The Effect of Instant Payments on Banks: Liquidity Transformation and Risk-Taking

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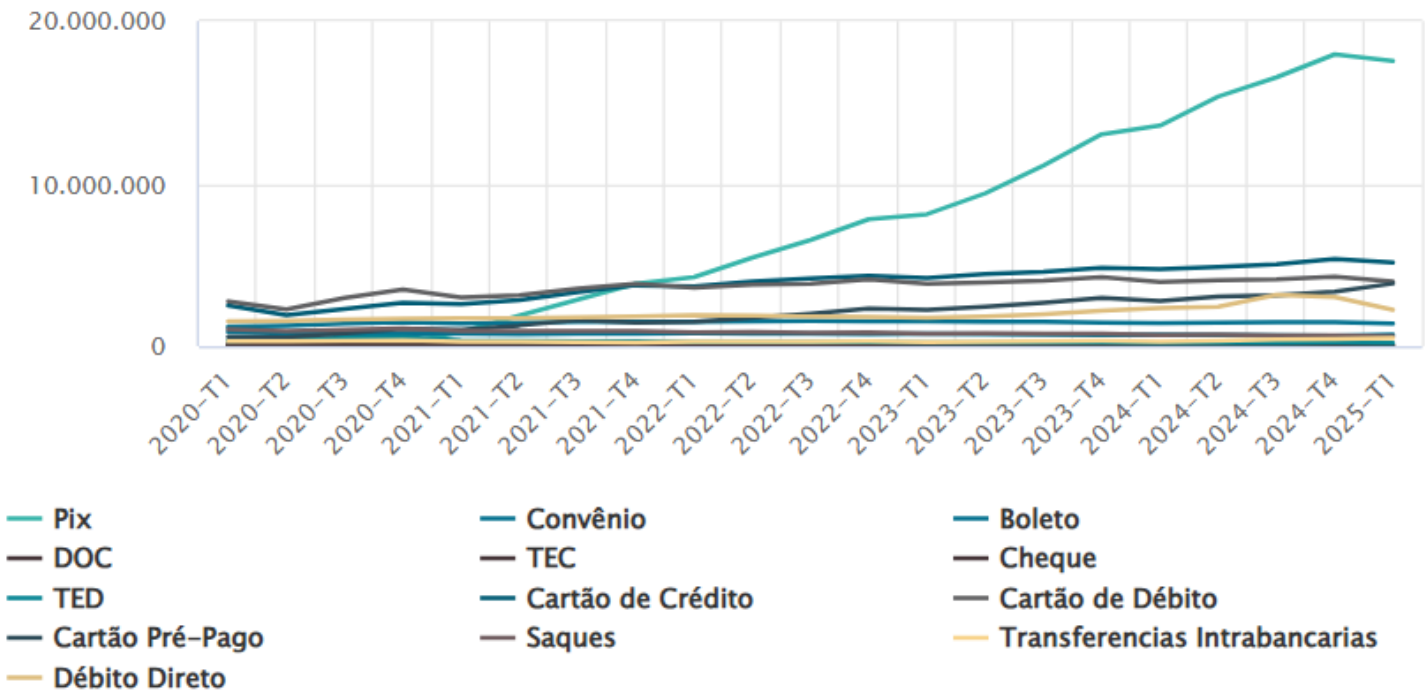
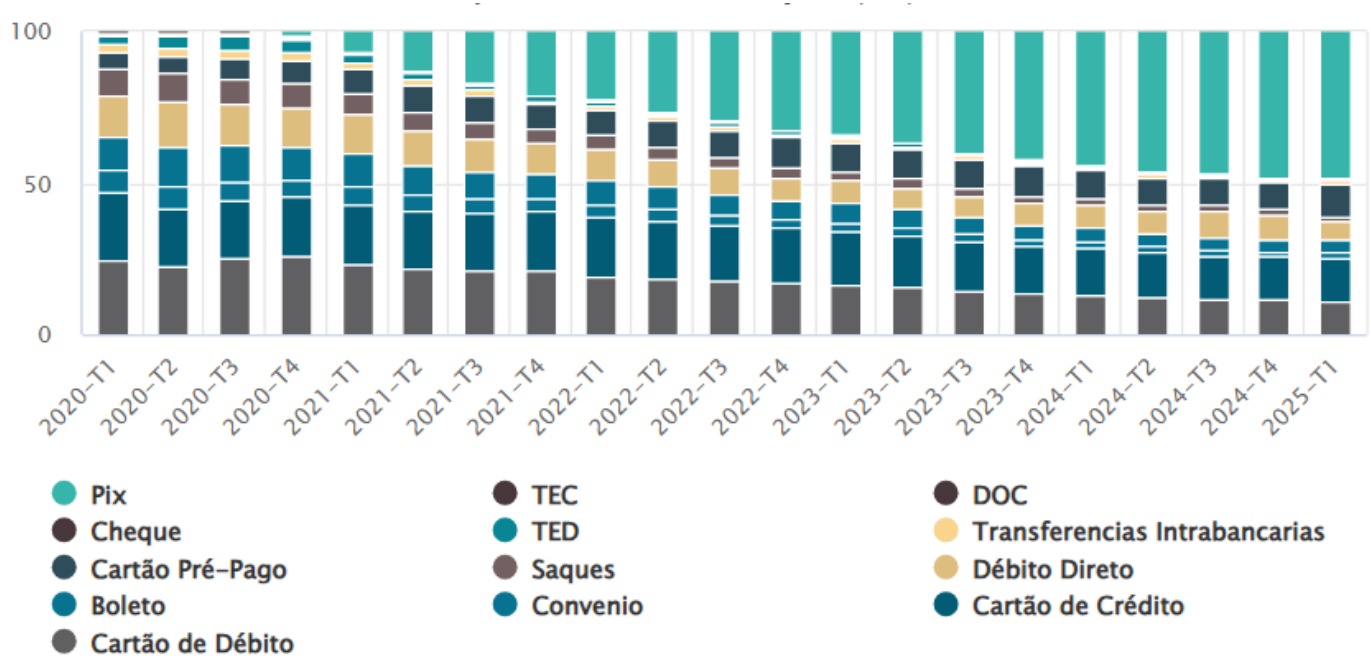
The views expressed here do not reflect those of the Central Bank of Brazil.

