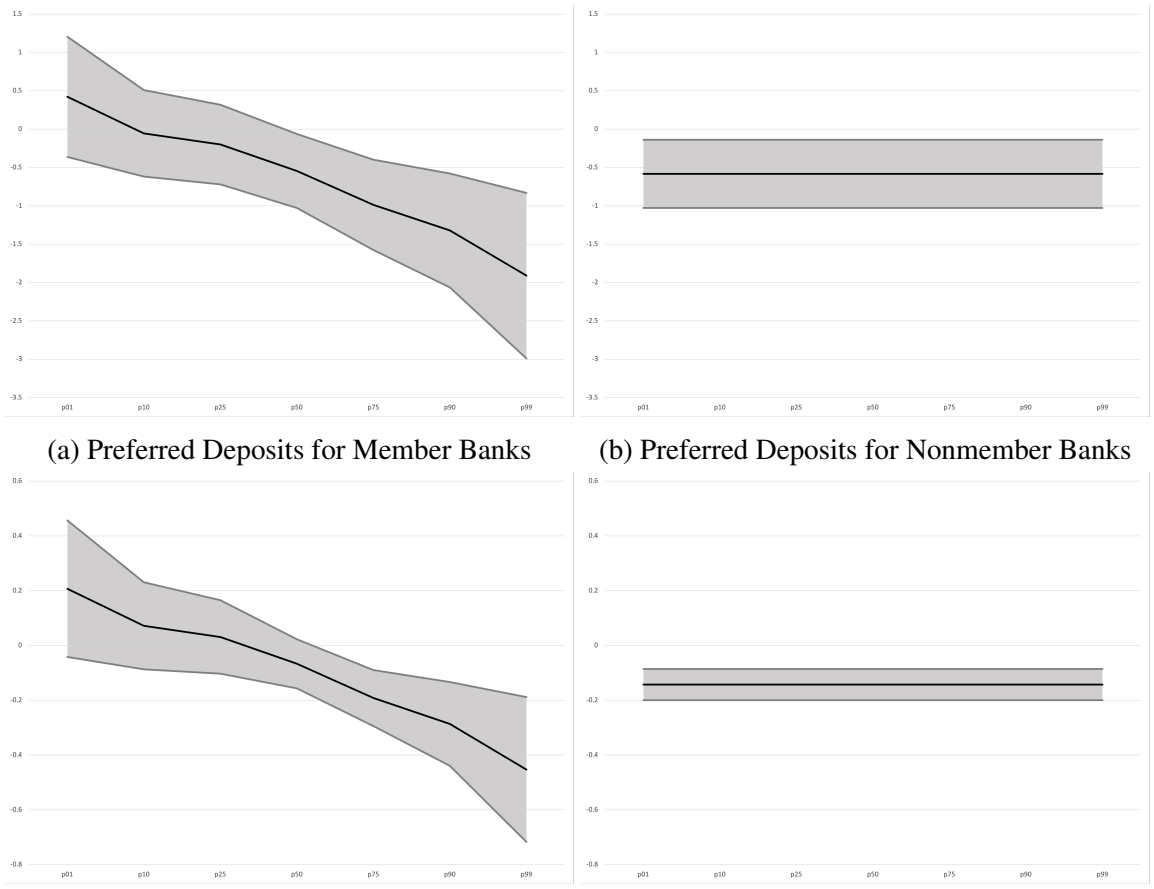


Figure 1: Pandemic Mortality Rates by County and Federal Reserve Membership Dispersion in 1918

Note: Federal Reserve Member versus Nonnmember banks as of 1918.

Source: *Annual Report of the Federal Reserve Board and Annual Report of State Department of Health of New York.*



(a) Preferred Deposits for Member Banks

(b) Preferred Deposits for Nonmember Banks

(c) Loans for Member Banks

(d) Loans for Nonmember Banks

Figure 2: The Differential Effects of the Pandemic, for Member and Nonmember banks

Note: Area around the solid line denotes the 95 percent confidence interval.

