Destabilizing Digital "Bank Walks"

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Columbia University
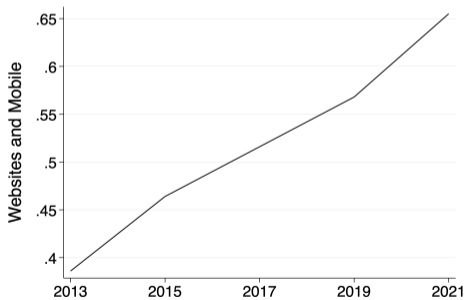
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Luigi Zingales
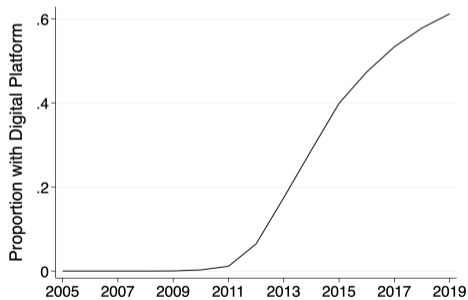University of Chicago

Rise of Digital Banking

Over the past decade digital platforms (websites + mobile apps):

- Became the leading way to access banking services
- Saw widespread adoption by commercial banks

Primary Banking Method (Source: FDIC)

Bank Adoption (Source: Koont 2023)

Destabilizing Digital "Bank Walks"

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- We are focusing on the inertia to changes in their opportunity cost, and to what extent the digitalization of the banking relationship changes this inertia

How has the digital (website + mobile) transformation of banking over the last decade changed...

- ... the stickiness of deposits and deposit betas?

- ... banks' deposit franchise value, and by how much?

How is this changing banking?

This Paper

As the Fed funds rate increases, digital banks experience

1. Larger outflow of deposits
   a. Time series: deposits as a share of GDP have become more sensitive to changes in f
   b. Cross section: deposit outflows are more pronounced in digital banks
   c. Within bank: deposit outflows are more pronounced in markets with high internet usage

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2. Larger increase of deposit rates (Higher deposit betas)
    a. Deposit betas higher for digital banks
    b. Bank profits constrain deposit rate increases

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2. Larger increase of deposit rates (Higher deposit betas)
   a. Deposit betas higher for digital banks
   b. Bank profits constrain deposit rate increases

3. 40% lower value of deposit franchise
   a. Calculate deposit franchise value following formula of Drechsler et al. 2023
   b. Stock market reaction more negative in response to $f\uparrow$ for digital banks
   c. SVB insolvent at the end of 2022 given adjusted deposit franchise value calculation

Literature Review

1. Deposit Betas:
   - Berger & Hannan (1989), Diebold & Sharpe (1990), Hannan & Berger (1991), Neumark & Sharpe (1992), Hutchison & Pennacchi (1996), Driscoll & Judson (2013), Drechsler, Savov, & Schnabl (2017, 2021)
   - Emphasis on technology rather than competition

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2. Financial Stability
   - Egan, Hortacsu, & Matvos (2017), Jiang, Matvos, Piskorski, & Seru (2023), Acharya, Chauhan, Rajan, & Steffen (2023), Drechsler, Savov, Schnabl, & Wang (2023)
   - "Deposit walks" versus deposit runs
   - The effect of digitalization on deposit franchise value

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   - "Deposit walks" versus deposit runs
   - The effect of digitalization on deposit franchise value

3. **Digital Banking and Fintech**
   - Philippon (2019), Stulz (2019), Hong, Lu, & Pan (2019), Jiang, Yu, & Zhang (2022), Haendler (2022), Curi, Lozano-Vivas, & Murgia (2023), Erel, Liebersohn, Yannelis, & Earnest (2023), Koont (2023)

Road Map

1. Data
2. Definitions
3. Results
    I. Deposit outflows
    II. Deposit betas
    III. Deposit franchise value
4. Implications

Koont 2023: Novel data on digital technology for the universe of U.S. commercial banks