Instant Payment Systems

- The rise in instant payment systems and PIX
  - 2016: UPI by the Reserve Bank of India
  - 2020: Pix by the Central Bank of Brazil
  - 2023: FedNow by the Federal Reserve



Instant Payment Systems



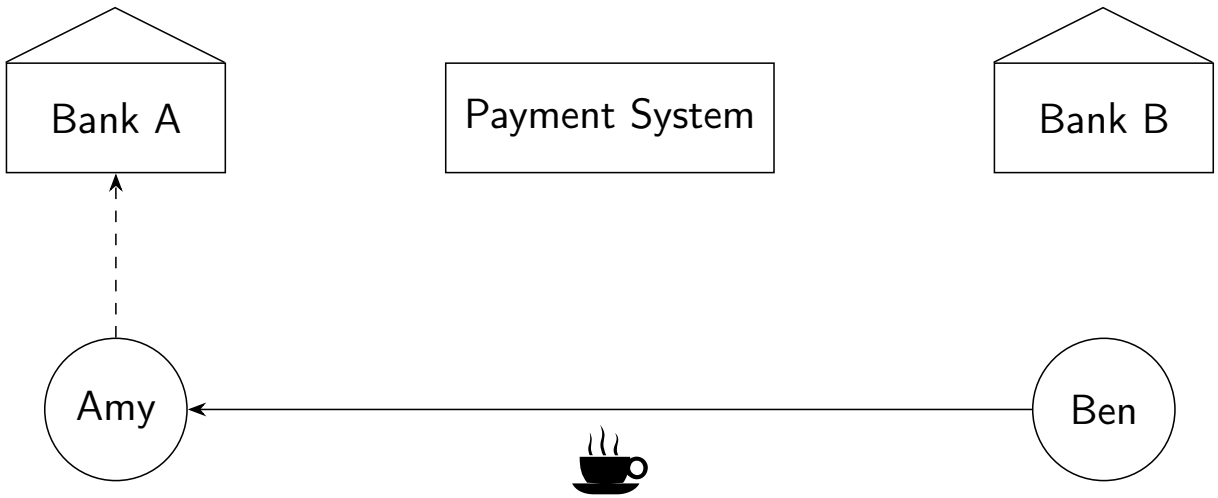
- CBDC
  - CBDC is the means of payment
  - Assets are on central bank's balance sheet
- Instant payments
  - Deposits (liability) become the instant means of payment
  - Assets remain on bank balance sheets

Research Question

- This paper: What are the implications of instant payments on banks ?
  - Banks demand more liquidity
  - Banks relax their credit origination standards

Traditional Payments

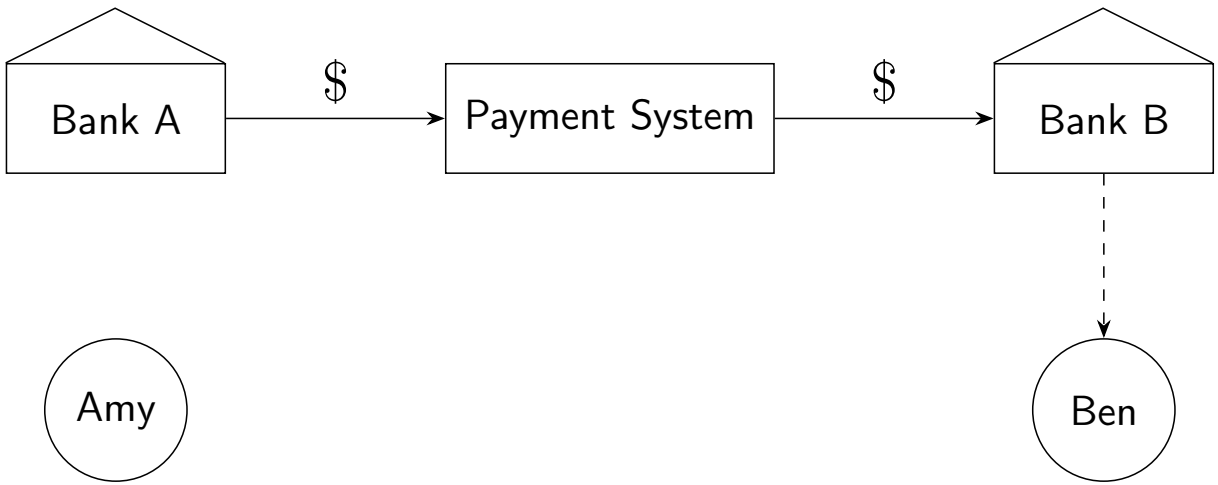
Figure: Traditional Payment System



- Customers request banks to send payments for them using their bank deposits
- E.g. Fedwire, ACH in the US; TED and DOC in Brazil

