High-Speed Internet, Financial Technology and Banking

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Financial Technology & Banking

Goldstein, Jiang and Karolyi (2019) & RFS Special Issue

One underlying interpretation: FinTechs lower barriers to entry

$\surd$ Mortgages (Buchak et al, 2018; Fuster et al, 2019)

$\surd$ Consumer credit (Bartlett et al, 2018; Tang, 2019)

$\surd$ Credit screening & scoring, inv mgt, payment systems (et cetera)

Swift Recap: FinTechs change bank business *"outside"* the bank

Do FinTechs shape business "inside" the bank?

Focus on interbank market, a specific tech & function:

Tech - the Real-Time Gross-Settlement System (RTGS)

Function - liquidity management (à la Bolton et al, 2011)

Bank
Liquidity

Do FinTechs shape business "inside" the bank?

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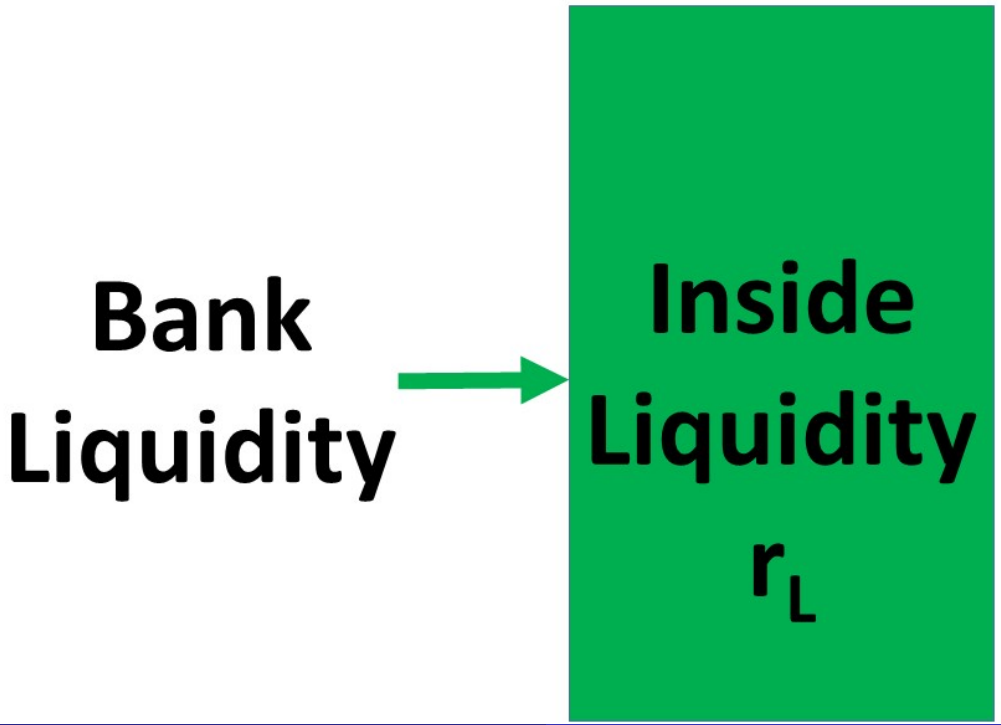

