

The Effect of the Central Bank Liquidity Support during Pandemics: Evidence from the 1918 Spanish Influenza Pandemic

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The views expressed herein are those of the authors and do not necessarily reflect the position of the Federal Reserve Bank of New York, the Federal Reserve Board, the Federal Reserve System, or the Federal Deposit Insurance Corporation.

Question and Answers

- Question
 - ▶ How does the central bank liquidity provision affect financial stability during pandemics?
- Strategy
 - ▶ Compare Federal Reserve member versus nonmember banks during the 1918 influenza pandemic
- Answers
 - ▶ Pandemic caused problems in financial stability
 - ▶ Central bank liquidity support did help local economy
 - ▶ Member banks did not pass on liquidity
 - ▶ Banks under severe stress could not fully utilize it

Literature

- Pandemic and economic outcomes (aggregate data): Brainerd and Siegler (2003), Barro, Ursua, and Weng (2020), Correia, Luck, and Verner (2020), Oscar, Singh and Taylor (2020)
- Socioeconomic or labor market outcomes (micro data): Noymer and Garenne (2000), Mamelund (2006), Garrett (2009)
- Local health output and aftermath (micro data): Karlsson, Nilsson, and Pichler (2014), Clay, Lewis, and Severnini (2018), Keyfits and Flieger (1968), Almond (2006)
- Limited research on the relationship btw pandemics and financial stability due to lack of micro-level data on financial sector

Methods

- Collect and construct a new data set:
 - ▶ Quarterly balance sheets of banks in New York 1914-1919
 - ▶ Panel data on mortality across counties
 - ▶ Federal Reserve membership
- Diff-in-diff with pandemic severity on
 - ▶ Deposit stability
 - ▶ Short-term borrowing (central bank liquidity support)
 - ▶ Bank lending

Advantages using the Historical Data

- Relatively homogenous banks with the same business model
- Interbank deposits and short-term borrowing
- Fed member vs nonmember banks
- Simple monetary policy
- No deposit insurance and alternatives

1 Historical Background

2 Data

3 Empirical Analysis

4 Conclusion

① Historical Background

② Data

③ Empirical Analysis

④ Conclusion

1918 Influenza Pandemic

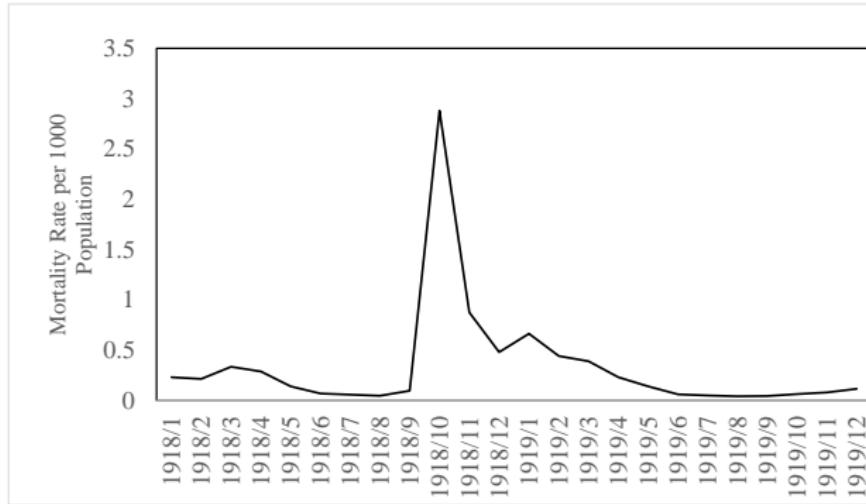
- 500 million affected and 50+ million killed globally
- 657,000 U.S. deaths
- NYS monthly I&P death rate : $0.5/1000 \rightarrow 3/1000$
- Large variation in the severity across NY counties
 - ▶ There is little consensus on the underlying cause (Huntington (1923), Crosby (1989), Kolata (1999), Brainerd and Siegler (2003))
 - ▶ “(the statistical evidence) supports the notion of influenza mortality as an exogenous shock to the population.” (Brainerd and Siegler, 2003)