1. Mobile banking platform release dates, features, ratings on Apple and Google *data.ai*

App			Company	App Price	App Initial Release Date
Wells Fargo Mobile		Jump to ▾	Wells Fargo	Free	May 17, 2009
Wells Fargo Mobile		Jump to ▾	Wells Fargo	Free	May 25, 2010

Blackhawk Bank & Trust Mobile

Ratings and Reviews

4.8 out of 5   712 Ratings

Blackhawk Bank & Trust (BhB&T) mobile banking makes banking from anywhere simple and convenient. From viewing your account activity to finding any of our branch locations in the Illinois and Iowa Quad Cities and surrounding areas, your accounts can be conveniently accessed 24/7.

Easy to Use:	Monitor your money:	Manage your accounts:	Secure:
• Enroll from the app	• Instant Balance	• Open a new account	• Username and password login
• Deposit checks	• Transaction history	• Make loan payments	• Fingerprint and Facial recognition enabled
• Make transfers	• Control your debit card	• Contact us	• Password approved transfers
• Send money	• View credit score	• Find our locations	
• Pay bills	• Customize real time alerts for your accounts		Member FDIC & Equal Housing Lender

2. Annual website maps: website complexity and features *archive.org*

1. Data: Additional Datasets

- Banks

    - Brokerage classification (Call reports)
    - Bank-level deposit and interest expense data (Call reports)
    - Branch-level deposit quantities (FDIC SOD), and rates (RateWatch)
    - Marked-to-market losses in 2022 (Jiang, Matvos, Piskorski, & Seru 2023)

- Local Counties

    - Internet subscriptions by county (Census American Community Survey 2019)

- Aggregate Trends

    - Fed funds rate, deposits, GDP (FRED)

2. Definitions

Digital Banks: Use number of app reviews by 2022 to capture intensive margin of digitalization

- Binary $= 1$, if the bank has a mobile banking app in year t with at least 300 reviews

- Continuous $= \dfrac{\text{Number of mobile app reviews}}{\text{Avg number of deposit accounts 2010–2022}}$,

  if the bank has a mobile banking platform in year t. Normalized to range between 0–1.

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Brokers: Banks that report non-zero brokerage income in year t in their Call Reports

2. Summary Statistics

Table 1: Digital Banks and Brokers in 2022

	Number	Mean	Assets (Mean)	Assets (Median)
Banks	4,756		4.97	0.32
Digital Banks (Binary)	876	0.18	20.82	1.25
Digital Banks (Continuous)	2,953	0.13	6.91	0.46
Brokers	398	0.08	42.87	3.00
Digital Brokers (Binary)	228	0.05	67.56	5.58
Digital Brokers (Continuous)	329	0.02	48.40	3.14

Question

How has the digital (website + mobile) transformation of banking over the last decade changed...

- ... the stickiness of deposits and deposit betas?

- ... banks' deposit franchise value, and by how much?

How is this changing banking?

3.1 Results: Deposit Outflows – Time Series 1971-2023

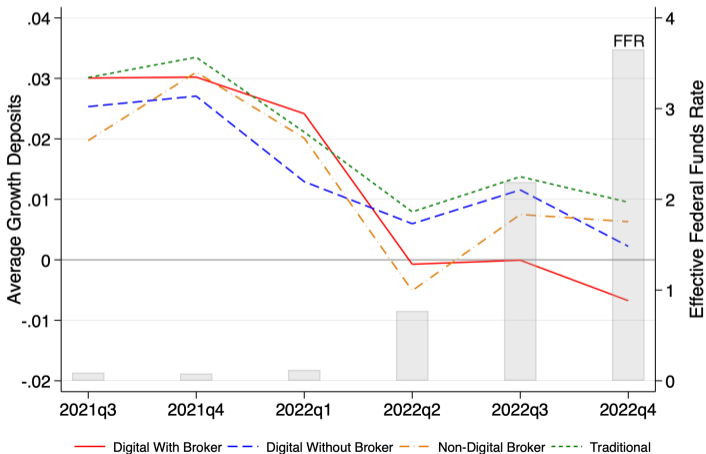Deposits as a share of GDP have become more sensitive to changes in the Fed funds rate

$$\Delta \left(\text{Deposits/GDP} \right)_{t,t-1} = \beta_0 + \beta_1 \times \Delta FFR_{t,t-1} \times \text{Decade}_t + \varepsilon_t, \quad t = quarter$$