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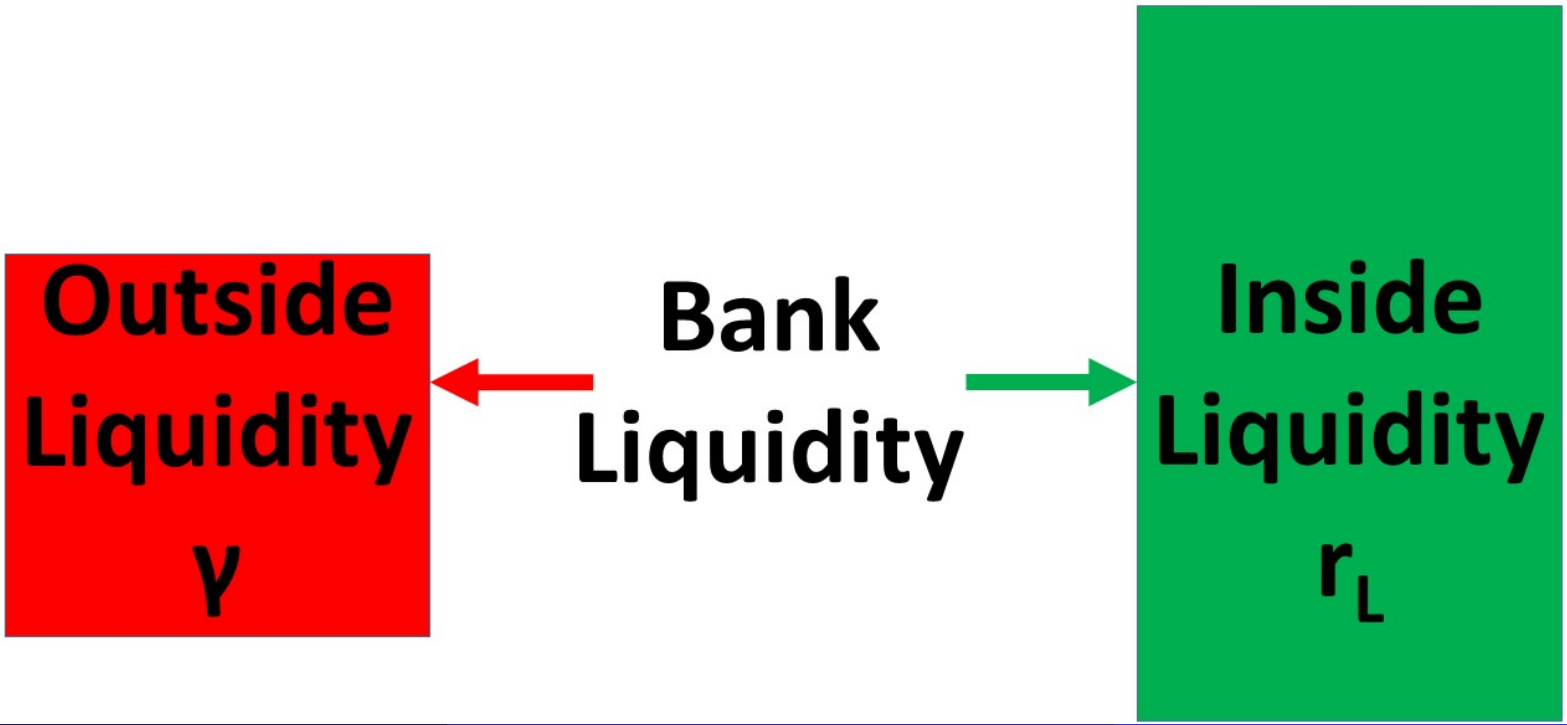