Traditional Payments

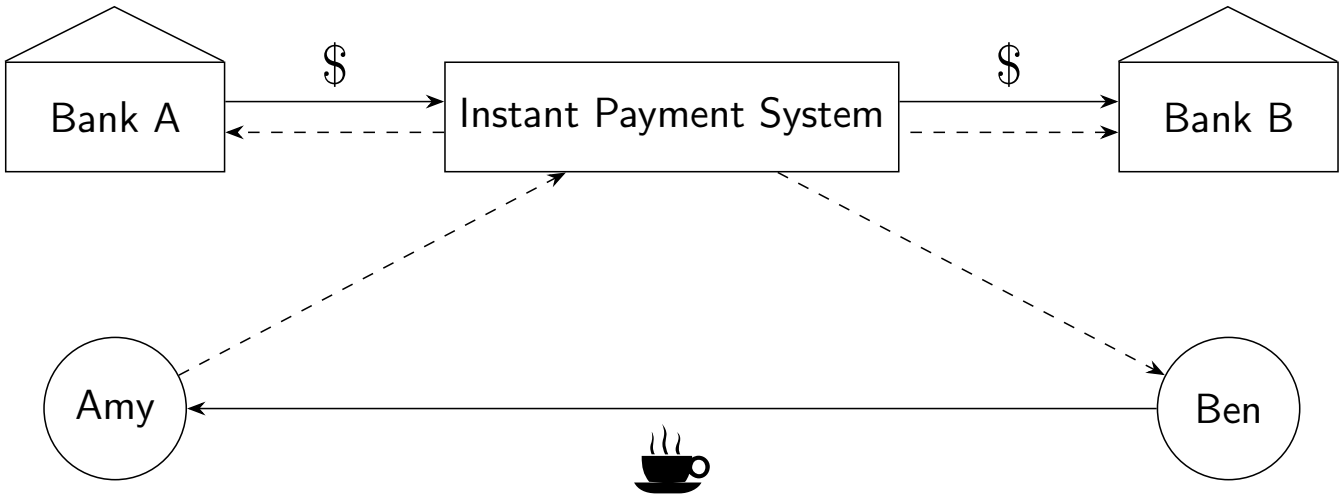
Figure: Traditional Payment System



- Customers request banks to send payments for them using their bank deposits, but banks may voluntarily delay
- E.g. Fedwire, ACH in the US; TED and DOC in Brazil

Instant Payments

Figure: Instant Payment System



- Customers directly and instantaneously send payments to other customers using their bank deposits
- E.g. FedNow in the US; Pix in Brazil
- **Payment convenience is improved by removing banks' ability to manage the timing of payments**

Model

Model Setup

- $t = 0, 1, 2, 3, ..., T-1, T$, with $T \geq 3$
- Two banks, each operating in market j
  - Each market has a continuum of households endowed with \$1
  - Market-specific consumption good j
- Bank financed by equity, demand deposits, and time deposits
  - Equity ratio: $\eta > 0$
  - Demand deposits: used for payments with 0 interest rate
  - Time deposits: interest rate $r > 0$ but no payment function

Model Setup - Households

- At $t = 0$, households with $IES > 1$ make portfolio choice between demand and time deposits, with α in demand deposits
- At $1 \leq t \leq T - 1$, household i in market j is subject to consumption shock with probability π_t^j
  - where π_t^j is i.i.d and $\sum_t \pi_t^j = 1$
- When shocked, household i withdraws demand deposits from bank j to purchase good $-j$ in the other market, resulting in a net payment from bank j to $-j$
- Tradeoff: demand deposits provide more consumption if shocked, savings deposits provide higher return if not shocked

Model Setup - Banks

- At $t = 0$, banks max expected equity value at T by choosing between liquid and illiquid assets, with x in liquid asset
- Liquid asset
  - Normalized return 1 at any t
- Illiquid asset (following Carletti,Leonello, and Marquez, 2024)
  - Normalized return $1 - \phi$, $0 < \phi < 1$, at any $t < T$
  - Return: $R(p)\theta$ with prob p at T, $R(p) > 1$ decreasing in p
  - Aggregate fundamental risk captured by $\theta \sim U[0, 1]$
- Tradeoff: liquid assets can settle payment balances at $t < T$, illliquid assets only recover $1 - \phi$ if liquidated to settle payments but may earn higher long term return

Traditional versus Instant Payment Systems

- Traditional payment system:
  - Banks delay the settlement of payment flows at t until τ, $t < \tau \leq T$
  - When processing of payments delayed at $t < T$, household holding α demand deposits enjoys a discounted consumption value of $\delta^{\tau - t}\alpha$
- Instant payment system:
  - Banks are required to use liquid assets to settle any payment balances at any t without delays
- Focus on symmetric equilibrium

Bank Liquidity Demand

- Proposition 2 (Bank Liquidity Demand): given any $\alpha > 0$, $x^*_{tra} < x^*_{ins}$, that is, banks hold more liquid buffers under instant payment system
- Intuition:
  - Instant payments remove banks' ability to delay/offset payments
  - More uncertain deposit flows
  - Higher potential of costly liquidations
  - Higher demand for liquidity buffers

Bank Risk Taking

- Proposition 3 (Bank Risk Taking): given any $\alpha > 0$, $p^*_{tra} > p^*_{ins}$, that is, banks taking more risks in loan lending under instant payment system
- Intuition
  - As the bank transforms less liquidity, higher liquidity holdings serve as buffers in the case of default
  - Larger distance to default crowds out screening/monitoring
  - Bank equity encouraged to take more risks

Data and Facts

Data

- Main sample: November 2020 to March 2023
- Transaction-level Pix data
  - Each transaction: time, amount, sending and receiving bank
  - Includes failed transactions due to sending and receiving banks
- Regulatory bank balance sheet and income data
  - Monthly, conglomerate-level
  - Deposit-taking and loan-making institutions: commercial banks and credit unions
  - 64 institutions adopted Pix within our sample period, around 85% of total market size

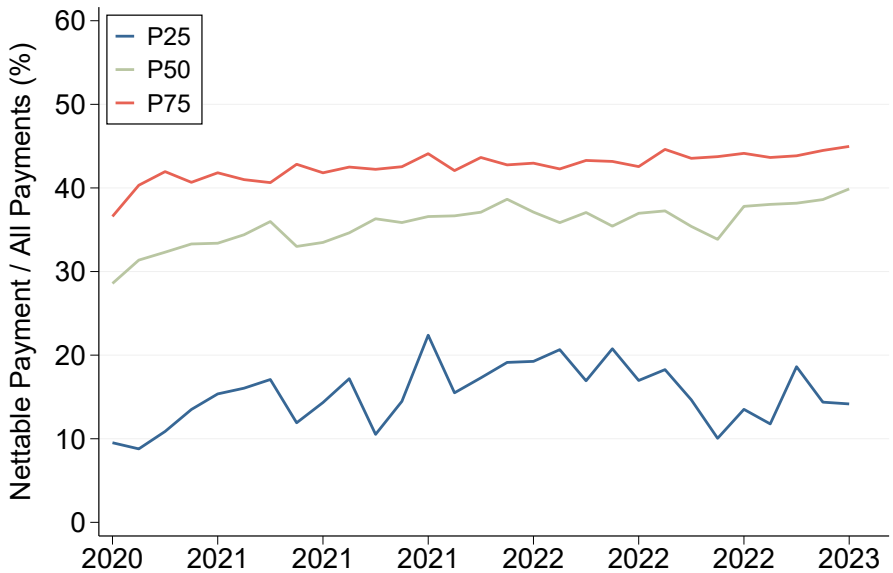
Defining Pix Usage

- In month t for bank i,

$$PixUsage_{it} = \frac{\sum_{d \in t} \min(Outflows_{id}, Inflows_{id})}{TotalAssets_{it}}$$