Annual Mortality Rates from Influenza and Pneumonia

Year	Mean	SD
1914	1.340	0.378
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

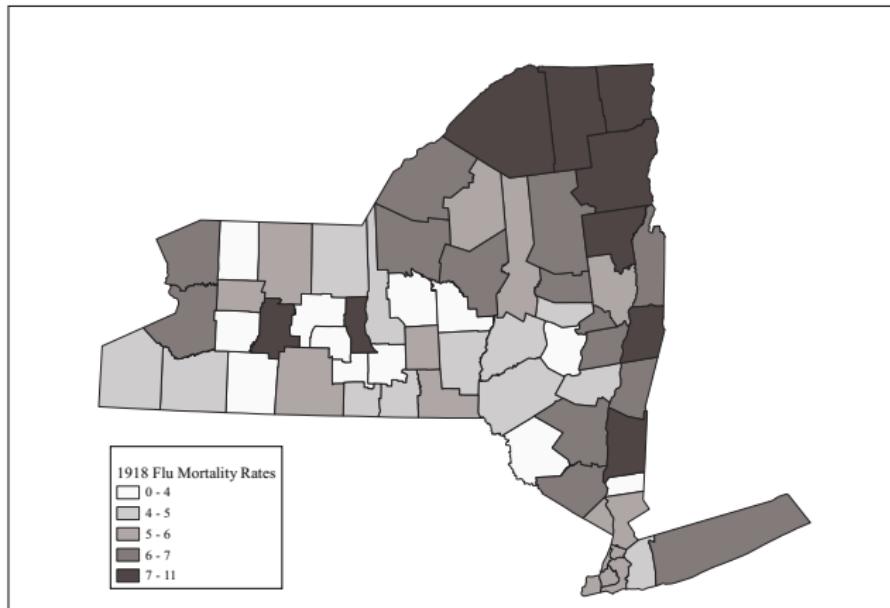
Source: Annual Report of State Department of Health of New York and authors' calculations

Influenza and Pneumonia Death Rates



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

Mortality Rates across New York Counties



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

The Dual Banking System

- The National Banking Act created a dual banking system
 - ▶ National-charter banks were supervised by OCC (national regulator)
 - ▶ State-charter banks were supervised by state banking regulators
- Federal Reserve started in 1914
 - ▶ National-charter banks were required to become members
 - ▶ State-charter banks had the option of becoming a member
 - ★ Many state banks chose not to become a member
- As a result we have three types of banks in our data
 - ① National-charter banks which are all Fed members
 - ② State-charter banks which are Fed members
 - ③ State-charter banks which are not Fed members

Federal Reserve Discount Window

- Discount window as exclusive monetary policy → No stigma
- Member banks vs nonmember banks (membership was voluntary)
 - ▶ Stricter regulation and supervision
 - ▶ 0% interest rate vs 2% interest rate on reserves
 - ▶ Nonmembers accessed DW through their member correspondents
- Fed amendment in 1917 and more state banks joined

Interbank Network: Correspondent Banking

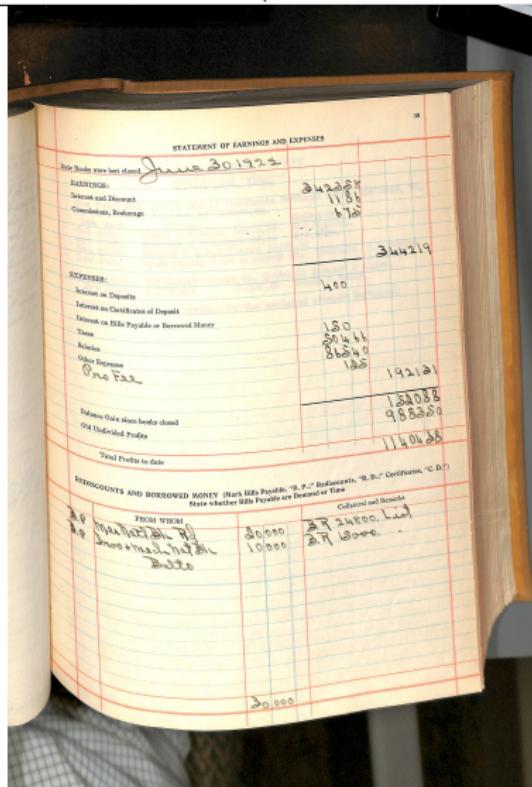
- Banks suffered from liquidity fluctuations
- Nonmembers relied on their “correspondents” to mitigate it
- Placed interbank deposits but also could borrow or lend
- Deposit and Short-term funds (red), Deposit (blue)