	Change in Deposits/GDP	
Δ FFR $\times$ 1970s	-0.000	0.000
	(0.001)	(0.001)
Δ FFR $\times$ 1980s	0.001	0.001
	(0.000)	(0.000)
Δ FFR $\times$ 1990s	-0.001	-0.002
	(0.002)	(0.002)
Δ FFR $\times$ 2000s	-0.005***	-0.005***
	(0.001)	(0.001)
Δ FFR $\times$ 2010s+	-0.027**	-0.016***
	(0.012)	(0.005)
Covid (2020Q2)		0.128***
		(0.003)
Constant	0.002	0.001
	(0.001)	(0.001)
Observations	199	199
R2	0.17	0.64

12

Outflows most pronounced for digital-brokers

Figure 2

13

$$\frac{\text{Dep}_{b,t} - \text{Dep}_{b,t-1}}{\text{Dep}_{b,t-1}} = \alpha_b + \beta_1 \ \Delta FFR_{t,t-1} + \beta_2 \ \Delta FFR_{t,t-1} \times \text{Digital}_{b,t}$$

$$+ \beta_3 \ \Delta FFR_{t,t-1} \times \text{Broker}_{b,t} + \beta_4 \ \Delta FFR_{t,t-1} \times \text{Digital}_{b,t} \times \text{Broker}_{b,t} + \varepsilon_t$$

	All (Non-brokered)	Core	Excl. Time	Insured
Δ FFR	-0.016***	-0.026***	-0.039***	-0.014***
	(0.001)	(0.001)	(0.001)	(0.001)
Δ FFR $\times$ Digital	-0.006***	-0.005***	-0.004**	-0.003**
	(0.001)	(0.001)	(0.002)	(0.001)
Δ FFR $\times$ Broker	-0.006**	-0.008***	-0.011***	0.005
	(0.003)	(0.003)	(0.003)	(0.003)
Δ FFR $\times$ Digital $\times$ Broker	0.000	-0.000	0.003	-0.004
	(0.004)	(0.004)	(0.005)	(0.004)
Digital-Broker Differential Outflow	-0.012	-0.013	-0.015	-0.003
F Digital	17.06	19.92	4.79	5.34
F Digital-Broker	19.18	28.13	17.11	0.40
Bank FE	Yes	Yes	Yes	Yes
Observations	75889	75692	75624	75954
R2	0.23	0.21	0.21	0.20

14

$$\frac{\text{Dep}_{b,t} - \text{Dep}_{b,t-1}}{\text{Dep}_{b,t-1}} = \alpha_b + \beta_1 \ \Delta FFR_{t,t-1} + \beta_2 \ \Delta FFR_{t,t-1} \times \text{Digital}_{b,t}$$

$$+ \beta_3 \ \Delta FFR_{t,t-1} \times \text{Broker}_{b,t} + \beta_4 \ \Delta FFR_{t,t-1} \times \text{Digital}_{b,t} \times \text{Broker}_{b,t} + \varepsilon_t$$