  - captures per unit gross payment flows
  - also captures the per unit loss in nettable payment flows due to Pix

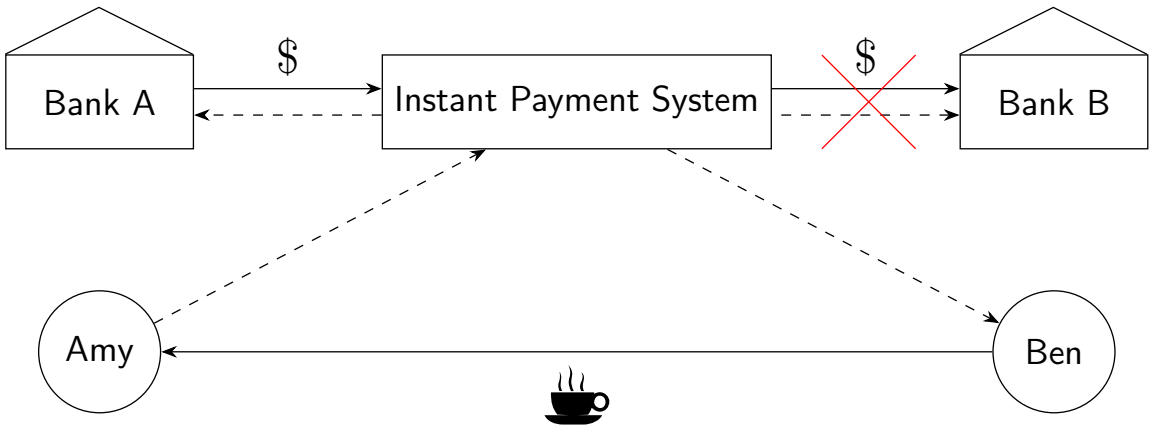
- The potential for intraday netting is large. Consider p25, p50, and p75 of $\frac{\sum_{d \in t} \min(Outflows_{id}, Inflows_{id})}{\sum_{d \in t} (Outflows_{id} + Inflows_{id})}$:



Empirical Analysis

Estimation Strategy

- Challenge: Pix usage correlated with unobserved and time-varying bank characteristics
- Instrument for Pix usage using transaction timeouts
  - The convenience of Pix is lost if either the sending bank fails to send or the receiving bank fails to receive
  - Banks more exposed to timeouts should have less Pix usage
  - For a given bank, only use timeouts *induced by other banks*



Estimation Strategy

- For a given bank i in month t, $Timeout_{it}$ captures exposure to timeouts induced by other banks j:

$$Timeout_{it} = \sum_{j \in J, j \neq i} \frac{PixRec_{ijt}}{PixRec_{it}} SenderTimeout_{ij} + \sum_{j \in J, j \neq i} \frac{PixSent_{ijt}}{PixSent_{it}} RecTimeout_{ij},$$

- Expect $\beta < 0$ for first stage:

$$PixUsage_{it} = \beta Timeout_{it} + Controls_{it} + \omega_t + \theta_i + \epsilon_{it},$$

Estimation Strategy

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- Expect $\beta < 0$ for first stage:

$$PixUsage_{it} = \beta Timeout_{it} + Controls_{it} + \omega_t + \theta_i + \epsilon_{it},$$

- Use $\widehat{PixUsage_{it}}$ to instrument for $PixUsage_{it}$ in

$$OutcomeVar_{it} = \beta PixUsage_{it} + Controls_{it} + \omega_t + \theta_i + \epsilon_{it},$$

- Controls: bank asset, core capital, number of branches
- All control variables are standardized

Effect of Pix Usage on Liquid Assets

Table: IV: The Effect of Pix Usage on Liquidity Ratios

	Liquid Ratio		Cash Ratio		Gov Bond Ratio		Loan Ratio	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Pix Usage	0.152***	0.154***	0.029**	0.030**	0.123***	0.124***	-0.279***	-0.284***
	(0.021)	(0.022)	(0.011)	(0.012)	(0.016)	(0.017)	(0.030)	(0.032)
Controls	No	Yes	No	Yes	No	Yes	No	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
SE Cluster	Bank	Bank	Bank	Bank	Bank	Bank	Bank	Bank
Observations	1471	1467	1471	1467	1471	1467	1471	1467

- 1 sd $\uparrow$ in Pix usage $\rightarrow$ 0.154 $\uparrow$ in liquid asset ratio

Effect of Pix Usage on Risk-Taking

Table: IV: The Effect of Pix Usage on Risk-Taking Ratios

	Prime Loan Ratio		Sub-Prime Loan Ratio		Default Loan Ratio		Loan Loss Ratio	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Pix Usage	-0.216***	-0.218***	0.186***	0.186***	0.025***	0.027***	0.119*	0.123**
	(0.035)	(0.038)	(0.031)	(0.032)	(0.008)	(0.008)	(0.062)	(0.061)
Controls	No	Yes	No	Yes	No	Yes	No	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
SE Cluster	Bank	Bank	Bank	Bank	Bank	Bank	Bank	Bank
Observations	1371	1367	1371	1367	1371	1367	1215	1211

- 1 sd $\uparrow$ in Pix usage $\rightarrow$ 0.027 $\uparrow$ in default loan ratio
- 1 sd $\uparrow$ in Pix usage $\rightarrow$ 0.123 $\uparrow$ in loan loss provisions ratio

Conclusion

- Instant payments alter the functionalities of banks by changing the functionalities of bank deposits
- Improved convenience of instant payments to consumers = banks lost ability to delay and offset payments across time
- As Pix usage increases,
  1. Banks' demand for liquid assets increases
  2. Banks may take on more risk in their loan book
- Important for the design of payment systems and CBDC going forward