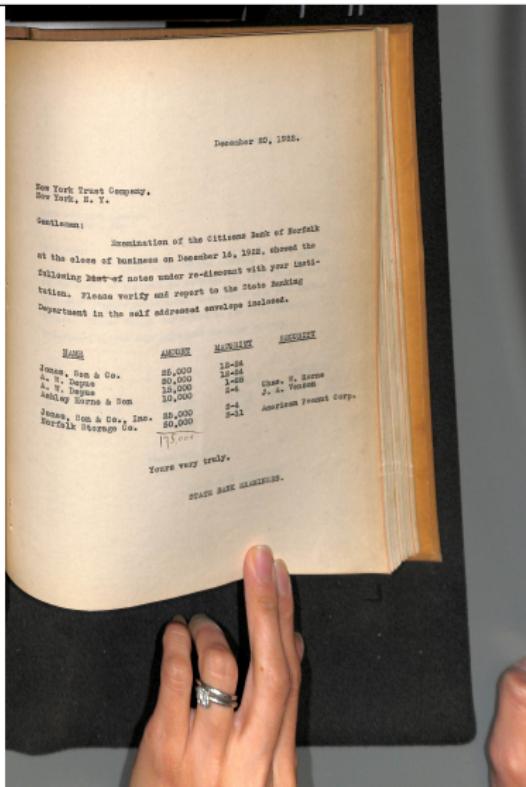
Source: Anderson, Erol, and Ordonez (2020)

Bank Exam Reports

Correspondent

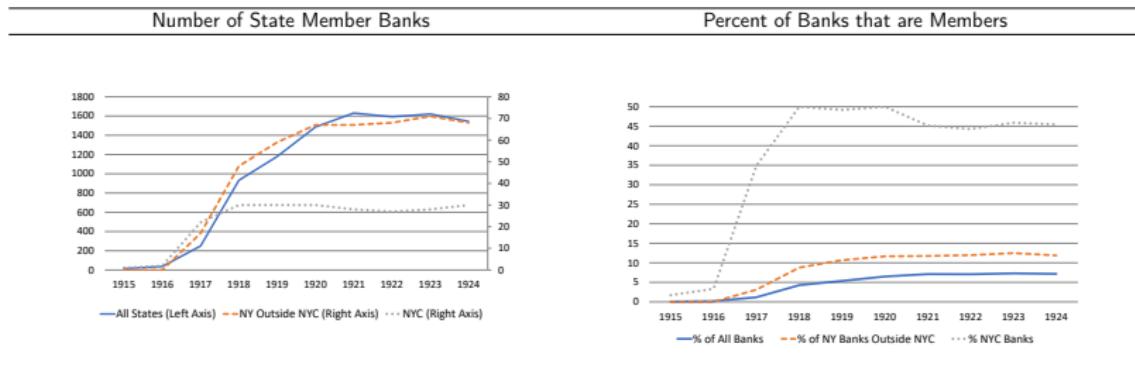


Collateral



Source: Anderson, Erol, and Ordonez (2020)