	All (Non-brokered)	Core	Excl. Time	Insured
Δ FFR	-0.017***	-0.026***	-0.039***	-0.014***
	(0.001)	(0.001)	(0.001)	(0.001)
Δ FFR $\times$ Digital	-0.005	-0.007**	-0.000	-0.002
	(0.003)	(0.003)	(0.004)	(0.003)
Δ FFR $\times$ Broker	-0.004*	-0.007***	-0.008***	0.005*
	(0.002)	(0.002)	(0.003)	(0.003)
Δ FFR $\times$ Digital $\times$ Broker	-0.015**	-0.011	-0.013	-0.013*
	(0.007)	(0.007)	(0.009)	(0.007)
Bank FE	Yes	Yes	Yes	Yes
Digital-Broker Differential Outflow	-0.019	-0.014	-0.008	-0.008
F Digital	2.47	5.41	0.01	0.63
F Digital-Broker	20.80	22.75	11.32	3.95
Observations	75889	75692	75624	75880
R2	0.23	0.21	0.21	0.20

Differential outflow for digital banks robust to inclusion of $\cdots$

1. Year FE: Binary Continuous
2. Additional controls: Binary Continuous
    - Bank assets and interaction with ΔFFR
    - Level terms for digital broker banks

- Offering a digital platform is an endogenous choice of the bank
- May correlate with characteristics that cause deposits, rates to behave differently as $f \uparrow$
  - Investment Opportunities
  - Clientele
- To address this possibility, we next look at *within-bank* deposit flows

$$\frac{\text{Dep}_{b,c,t} - \text{Dep}_{b,c,t-1}}{\text{Dep}_{b,t-1}} = \alpha_{bt} + \alpha_{ct} + \alpha_{bc} + \beta_1 \ \Delta FFR_{t,t-1} \times \text{Internet}_c \times \text{Digital}_{b,t} + \varepsilon_t$$

- Internet_c: county-level proportion of households that have internet subscriptions, ranges from 0 to 1
- β_1: Differential outflows within-county (α_{ct}) for digital banks in year t, relative to the average outflow of that bank in year t (α_{bt}) and in county c (α_{bc})

Digital banks' deposit outflows are more pronounced in markets with higher internet usage

	Binary			Continuous		
	(1)	(2)	(3)	(4)	(5)	(6)
Δ FFR × HH Internet Prop.	0.038	-0.030		-0.009	-0.073***	
	(0.030)	(0.027)		(0.025)	(0.023)	
Digital × Δ FFR × HH Internet Prop	-0.112***	-0.104***	-0.058*	-0.081*	-0.075*	-0.057
	(0.036)	(0.034)	(0.034)	(0.045)	(0.043)	(0.042)
Bank-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
County FE	No	Yes	No	No	Yes	No
Bank-County FE	No	No	Yes	No	No	Yes
County-Year FE	No	No	Yes	No	No	Yes
Observations	288584	288577	282008	288061	288055	281956
R2	0.25	0.27	0.51	0.24	0.27	0.51

More restrictive FE as move from left to right for binary and continuous digital classification

Question

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3.11 Results: Deposit Betas

- Drechsler, Savov, Schnabl 2021 estimate:

$$\Delta DepExp_{bt} = \alpha_b + \sum_{\tau=0}^{3} \beta_{b,\tau} \Delta FFR_{t-\tau} + \varepsilon_{bt}$$

- Definition of deposit beta: bank-level measure of banks' cumulative sensitivity of deposit interest rates to changes in the Fed funds rate over a full year

$$\text{Deposit beta} = \sum_{\tau=0}^{3} \beta_{b,\tau}$$

$$\Delta DepExp_{bt} = \alpha_b + \sum_{\tau=0}^{3} \beta_\tau \Delta FFR_{t-\tau} + \sum_{\tau=0}^{3} \beta_\tau^{\mathrm{Type}} \Delta FFR_{t-\tau} \times \mathrm{Bank\ Type}_{b,t} + \varepsilon_{bt}$$

	Beta (Level Change in Deposit Exp/Deposits)			
	(1)	(2)	(3)	(4)
	1983-2022	2010-2022	Digital 2010-2022	Digital Broker 2010-2022
$\sum_{\tau=0}^{3} \beta_\tau$	0.413	0.390	0.380	0.387
$\sum_{\tau=0}^{3} \beta_\tau + \sum_{\tau=0}^{3} \beta_\tau^{\mathrm{Type}}$			0.445	0.436
F Statistic			8.91	7.71
Observations	1,232,446	301,929	301,929	301,929
R2	0.20	0.29	0.29	0.29