Appendix

Effect of Pix Usage on Deposits

Table: OLS: The Effect of Pix Usage on Deposit Ratios

	Demandable Ratio		Checking Ratio		Saving Ratio	
	(1)	(2)	(3)	(4)	(5)	(6)
Pix Usage	0.016**	0.015*	0.016**	0.016**	0.000	-0.001
	(0.008)	(0.008)	(0.008)	(0.008)	(0.001)	(0.001)
Controls	No	Yes	No	Yes	No	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
SE Cluster	Bank	Bank	Bank	Bank	Bank	Bank
Observations	1501	1497	1501	1497	1501	1497
Adjusted R^2	0.871	0.872	0.841	0.841	0.975	0.978

Effect of Pix Usage on Liquid Assets

Table: OLS: The Effect of Pix Usage on Liquidity Ratios

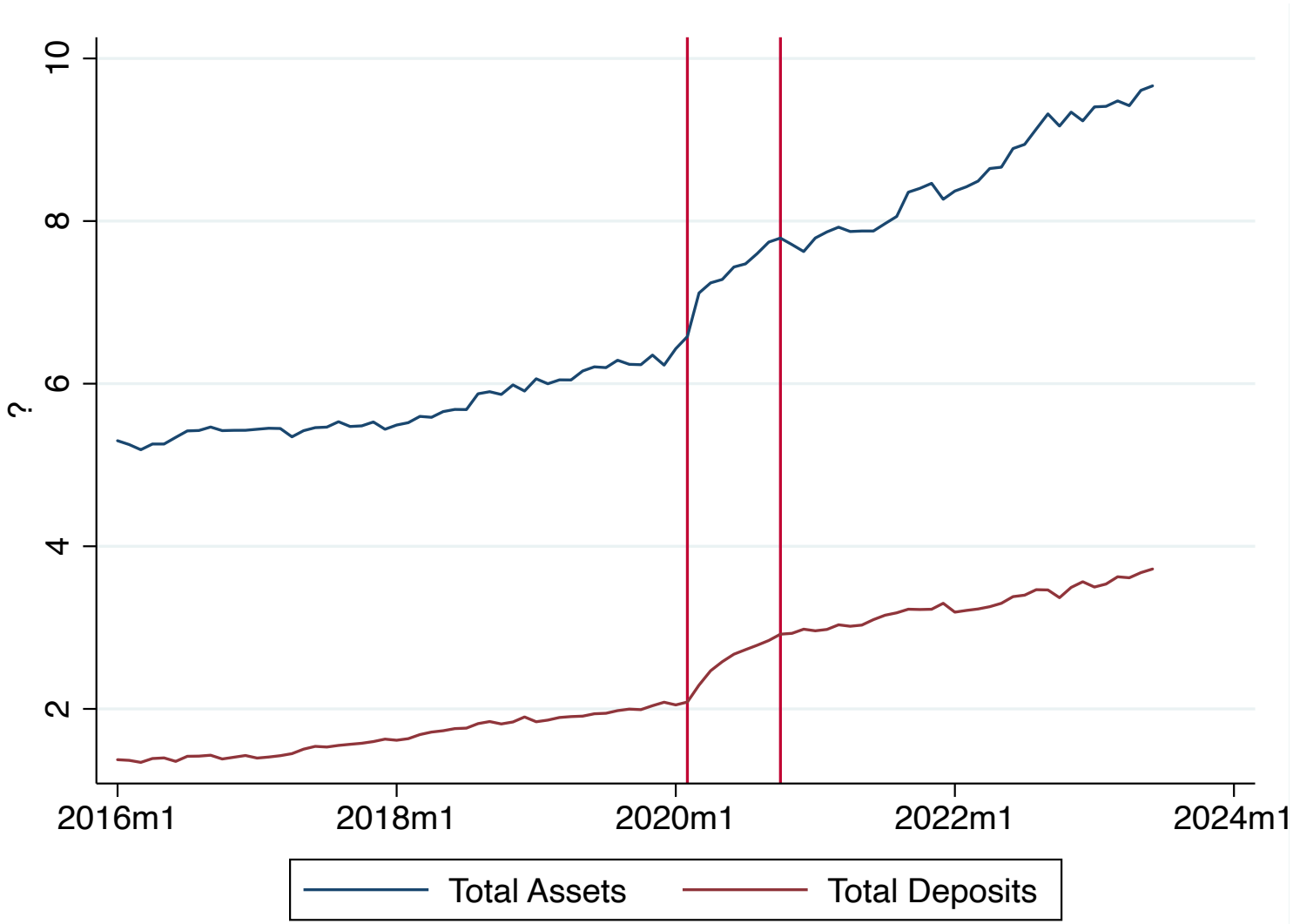
	Liquid Ratio		Cash Ratio		Gov Bond Ratio		Loan Ratio	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Pix Usage	0.021**	0.022**	-0.003	-0.004	0.025***	0.025***	-0.021**	-0.022**
	(0.010)	(0.011)	(0.004)	(0.004)	(0.009)	(0.009)	(0.009)	(0.010)
Controls	No	Yes	No	Yes	No	Yes	No	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
SE Cluster	Bank	Bank	Bank	Bank	Bank	Bank	Bank	Bank
Observations	1501	1497	1501	1497	1501	1497	1501	1497
Adjusted R^2	0.709	0.708	0.614	0.613	0.757	0.757	0.971	0.971