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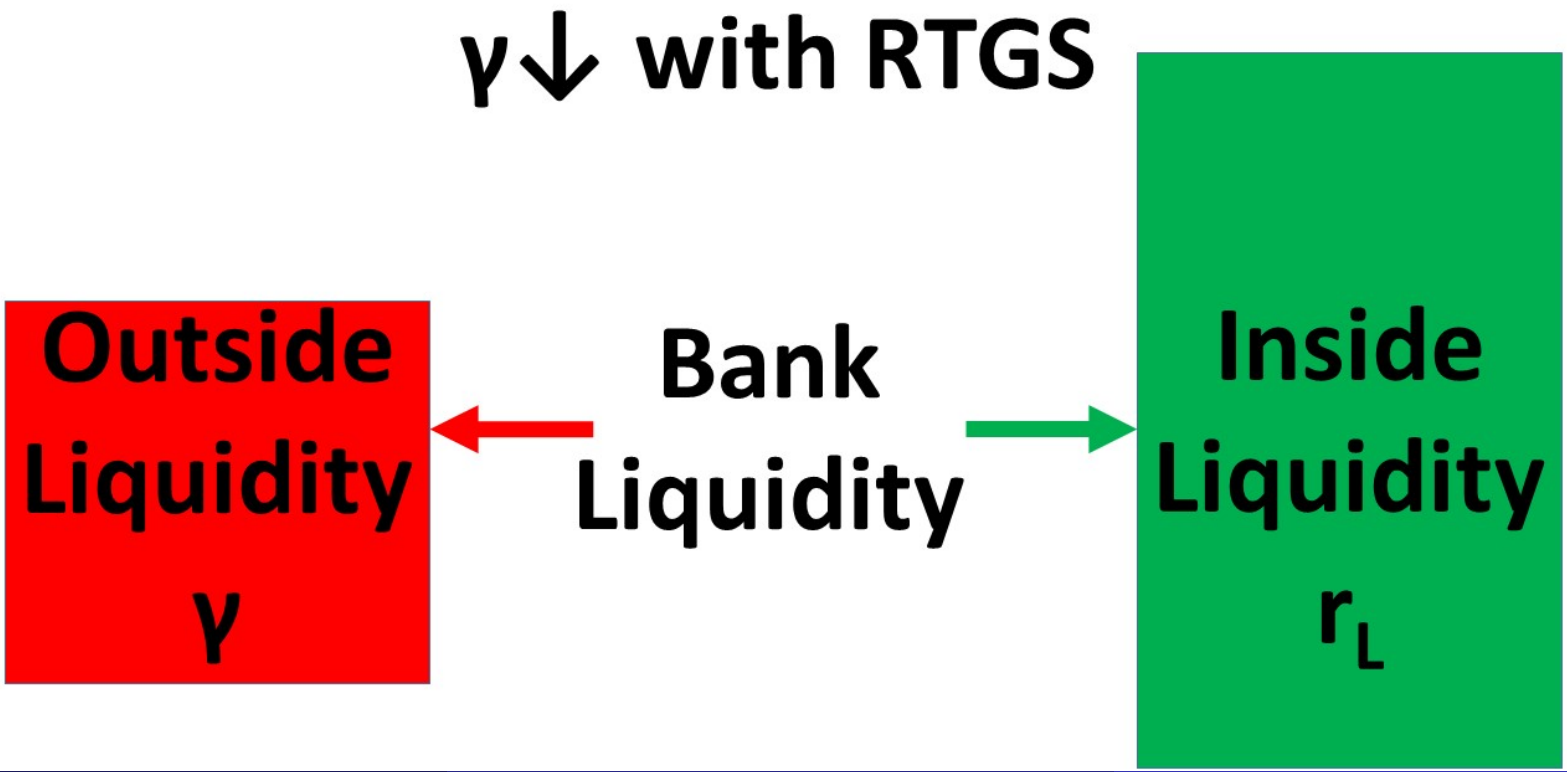