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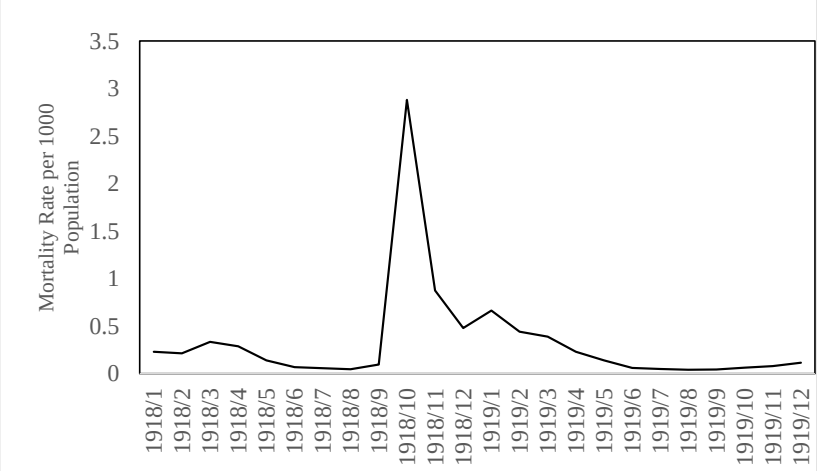
Appendices

A Annual Mortality Rates from Influenza and Pneumonia

Figure A1: Monthly Influenza and Pneumonia Death Rates per 1,000 Population in New York, 1918-1919.



Source: *Annual Report of State Department of Health of New York*.

Table A1: Annual Mortality Rates from Influenza and Pneumonia per 1000 people, 1915-1920

Year	Mean	SD
1915	1.534	0.354
1916	1.643	0.500
1917	1.773	0.471
1918	5.463	1.645
1919	1.928	0.467
1920	1.869	0.429

Source: *Annual Report of State Department of Health of New York* and authors' calculations.

B Checking the Exogeneity of Pandemic to Banking Activity

The existing literature argues that the spread and severity of the pandemic across the U.S. is not related to economic conditions (e.g., see (Brainerd and Siegler, 2003)). Nevertheless, as a check on this exogeneity assumption, we provide summary statistics on our objects of interest (growth rates of various balance sheet variables) in the pre-pandemic period, based on pandemic-related mortality rates. Specifically, we categorize banks based on the quantiles of the influenza mortality-rate distribution in the pandemic period. Hence, banks in counties with the highest mortality rates in the pandemic are in the top category, whereas banks in counties with the lowest mortality rates are in the bottom category. These summary statistics are reported in Table B2, and demonstrate that banks in each mortality-rate group were behaving similarly in terms of growth rates. Note that any difference in the mean growth rate across groups is quite small compared to the magnitude of the standard deviation of these growth rates. As such, we argue there are not any systematic differences across banks located in counties, which had different exposures to the 1918 influenza.

Table B2: : Mean and Standard Deviation of Balance Sheet Growth Rates for 1915-1917, by Influenza Mortality Severity Quintile in 1918

	(0-20)	(20-40)	(40-60)	(60-80)	(80-100)
Reserves	5.39	5.9	6	2.03	3.8
	(37.32)	(36.5)	(40.62)	(39.04)	(41.09)
Vault cash	1.3	3.2	3.27	1.17	1.92
	(26.96)	(24.9)	(24.27)	(24.76)	(22.41)
Non-Fed interbank reserves	9.31	6.7	6.08	2.12	4.54
	(58.96)	(50.02)	(61.16)	(53.23)	(59.23)
Securities	4.26	6.06	6.13	9.09	5.98
	(20.05)	(23.08)	(22.43)	(26.1)	(27.7)
Loans	1.9	3.3	3	4.17	2.13
	(9.66)	(17.28)	(9.19)	(11.07)	(8.74)
Deposits	2.99	4.65	5	4.59	3.81
	(9.36)	(9.65)	(10.45)	(10.25)	(10.85)
Short term borrowing	0.56	0.41	-1.91	9.58	1.25
	(99.66)	(70.62)	(100.19)	(80.74)	(85.33)

Note: Columns are groups of banks, categorized by the severity of influenza mortality rates in 1918. The first column includes banks located in counties that fall into the lowest quintile of 1918 mortality rates. The second column are those banks located in counties that fall into the second lowest quintile mortality rates, and so. Cell entries are means, with standard deviations in parenthesis, over the 1915 to 1917 period.
Source: *Annual Report of the Superintendent of Banks* and authors' calculations.