Effect of Pix Usage on Risk-Taking

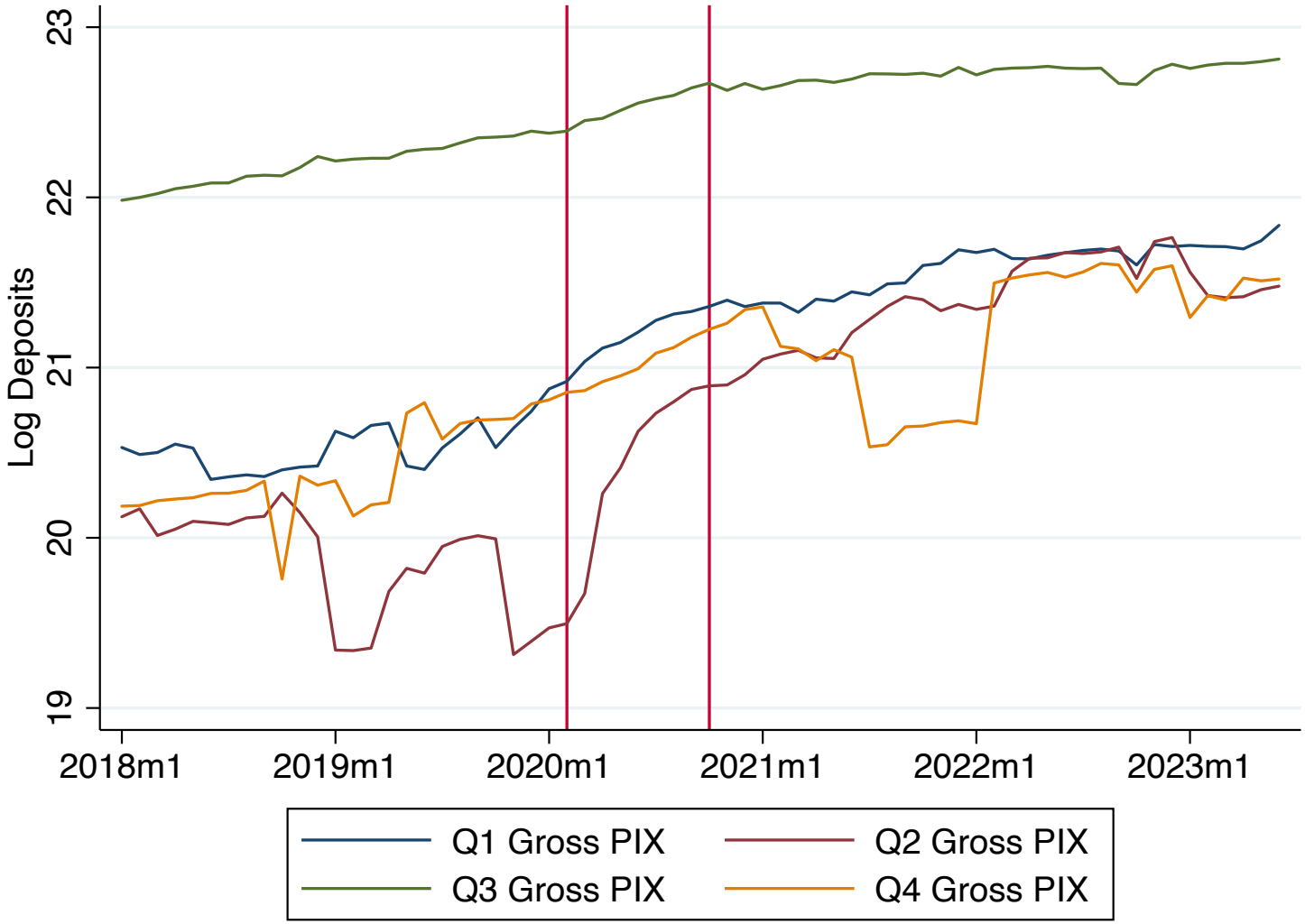
Table: OLS: The Effect of Pix Usage on Risk-Taking Ratios

	Prime Loan Ratio		Sub-Prime Loan Ratio		Default Loan Ratio		Loan Loss Ratio	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Pix Usage	-0.053**	-0.052**	0.056***	0.054***	-0.000	-0.000	0.007	0.007
	(0.024)	(0.024)	(0.014)	(0.014)	(0.005)	(0.005)	(0.006)	(0.007)
Controls	No	Yes	No	Yes	No	Yes	No	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
SE Cluster	Bank	Bank	Bank	Bank	Bank	Bank	Bank	Bank
Observations	1397	1393	1397	1393	1397	1393	1236	1232
Adjusted R^2	0.926	0.927	0.926	0.928	0.916	0.917	0.889	0.887