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$\sum_{\tau=0}^{3} \beta_\tau$	0.413	0.390	0.366	0.387
$\sum_{\tau=0}^{3} \beta_\tau + \sum_{\tau=0}^{3} \beta_\tau^{\text{Type}}$			0.436	0.464
F Statistic			37.17	4.36
Observations	1,232,446	301,929	301,929	301,929
R2	0.20	0.29	0.29	0.29

$$\Delta DepExp_{bt} = \alpha_b + \sum_{\tau=0}^{3} \beta_\tau \Delta FFR_{t-\tau} + \sum_{\tau=0}^{3} \beta_\tau^{\text{Type}} \Delta FFR_{t-\tau} \times \text{Bank Type}_{b,t} + \varepsilon_{bt}$$

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An increase of 100 bp in the Fed funds rate results in an increase of about 44–46 bp in digital broker's deposit interest expense, versus 39 bp for a traditional bank

- Digital banks do not have to lose deposits as they can in principle match, one-to-one, any increase in the Fed funds rate.
- But, of course, this can only come at the expense of their profitability, especially if the return on their assets is locked in, in the short term

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- But, of course, this can only come at the expense of their profitability, especially if the return on their assets is locked in, in the short term
- Consider SVB: In 2022 had $173.1 billion in deposits and reports $2.2 billion in pre-tax income in its consolidated statements of income.
- Thus, if the bank had paid 125 bps more on its deposits, its net profits would have gone to zero.
- The ability of SVB to raise interest rates on deposits without suffering operating income losses was not that large.

For each bank compute the increase in the deposit rate which when applied to all the deposits would eliminate the bank's 2022 operating income, assuming no adjustments on asset returns:

Break Even Deposit Rates
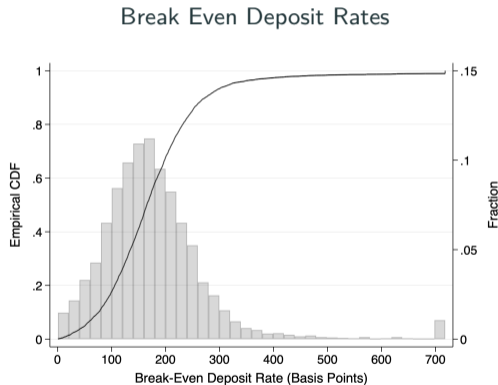
Over 40% of banks would become unprofitable if they had raised the interest on deposits by 150 bps or more.

How has the digital (website + mobile) transformation of banking over the last decade changed...

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How has this changed banking?

3.III Results: Deposit Franchise Value

Drechsler, Savov, Schnabl, and Wang (2023) build on their previous influential work to suggest a simple expression for the value of the deposit franchise (*DF*), the difference between the book and market value of deposits:

$$DF(f) = D(1 - w(s, f)) \left(1 - \beta - \frac{c}{f}\right)$$

- *f* Fed funds rate
- *D* level of deposits
- *c* costs of servicing a dollar of deposits
- β deposit beta
- $w(s, f)$ outflow rate

To bring to data, need estimates of deposit betas β and deposit outflows $w(s, f)$

3.III Results: Deposit Franchise Value

$$DF(f) = D(1 - w(s, f)) \left(1 - \beta - \frac{c}{f}\right)$$

- β deposit beta differs for each type of bank:
    - Traditional banks $= 0.345$
    - Digital-broker banks $= 0.402$

- $w(s, f)$ outflow rate: Linear approximation for $f_1 - f_0 = .04$ at the end of 2022, and where we assume $f_0 = 0$ and $w(0) = 0$

$$w(f_1) \approx w'(f_0) \times (f_1 - f_0)$$

  $w'(f_0)$ differs for each type of bank:
    - Traditional banks $= 1.6\%$
    - Digital-broker banks $= 2.9\%$

- $c = 0.02$ (DSSW 2023)

$\implies$ Deposit franchise value is 40% lower for digital-broker banks relative to if the bank had the same quantity of deposits but was a traditional bank.