Adoption of Membership by State Banks



Source: Annual Report of the Superintendent of Banks 1914-1919

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Data Sources

- Annual Report of the Superintendent of Banks 1914-1919:
 - ▶ All state-charter banks and trust companies (quarterly)
 - ▶ Exclude major financial centers (New York, Albany, Buffalo, Rochester)
 - ▶ Use growth rate of balance sheet items
- Annual Report of State Department of Health of New York
 - ▶ Yearly data for each county (mortality by causes)
 - ▶ Monthly data for the entire state of New York
 - ▶ Interpolate county-level data to a quarterly frequency
- Annual Report of the Federal Reserve Board:
 - ▶ Federal Reserve membership status

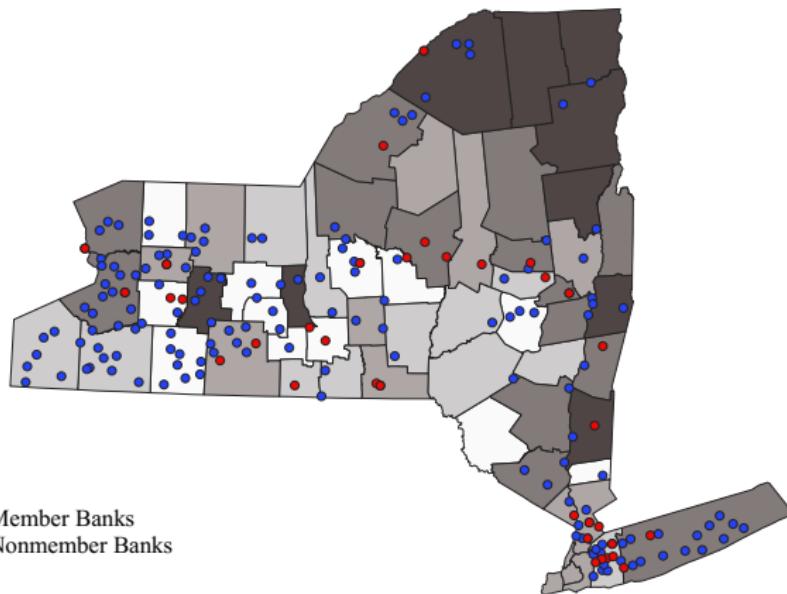
Balance Sheet by Federal Reserve Membership

	Member Banks			Nonmember Banks		
	Pre-Pandemic	Pandemic	Post-Pandemic	Pre-Pandemic	Pandemic	Post-Pandemic
Liquid assets to assets	11.8 (5.518)	10.74 (4.959)	11.61 (5.063)	14.48 (6.774)	14.1 (6.674)	14.22 (6.628)
Vault reserves to assets	2.909 (1.696)	2.296 (1.252)	2.45 (1.000)	3.558 (1.430)	3.297 (1.270)	3.426 (1.338)
NonFed-interbank reserves to assets	6.752 (4.523)	4.816 (3.655)	5.029 (4.287)	10.91 (6.386)	10.68 (5.948)	10.63 (5.835)
Securities to assets	34.7 (12.400)	38.66 (11.120)	34.34 (11.110)	30.53 (15.620)	35.96 (14.950)	33.37 (14.220)
Loans to assets	49.01 (12.000)	46.13 (10.840)	50.23 (11.680)	51.14 (15.080)	45.9 (13.860)	49 (14.350)
Capital equity to liabilities	12.35 (4.064)	11.76 (3.973)	11.91 (4.647)	15.24 (7.147)	14.61 (7.487)	13.42 (5.157)
Deposits to liabilities	78.42 (9.779)	77.66 (10.530)	79.33 (9.970)	80.12 (8.721)	81.98 (8.316)	82.41 (11.530)
Short-term borrowing to liabilities	6.988 (7.702)	7.924 (8.306)	6.828 (8.608)	3 (5.095)	1.932 (3.641)	1.512 (3.244)