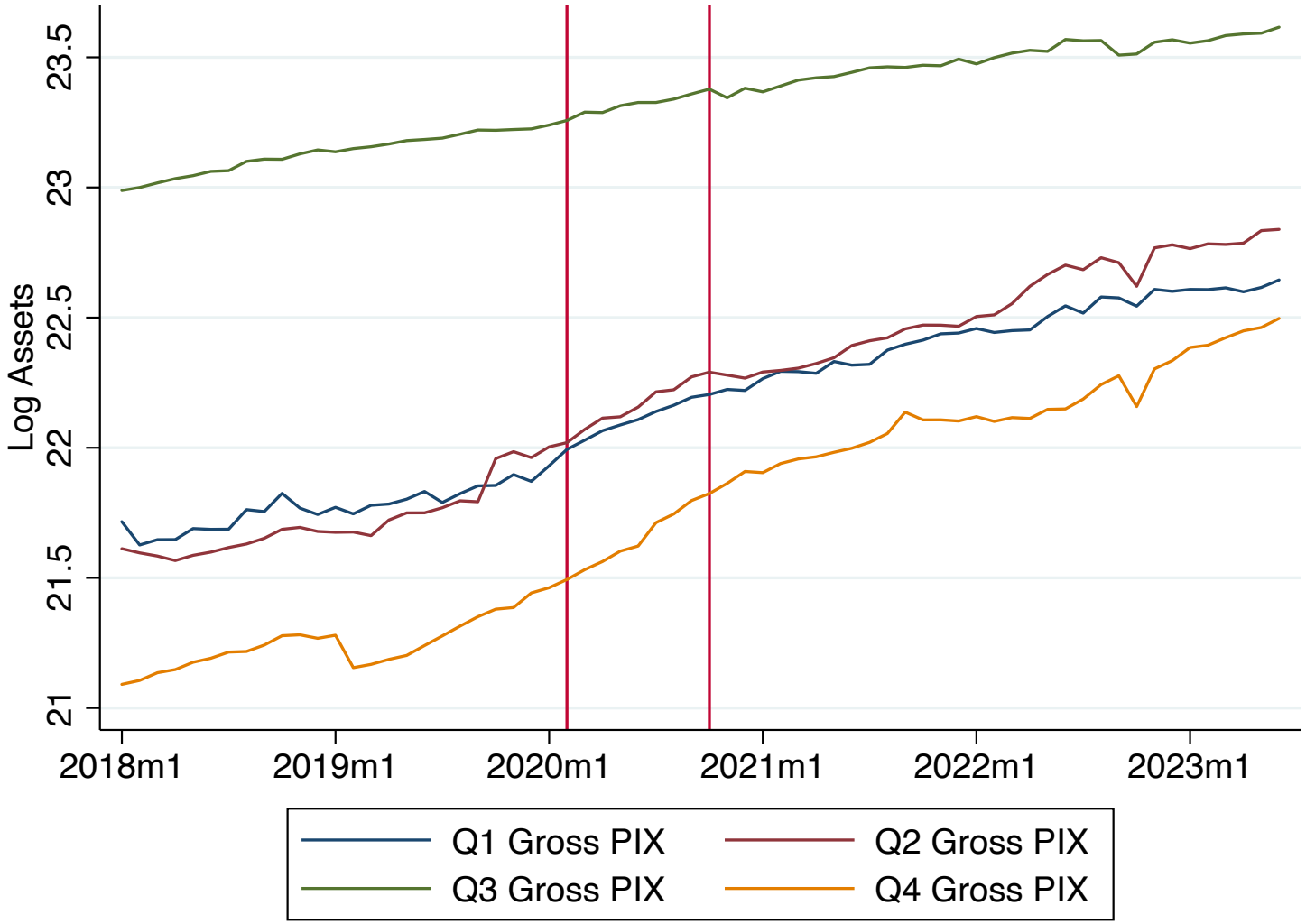
Total Assets and Deposits



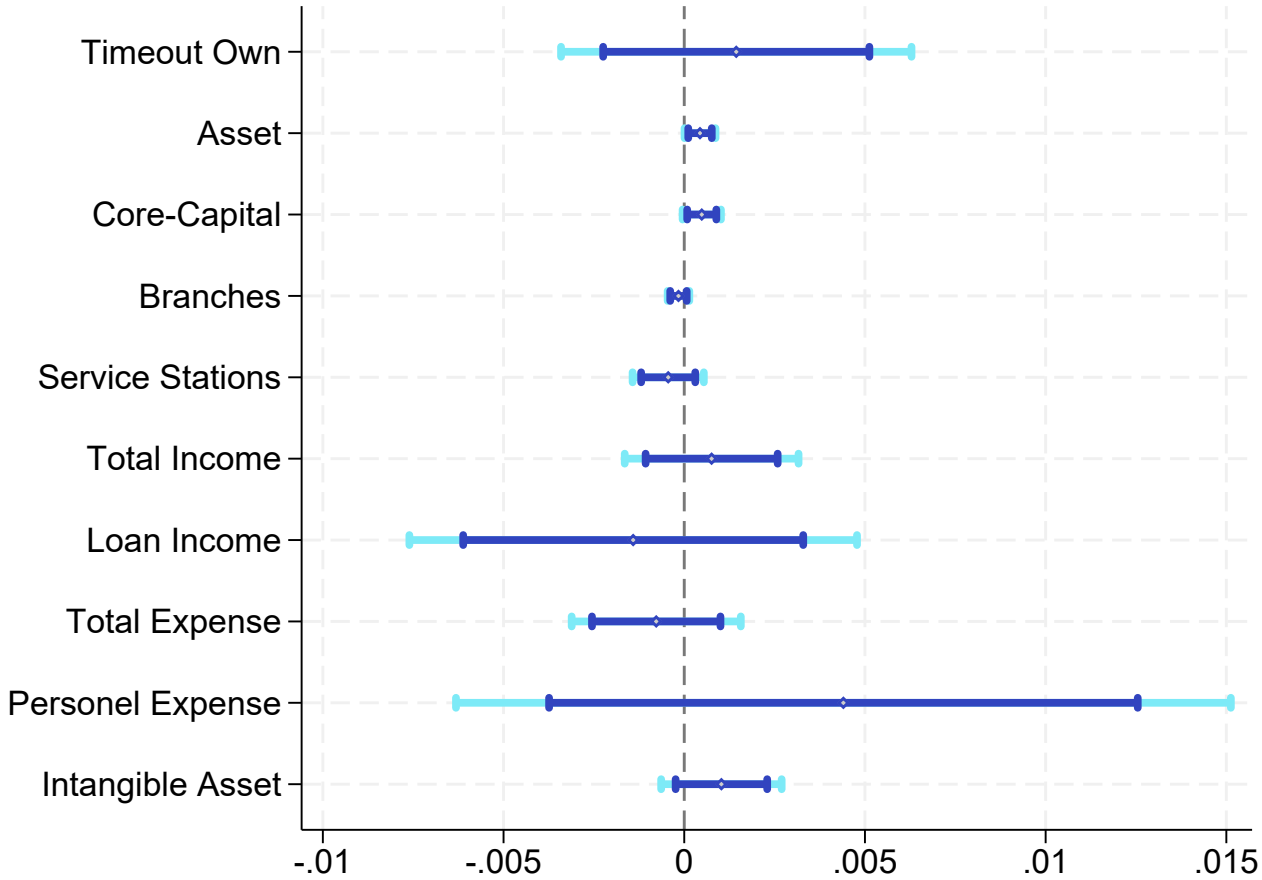
Deposits by Pix Usage



Assets by Pix Usage



Balancing of Observables



$$Observables_{it} = \beta Timeout_{it} + \omega_t + \theta_i + \epsilon_{it},$$

First Stage Results

Table: First Stage: The Effect of Timeouts on Pix Usage

	Pix Usage	
	(1)	(2)
Timeout IV	-0.013***	-0.013***
	(0.002)	(0.002)
Asset		-0.329
		(0.200)
Core-Capital		-0.083
		(0.169)
Branches		0.174
		(0.236)
Bank FE	Yes	Yes
Time FE	Yes	Yes
SE Cluster	Bank	Bank
Observations	1471	1467
Adjusted R^2	0.899	0.899
Kleibergen-Paap F	68.924	59.938
Montiel-Pflueger F	69.970	60.848