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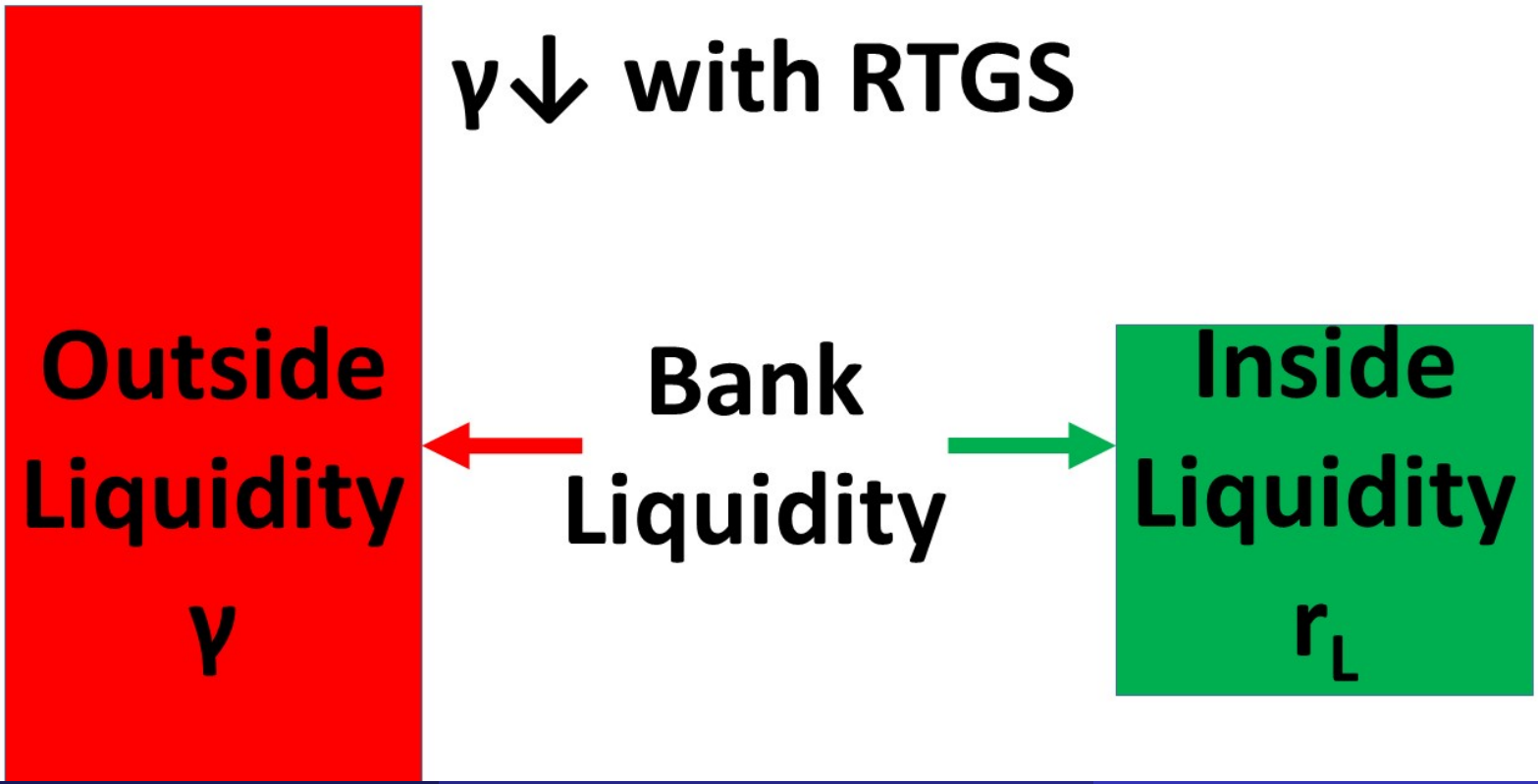


This Paper

Data & Natural Experiment

1. Data on 489 commercial banks & 28171 firms
2. Machine-learning to measure FinTech adoption at bank level
3. Staggering of submarine cables, 37 African countries, '00-'13

Methods & Empirical Analysis

* Event Study & D-i-D $\rightarrow$ *country-level variation*
* Key Heterogeneity $\rightarrow$ *bank-level variation*
* Identify Supply Effect $\rightarrow$ *multi-national bank-level variation*
* Effect on Firms $\rightarrow$ *country-level variation*