Growth Rates by Federal Reserve Membership

	Member Banks			Nonmember Banks		
	Pre-Pandemic	Pandemic	Post-Pandemic	Pre-Pandemic	Pandemic	Post-Pandemic
Asset Growth	3.318 (8.659)	2.851 (16.41)	4.393 (8.606)	2.829 (9.39)	1.147 (10.24)	4.7 (8.814)
Liquid Asset Growth	-3.407 (34.95)	-2.986 (43.86)	8.634 (37.59)	-2.403 (45.77)	-6.327 (44.15)	5.66 (38.00)
Vault reserves growth	-5.61 (30.17)	-5.795 (30.12)	8.454 (31.21)	-0.48 (29.57)	-4.015 (30.03)	5.802 (28.26)
Interbank reserves growth	-17.58 (63.12)	-12.14 (82.13)	3.359 (69.09)	-2.726 (67.2)	-4.723 (61.9)	5.211 (53.03)
Securities growth	8.121 (21.59)	10.24 (26.2)	-2.364 (16.29)	9.992 (27.96)	18.56 (34.22)	1.892 (21.87)
Loan growth	2.255 (12.29)	0.708 (20.14)	8.37 (9.916)	0.24 (10.89)	-2.894 (12.25)	7.071 (11.67)
Deposits growth	1.577 (10.1)	3.366 (15.03)	6.103 (10.44)	2.436 (12.14)	3.501 (11.57)	5.445 (10.85)
Short-term borrowing growth	170 (1311.8)	77.88 (1506.6)	-75.81 (1303.7)	108.1 (1578.5)	-156.4 (1385.9)	-79.31 (1390.2)

Locations of Banks by Membership Status



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Baseline Framework

- Diff-in-diff : county-level variation with lagged quarterly effect
 - ▶ Assumption : severity of influenza \perp bank characteristics
- Funding stability: deposits and short-term borrowing
 - ▶ Deposit outflows:
 - consumption smoothing
 - loss of confidence in the banking sector (no deposit insurance)
 - ▶ Short-term borrowing:
 - member banks - direct access to DW
 - nonmember banks - indirect access through member banks
- Asset side response: loans, securities, cash, interbank deposits
(cf. demand shock to loans?)

Verification of the Identifying Assumption

Pandemic flu mortality percentile Balance sheet ratios in 1918	(0-20)	(21-40)	(41-60)	(61-80)	(81-100)
Liquid assets to assets	15.32 (6.352)	16.34 (6.219)	15.53 (6.59)	15.74 (6.345)	14.82 (6.36)
Vault reserves to assets	4.169 (1.439)	4.291 (1.338)	3.809 (1.511)	4.303 (1.532)	4.215 (1.604)
NonFed-interbank reserves to assets	11.15 (6)	12.05 (5.904)	11.72 (6.389)	11.43 (6.15)	10.59 (6.007)
Securities to assets	20.06 (15.6)	25.07 (16.59)	25.52 (14.88)	25 (12.83)	26.72 (16.14)
Loans to assets	61.16 (15.5)	54.6 (16.69)	55.48 (16.33)	56.01 (12.21)	55.66 (15.44)
Capital equity to liabilities	18.3 (8.168)	16.95 (5.733)	16.91 (7.333)	17.56 (5.762)	17.9 (9.095)
Deposits to liabilities	78.86 (9.48)	81.34 (6.436)	80.19 (8.098)	80 (6.565)	79.91 (9.549)
Short-term borrowing to liabilities	1.594 (3.925)	0.697 (2.364)	1.072 (2.741)	0.928 (2.485)	0.624 (1.779)

Quarterly Regressions

$$\Delta y_{i,t} = \alpha_i + \beta_1 P_t + \beta_2 x_{i,t} + \beta_3 P_t \cdot x_{i,t} + Z'_{i,t} \gamma + \epsilon_{i,t} \quad (1)$$

- P_t : pandemic dummy
- $x_{i,t}$: mortality rate
- $Z'_{i,t}$: bank-level controls (liquid asset to asset, equity to liabilities, loan quality, log asset return)

$$\begin{aligned} \Delta y_{i,t} = & \alpha_i + \beta_1 P_t + \beta_2 M_{i,t} + \beta_3 x_{i,t} + \beta_4 P_t \cdot x_{i,t} + \beta_5 P_t \cdot M_{i,t} \\ & + \beta_6 M_{i,t} \cdot x_{i,t} + \beta_7 P_t \cdot M_{i,t} \cdot x_{i,t} + Z'_{i,t} \gamma + \epsilon_{i,t} \end{aligned} \quad (2)$$