C Bank Balance Sheet

Table C3: Assets and Liabilities Reported, New York State Banks, 1915-1920

Assets		Liabilities	
Securities	Stocks and bonds, viz.: Public securities (market value) Private securities (market value)	Equity capital	Capital Surplus, including all undivided profits (market value)
Total loans	Mortgages owned Loans and discounts secured by bond and mortgage, deed or other real estate collateral Loans and discounts secured by other collateral Loans, discounts, and bills purchased not secured by collateral	Deposits	Preferred deposits Due depositors, not preferred
		Short-term borrowings	Bills payable Rediscounts
		Other liabilities	Due to trust companies, banks, and bankers Acceptances of drafts payable at a future date or authorized by commercial letters of credit Other liabilities Add for cents
Interbank reserves	Due from the Federal Reserve Bank of New York less offsets Due from trust companies, banks, and bankers		
Vault reserves	Specie Legal tender notes and notes of national banks Federal reserve notes Cash Items		
Other assets	Customers' liability on acceptances (per contra, see liabilities) Other assets Real estate owned Add for cents Overdrafts		

Source: *New York State Banking Department* (1915-1920).

Table C3 displays the set of balance sheet variables of state-chartered banks and trust companies recorded in the Annual Report of the Superintendent of Banks and how we aggregate these variables for our analysis. On the asset side, regulators report a fine breakdown of bank reserves which we group into two categories: vault reserves and inter-bank reserves. Vault reserves were composed of 'specie,' 'legal tender notes and notes of national banks,' 'Federal reserve notes,' and 'cash items.' This collection of items are currency or currency-like instruments that are held at the bank. Inter-bank reserves, or reserves that a bank has deposited at other banks or at a Federal Reserve Bank, is the sum of 'due from trust companies, banks, and bankers' and 'due from the Federal Reserve Bank.' The structure of the banking system in the early 1900s was a tiered system whereby smaller banks placed reserves at larger banks located in reserve cities (Anderson, Paddrik and Wang, 2019). This structure was formalized in that banks that were not members of the Federal Reserve (nonmember banks) were required to meet their reserve requirements by holding deposits in these reserve-city banks. Banks that were members of the Federal Reserve (member banks) met their reserve requirements by placing cash at the Federal Reserve.[26] Nevertheless, these member banks also placed cash at reserve-city banks, because these interbank deposits, which were generally considered safe assets, earned interest whereas deposits held at the Federal Reserve did not.

New York state regulators also collected detailed information on the loans made by banks, placing them into four categories. The first category is 'mortgages owned,' which are real estate loans. State banks were allowed to make mortgage loans against farmland within one hundred miles of their location (or headquarters) with several restrictions. The second category is 'loans and discounts secured by bond and mortgage, deed, and other real estate collateral,' which are loans collateralized by mortgage security and deeds.[27] The third category is 'loans and discounts secured by other collateral,' which are loans collateralized by anything except for real estate security, Liberty Bonds, and securities. The fourth and final category is 'loans, discounts, and bills purchased not secured by collateral,' which are promissory notes. We aggregate these four categories for our analysis, defining the sum as total loans. We also create a measure of the quality of a bank's loan that is equal to the ratio of secured loans over total loans.