This Paper & Results

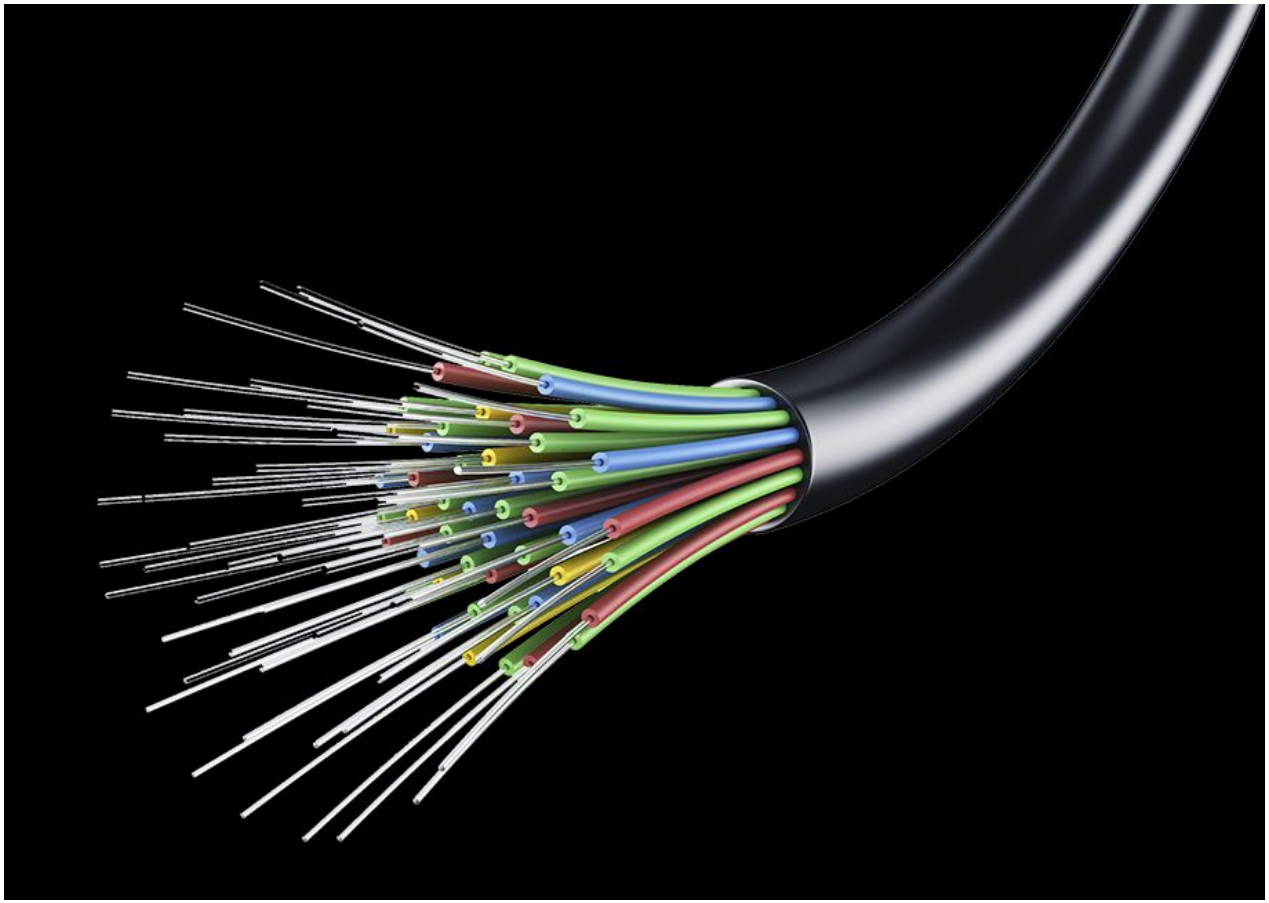
Data & Natural Experiment

1. Data on 489 commercial banks & 28171 firms
2. Machine-learning to measure FinTech adoption at bank level
3. Staggering of submarine cables, 37 African countries, '00-'13