- $M_{i,t}$: member bank dummy

Quarterly over All Banks, 1914:Q1 - 1919:Q4

	(1) Deposits	(2) Short-term borrowing	(3) Loans	(4) Securities	(5) Liquid Assets
Pandemic	0.0934 (0.0621)	-2.029 (3.464)	-0.0447 (0.0668)	0.280*** (0.0854)	0.0535 (0.139)
Flu death rate	-0.745 (17.59)	-3599.0** (1704.5)	-7.906 (16.74)	56.62 (36.42)	-31.89 (46.85)
Pandemic x Flu death rate	-20.21 (20.48)	3406.2* (1944.7)	-2.043 (22.56)	-80.63** (39.1)	8.225 (53.95)
Constant	1.857*** (0.32)	27 (17.15)	0.208 (0.423)	2.062** (0.566)	5.352*** (1.096)
Observations	4536	4536	4536	4536	4536
Bank Controls	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes

Fed-member vs Non-member Banks, 1918:Q1 - 1919:Q4

	(1)	(2)	(3)	(4)	(5)
	Deposits	Short-term borrowing	Loans	Securities	Liquid Assets
Pandemic	0.0665*	-0.643	-0.076***	0.170**	-0.0329
	(0.0375)	(3.509)	(0.0274)	(0.0682)	(0.111)
Member x Pandemic	0.164	-17.92*	0.448**	0.0884	0.201
	(0.119)	(9.777)	(0.169)	(0.219)	(0.238)
Flu death rate	22.88	-4349.2*	-15.22	57.3	58.24
	(18.37)	(2418.8)	(21.25)	(43.47)	(71.45)
Member x Flu death rate	44.21*	-6244.9*	-11.57	35.39	139.6**
	(24.51)	(3400.5)	(22.69)	(25.35)	(59.38)
Pandemic x Flu death rate	-33.72*	3184.2	13.01	-65.54	-61.62
	(17.95)	(2307.3)	(21.46)	(43.4)	(72.08)
Member x Pandemic x Flu death rate	-79.19**	10456***	-92.35**	-60.21	-181.1**
	(38.08)	(3814.6)	(44.65)	(60.45)	(90.23)
Constant	3.227***	30.36	2.084***	4.159**	8.059***
	(0.817)	(50.13)	(0.591)	(1.607)	(2.137)
Observations	1611	1611	1611	1611	1611
Bank Controls	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes

Long-term Effects

$$\begin{aligned}\Delta y_{i,t} = & \alpha_i + \sum_{k=0}^K [\beta_{1,k} P_{i,t-k} + \beta_{2,k} x_{i,t-k} + \beta_{3,k} P_{i,t-k} \cdot x_{i,t-k}] \\ & + Z'_{i,t} \gamma + \delta t + \epsilon_{i,t}\end{aligned}\tag{3}$$

- k : index for the distributed lags up to $K = 3$

$$\begin{aligned}\Delta y_{i,t} = & \alpha_i + \sum_{k=0}^K [\beta_{1,k} P_{i,t-k} + \beta_{2,k} M_{i,t-k} + \beta_{3,k} x_{i,t-k} \\ & + \beta_{4,k} P_{i,t-k} \cdot x_{i,t-k} + \beta_{5,k} M_{i,t-k} \cdot x_{i,t-k} + \beta_{6,k} P_{i,t-k} \cdot M_{i,t-k} \\ & + \beta_{7,k} P_{i,t-k} \cdot M_{i,t-k} \cdot x_{i,t-k}] + Z'_{i,t} \gamma + \epsilon_{i,t}\end{aligned}\tag{4}$$