The liability side of the balance sheets was mainly composed of capital, deposits, and short-term borrowing, where capital and deposits comprise over 90 percent of total liabilities. We aggregate capital and equity into one measure called equity capital, which is equal to the sum of 'capital' and 'surplus, including all undivided profits.' We calculate total deposits as the sum of 'preferred deposits' and 'due depositors, not preferred,' and define short-term borrowing as the sum of 'rediscounts' and 'bills payable.' Rediscounts are loans sold with recourse, and bills payable are promissory notes issued by the bank. During our sample period, nonmember banks primarily borrowed from correspondent banks located in near towns. These correspondent banks were national banks that were members of the Federal Reserve.[28] In contrast, member banks borrowed directly from Federal Reserve Banks.[29]

[26] Only banks that were members of the Federal Reserve were eligible to place cash reserves at their regional Federal Reserve Banks.

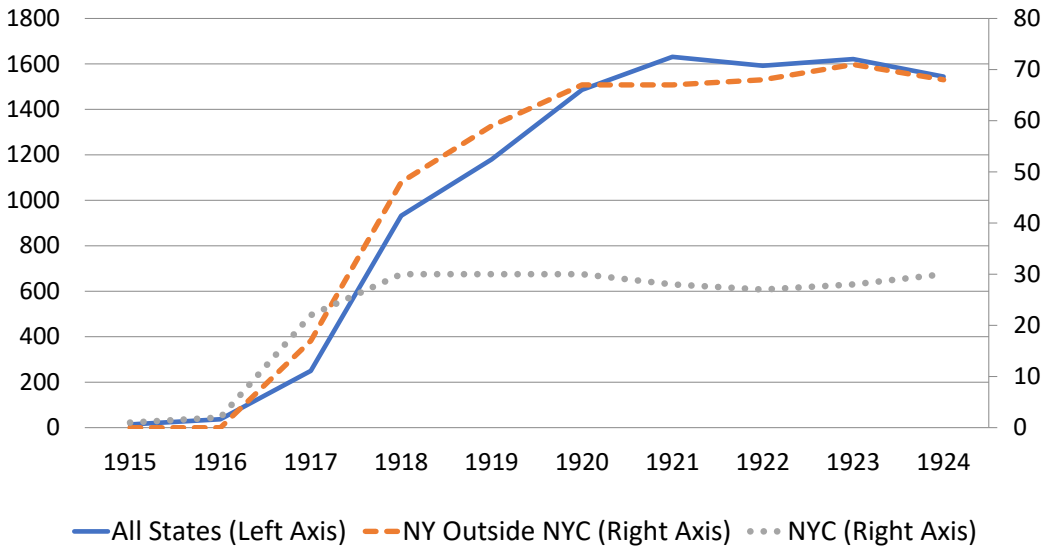
[27] A deed was taken as a mortgage but not an absolute transfer of ownership. Moreover, well-managed banks avoided deeds.

[28] The Federal Reserve Act made it compulsory for national banks to become members of the Federal Reserve System, while it made it voluntary for state banks to become members.

[29] For more information, see Carlson and Wheelock (2018) and Anderson, Erol and Ordoñez (2022).

D Likelihood of Federal Reserve Membership

Figure D2: Number of State-Charter Bank Members (1915-1924)



E Additional Results

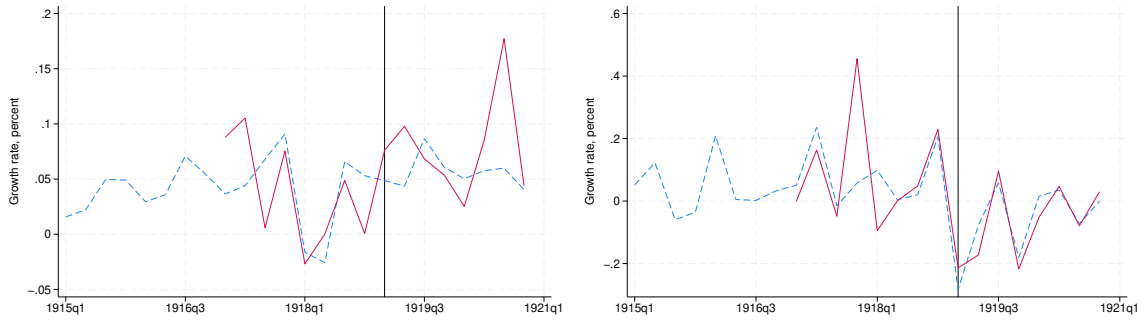
The sample period analyzed is from 1915 to 1920. In 1917, the Federal Reserve introduced major reforms to the membership process for state-charter banks. This results in a surge of state-charter banks seeking membership in the Federal Reserve System. Indeed, it is not until the first quarter of 1917 that we start to observe a number of state-charter banks in the sample which are members of the Federal Reserve System (member banks). In the analysis of the effect of the pandemic across member and nonmember banks, we use the entire sample period. Here, we explore whether the results are robust to using a shorter sample from 1917 to 1920. These results are illustrated in table E4 and are comparable to those in table 3.