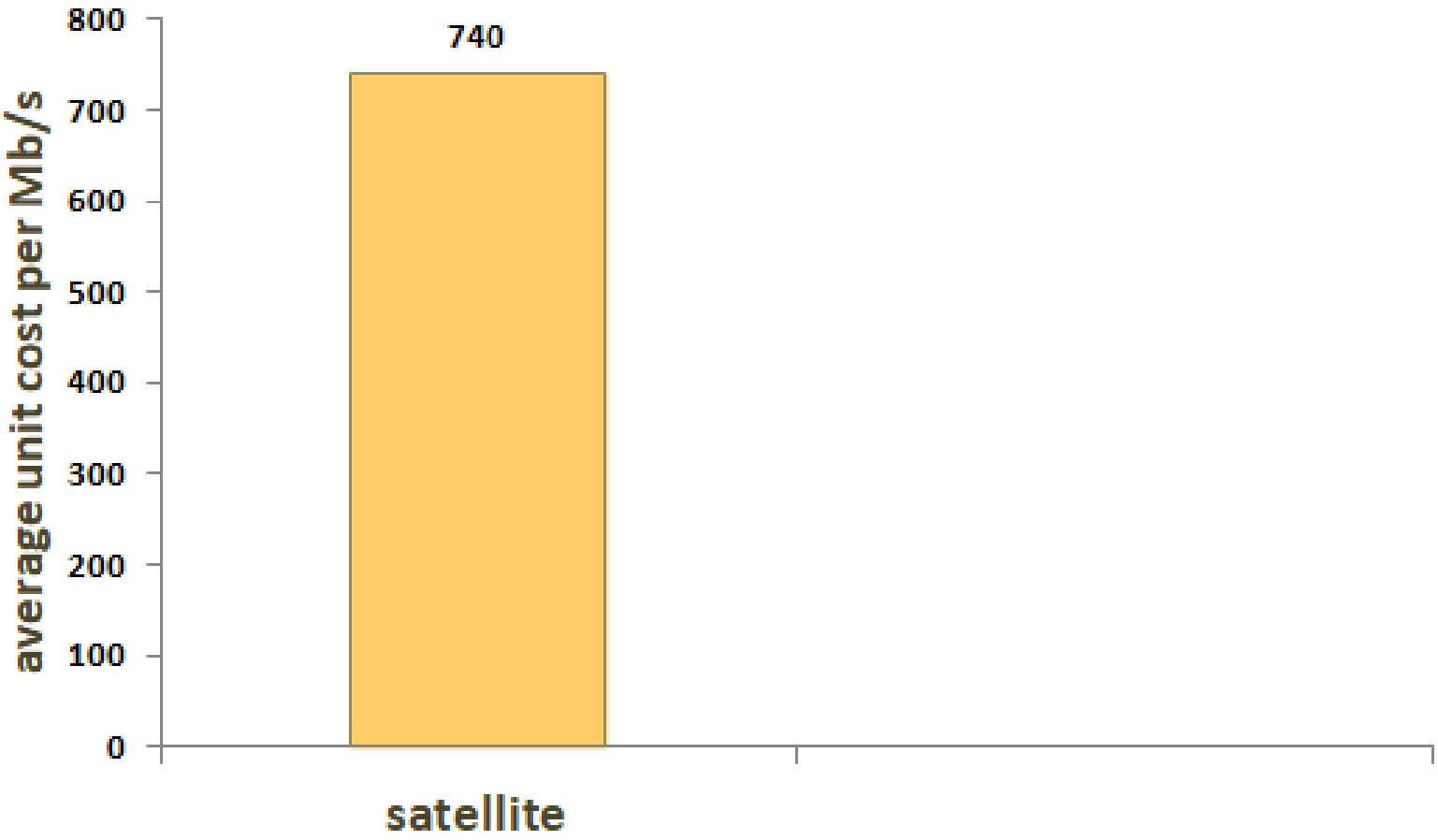
Methods & Empirical Analysis

* Event Study & D-i-D $\rightarrow$ **Adopt, intbank & credit $\uparrow$, hoard $\downarrow$**
* Key Heterogeneity $\rightarrow$ **Weak pre-cable users win!**
* Identify Supply Effect $\rightarrow$ **Country vs Group Connectedness**
* Effect on Firms $\rightarrow$ **Credit, maturity, sales & workforce $\uparrow$**

Natural Experiment $\rightarrow$ RTGS & Staggering of the Submarine Fiber-Optic Cable in Africa