Long-Term Effect by Fed Membership, Quarterly,

1918:Q1-1919:Q4

	(1)	(2)	(3)	(4)	(5)
	Deposits	Borrowing	Loans	Securities	Liquid Asset
Cumulative Effect of Pandemic	0.247	-12.51	-0.114	0.49	1.247
P-Value of Cumulative Effect of Pandemic	0.039	0.159	0.0896	0.013	0.00359
Cumulative Effect of Pandemic x Flu death rate	32.69	17078.2	7.719	-231.7	-98.36
P-Value of Cumulative Effect of Pandemic x Flu death rate	0.188	0.016	0.237	0.0492	0.185
Cumulative Effect of Flu death rate x Member	-56.29	-11254.8	208.7	43.41	-981.9
P-Value of Cumulative Effect of Flu death rate x Member	0.183	0.157	0.0412	0.225	0.0158
Cumulative Effect of Pandemic x Member banks	0.341	-23.25	0.572	0.189	0.921
P-Value of Cumulative Effect of Pandemic x Member banks	0.0774	0.0155	0.0372	0.194	0.0527
Cumulative Effect of Pandemic x Member banks x Flu death rate	-29.13	18162.2	-337.2	-117	762.7
P-Value of Cumulative Effect of Pandemic x Member banks x Flu death rate	0.21	0.102	0.00604	0.177	0.032
Observations	1501	1501	1501	1501	1501
Bank Controls	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes

Yearly Regressions

- Repeat the regressions with annual frequency data
 - ➊ Compare our results with other papers
 - ➋ Importance of capturing short-term disruptions
 - ➌ Match the frequency of annual mortality rates

Effect by Membership, Yearly, 1918-1919

	(1)	(2)	(3)	(4)	(5)
	Deposits	Borrowing	Loans	Securities	Liquid Assets
Member	0.129 (0.148)	-21.86** (11.040)	0.484** (0.235)	-0.146 (0.298)	0.116 (0.311)
Flu death rate	-0.0111* (0.006)	-1.606** (0.779)	0.009 (0.009)	-0.0401* (0.021)	-0.0346* (0.021)
Member x Flu death rate	-0.0221 (0.027)	4.866** (1.951)	-0.0789* (0.044)	0.00764 (0.051)	-0.0177 (0.052)
Constant	0.239 (0.226)	28.19 (22.92)	-0.178 (0.309)	1.109* (0.590)	0.924 (0.593)
Observations	199	199	199	199	199
Bank Controls	Yes	Yes	Yes	Yes	Yes

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Conclusion

- Large variation following pandemic severity across counties
- Friction in central bank liquidity support
 - ▶ Liquidity pass through
 - ▶ Failure to provide insurance to more severely affected
- Policy Implications
 - ▶ Friction in intermediation and uneven supply of credit
 - ▶ Various channels of liquidity support could help
 - ▶ Fair and effective insurance of credit supply
- Various channels to support liquidity might be necessary for fairness and effectiveness

Appendix

Robustness Checks

Short-term borrowing	(1)	(2)	(3)	(4)
	Growth 1918-1919	Logit 1918-1919	Logit 1916-1919	Tobit 1916-1919
Pandemic	-1.540*** (0.418)	0.492 (0.963)	-0.254 (0.812)	-3.092 (3.575)
Member x Pandemic	2.163*** (0.529)	-4.804 (3.711)	-3.347 (2.446)	-2.278 (7.255)
Flu death rate	-325.3* (175.9)	-4.874 (481.9)	-63.04 (383.4)	-1723.7 (1549.6)
Member x Flu death rate	-66.83 (205.1)	-450.9 (624.8)	-784 (494.8)	(2189) (2057.1)
Pandemic x Flu death rate	472.4** (198)	130.8 (499)	287.3 (404.7)	2933.6* (1673.6)
Member x Pandemic x Flu death rate	-335.3 (257.6)	1889.3* (1103)	1786.4** (806.4)	2924.3 (2590.2)
Constant	5.608 (5.009)			
Observations	477	912	2463	4002
Bank Controls	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	No
Bank FE	Yes	Yes	Yes	No