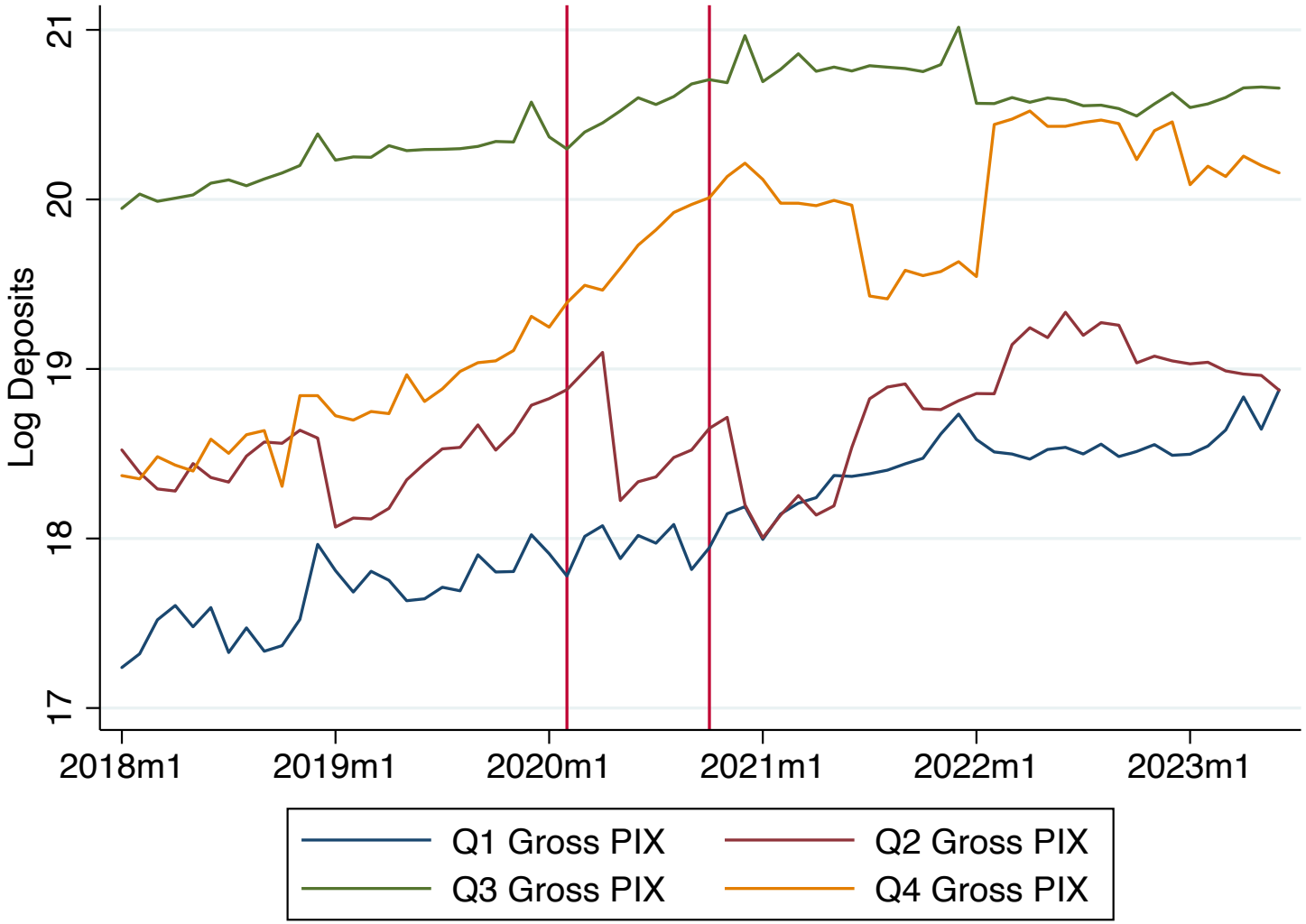
Effect of Pix Usage on Deposits

Table: IV: The Effect of Pix Usage on Deposit Ratios

	Demandable Ratio		Checking Ratio		Saving Ratio	
	(1)	(2)	(3)	(4)	(5)	(6)
Pix Usage	0.127***	0.127***	0.124***	0.125***	0.004**	0.003*
	(0.016)	(0.017)	(0.016)	(0.016)	(0.002)	(0.002)
Controls	No	Yes	No	Yes	No	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
SE Cluster	Bank	Bank	Bank	Bank	Bank	Bank
Observations	1471	1467	1471	1467	1471	1467

- 1 sd $\uparrow$ in Pix usage $\rightarrow$ 0.127 $\uparrow$ in demandable deposit ratio

Demandable Deposits by Pix Usage



Effect of Pix Usage on Deposits

Table: Effect on Liability Ratios (OLS)

	Savings Dep Ratio		Checkings Dep Ratio		Repo Ratio	
	(1)	(2)	(3)	(4)	(5)	(6)
Pix Usage	0.015***	0.015***	0.213***	0.297***	0.048***	0.083*
	(0.003)	(0.003)	(0.031)	(0.025)	(0.015)	(0.01
Capital Ratio	-0.020***	-0.020***		0.011		-0.033
	(0.001)	(0.001)		(0.012)		(0.00
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Bank-Type-Time FE	1729	1729	1976	1729	1976	172
Observations	0.97	0.97	0.79	0.81	0.68	0.73

Effect of Pix Usage on Liquid Assets

Table: Effect on Liquid Asset Holding (OLS)

	Liquid Ratio		Cash Ratio		Gov Bond Ratio	
	(1)	(2)	(3)	(4)	(5)	(6)
Pix Usage	0.066***	0.066***	-0.001	-0.001	0.117***	0.117***
	(0.024)	(0.024)	(0.018)	(0.018)	(0.019)	(0.019)
Capital Ratio		0.017**		-0.002		0.024***
		(0.006)		(0.004)		(0.007)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Bank-Type-Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1729	1729	1729	1729	1729	1729
Adjusted R2	0.51	0.51	0.50	0.50	0.63	0.63

Effect of Pix Usage on Income Ratios

Table: Effect on Income Ratios (OLS)

	Total	Non-Fee	Fee	Package	Non-Package
	(1)	(2)	(3)	(4)	(5)
Pix Usage	-0.017***	-0.044***	0.003	0.005	-0.029***
	(0.001)	(0.002)	(0.008)	(0.003)	(0.011)
Controls	Yes	Yes	Yes	Yes	Yes
Bank-Type-Time FE	Yes	Yes	Yes	Yes	Yes
Observations	1704	1704	1704	1704	1704
Adjusted R2	0.99	0.99	0.94	0.97	0.87