- Calculate abnormal return for each bank stock on days -20 to -5 leading up to the 2022 rate hike days

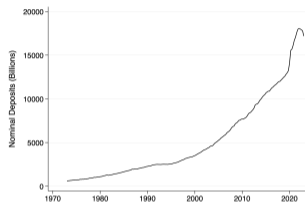- Regress abnormal return on digital dummy, on rate hike days:

$$\text{Abnormal Return}_{it} = \beta_0 + \beta_1 \times \text{Digital}_i + \varepsilon_i$$

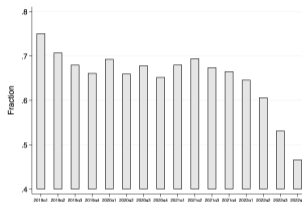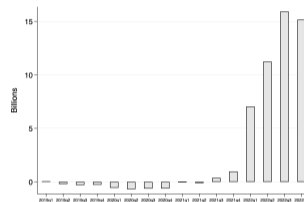|	(1)	(2)
Digital	-0.003*	-0.003*
	(0.002)	(0.002)
Security Losses		0.006
		(0.023)
Constant	-0.003**	-0.003*
	(0.001)	(0.002)
Observations	709	709
R2	0.01	0.01

Nominal Deposits

Non-Interest Bearing Deposits Ratio

Hold to Maturity Losses

- SVB lost 25 billion dollars throughout 2022, or about 13% of its deposits.

- Non-interest bearing deposits ratio dropped rapidly, falling from 67% to 47%

- Hold to maturity losses spike to $16 Billion, close to the value of equity

$\implies$ Value of deposit franchise crucial in understanding solvency of SVB

SVB was the ultimate digital-broker bank: It did not only have digital platforms, and brokerage services; its clients were precisely savvy tech entrepreneurs and investors.

Calculate deposit franchise value and observe marked-to-market losses (Jiang et al. 2023)

- If SVB were evaluated as if it were a traditional bank, remains solvent in early 2023: its equity and deposit franchise value less its marked-to-market losses remains positive ≈$3B

- Once we recognize that SVB is a digital-broker bank, becomes insolvent: its equity and deposit franchise value less its marked-to-market losses becomes negative ≈ -$5B

SVB was the ultimate digital-broker bank: It did not only have digital platforms, and brokerage services; its clients were precisely savvy tech entrepreneurs and investors.

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- Once we recognize that SVB is a digital-broker bank, becomes insolvent: its equity and deposit franchise value less its marked-to-market losses becomes negative $\approx$ -$5B

In a world of digital banking, monetary policy has a stronger impact on financial stability on account of the lower value of banks' deposit franchise

Implications

- The value of banks' deposit franchise has been a major source of financial stability during banking crises
- Digitalization reduces the value of the franchise:
    1. Higher sensitivity to rates
    2. Higher sensitivity to risk?
- Increases instability of banking sector and reduces the specialty of banks
- Additional constraint to monetary policy

Summary

For digital banks,

1. Deposit outflows are larger as the Fed funds rate f increases

2. Deposit betas are higher the sensitivity of deposit rates to increases in f

3. Deposit franchise value is 40% lower relative to that of a non-digital bank
   - SVB insolvent in early 2023 given adjusted deposit franchise value calculation