Table E4: Robustness: The 1918 Pandemic on State-Charter Member versus Nonmember NY Banks, 1917-1920

	Regular Deposits	Preferred Deposits	Short Term Borrowing	Loans	Securities Holdings	Reserves
Member	0.00303	-0.00389	-0.151	-0.0175	-0.0105	0.0502
	(0.0113)	(0.0323)	(0.133)	(0.0176)	(0.0132)	(0.0353)
Pandemic	0.0771	−0.579*	-0.720	−0.125**	0.223**	-0.0278
	(0.0390)	(0.229)	(0.390)	(0.0263)	(0.0698)	(0.0999)
Member x Pandemic	0.0375	1.714**	2.079**	0.558**	0.165	0.276
	(0.137)	(0.603)	(0.426)	(0.189)	(0.229)	(0.272)
Pandemic x Flu	-13.17	98.51	118.6	6.704	-11.38	2.755
	(8.396)	(52.22)	(82.56)	(5.337)	(17.38)	(21.20)
Member x Pandemic x Flu	-1.413	−398.8**	−356.2**	−115.1**	-43.18	-70.44
	(29.80)	(136.7)	(96.56)	(41.98)	(50.92)	(58.96)
Constant	2.266**	4.335**	-0.175	0.745	2.804**	7.102**
	(0.424)	(1.550)	(2.542)	(0.603)	(0.786)	(1.508)
Observations	3406	2756	721	3423	3423	3423

Note: This table is comparable to table 3 except that the results are estimated on a shorter sample period of the first quarter of 1917 to the fourth quarter of 1920. Pandemic is an indicator variable equal to 1 in the first quarter of 1919, Member is an indicator variable equal to 1 if the bank is a member of the Federal Reserve System, and Flu are the county-level flu death rates measured at the start of the first quarter of 1919. Standard errors, which are clustered at the county-level, are reported in parenthesis beneath the estimated coefficients. All regressions contain bank controls as well as fixed effects for banks, years, and quarters.

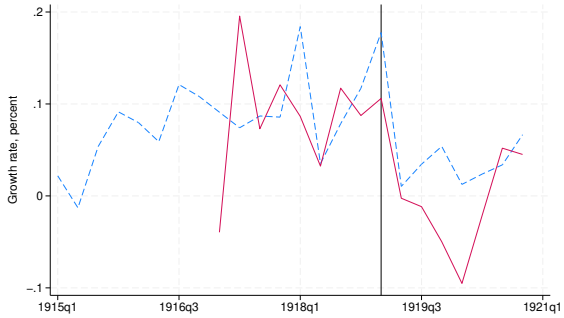
* denotes a p-value less than 0.05, ** denotes a p-value less than 0.01.



(a) Regular deposits

(b) Preferred deposits

(c) Loans



(d) Securities holdings

Figure E3: Growth Rates of Balance Sheet Variables, for Member and Nonmember banks

Note: The vertical line marks when the 1918 Influenza epidemic effected NY. Before 1917, there is only one member bank in our sample. Its membership was active from the first quarter of 1915 to the fourth quarter of 1915.