Appendix

Robustness of outflows to inclusion of Year FE: Binary

	(1) All (Non-brokered)	(2) Core	(3) Excl. Time	(4) Insured
Δ FFR $\times$ Digital	-0.006***	-0.005***	-0.005***	-0.003**
	(0.001)	(0.001)	(0.002)	(0.001)
Δ FFR $\times$ Broker	-0.006**	-0.008***	-0.006**	0.005
	(0.003)	(0.003)	(0.003)	(0.003)
Δ FFR $\times$ Digital $\times$ Broker	0.001	0.002	0.001	-0.003
	(0.004)	(0.004)	(0.005)	(0.004)
Bank FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	75889	75692	75624	75954
R2	0.28	0.34	0.27	0.26

Return to robustness checks: Back

Robustness of outflows to inclusion of Year FE: Continuous

	(1) All (Non-brokered)	(2) Core	(3) Excl. Time	(4) Insured
Δ FFR $\times$ Digital	-0.006*	-0.007**	-0.004	-0.002
	(0.003)	(0.003)	(0.004)	(0.003)
Δ FFR $\times$ Broker	-0.005*	-0.007***	-0.005*	0.004
	(0.002)	(0.002)	(0.003)	(0.003)
Δ FFR $\times$ Digital $\times$ Broker	-0.011	-0.005	-0.010	-0.009
	(0.007)	(0.007)	(0.009)	(0.007)
Bank FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	75889	75692	75624	75880
R2	0.28	0.34	0.27	0.26

34

Robustness of outflows to inclusion of controls: Binary

	All Deposits (Non-brokered)			Insured Deposits		
	(1)	(2)	(3)	(4)	(5)	(6)
Δ FFR	0.003	-0.017***	0.003	-0.038***	-0.014***	-0.038***
	(0.006)	(0.001)	(0.006)	(0.007)	(0.001)	(0.007)
Δ FFR $\times$ Digital	-0.003**	-0.009***	-0.007***	-0.005***	-0.005***	-0.008***
	(0.002)	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)
Δ FFR $\times$ Broker	-0.003	-0.003	0.000	0.002	0.008**	0.006
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)
Δ FFR $\times$ Digital $\times$ Broker	0.000	-0.001	-0.001	-0.004	-0.005	-0.006
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Assets & Assets$\times$FFR	Yes	No	Yes	Yes	No	Yes
Digital & Broker Level Terms	No	Yes	Yes	No	Yes	Yes
Digital-Broker Differential Outflow	-0.003	-0.009	-0.007	-0.005	-0.005	-0.008
F Digital	4.17	37.88	17.51	11.47	12.62	25.69
F Digital-Broker	4.56	22.77	6.64	5.82	0.40	6.81
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	75889	75889	75889	75954	75954	75954
R2	0.23	0.24	0.24	0.21	0.21	0.21

Return to robustness checks:

Robustness of outflows to inclusion of controls: Continuous

	All Deposits (Non-brokered)			Insured Deposits		
	(1)	(2)	(3)	(4)	(5)	(6)
Δ FFR	0.005	-0.017***	0.004	-0.032***	-0.015***	-0.033***
	(0.006)	(0.001)	(0.006)	(0.006)	(0.001)	(0.006)
Δ FFR $\times$ Digital	-0.002	-0.012***	-0.010***	-0.003	-0.006**	-0.009***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Δ FFR $\times$ Broker	-0.001	-0.002	0.002	0.003	0.007**	0.005*
	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)
Δ FFR $\times$ Digital $\times$ Broker	-0.014*	-0.015**	-0.014*	-0.016**	-0.014*	-0.016**
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Assets & Assets$\times$FFR	Yes	No	Yes	Yes	No	Yes
Digital & Broker Level Terms	No	Yes	Yes	No	Yes	Yes
Digital-Broker Differential Outflow	-0.014	-0.027	-0.024	-0.016	-0.013	-0.020
F Digital	0.46	13.67	10.07	0.68	4.49	8.60
F Digital-Broker	8.34	29.06	14.90	7.43	5.72	11.71
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	75889	75889	75889	75880	75880	75880
R2	0.23	0.24	0.24	0.21	0.21	0.21

Return to robustness checks: Back