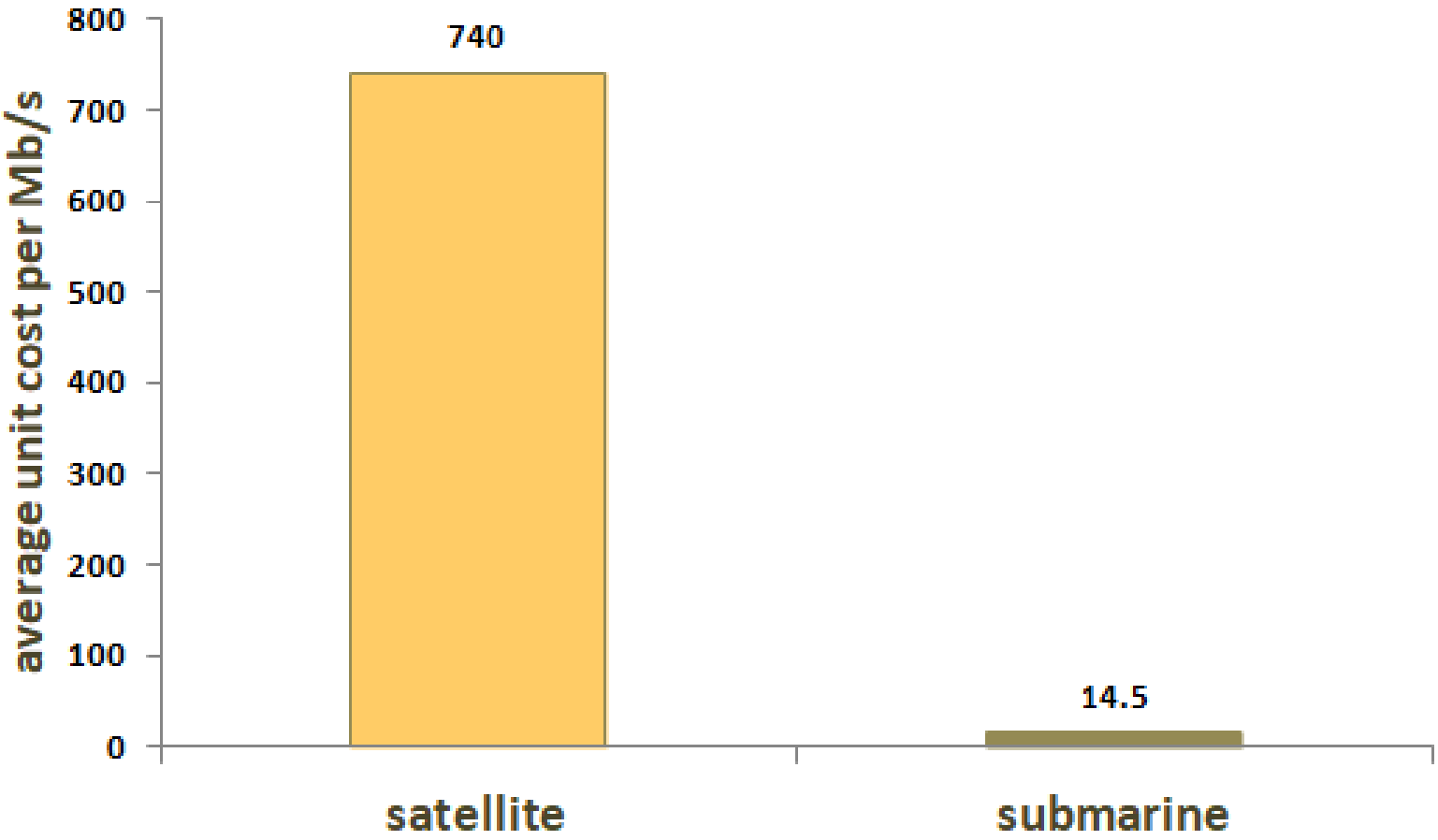


Submarine Cable → RTGS connection cost **98%↓**



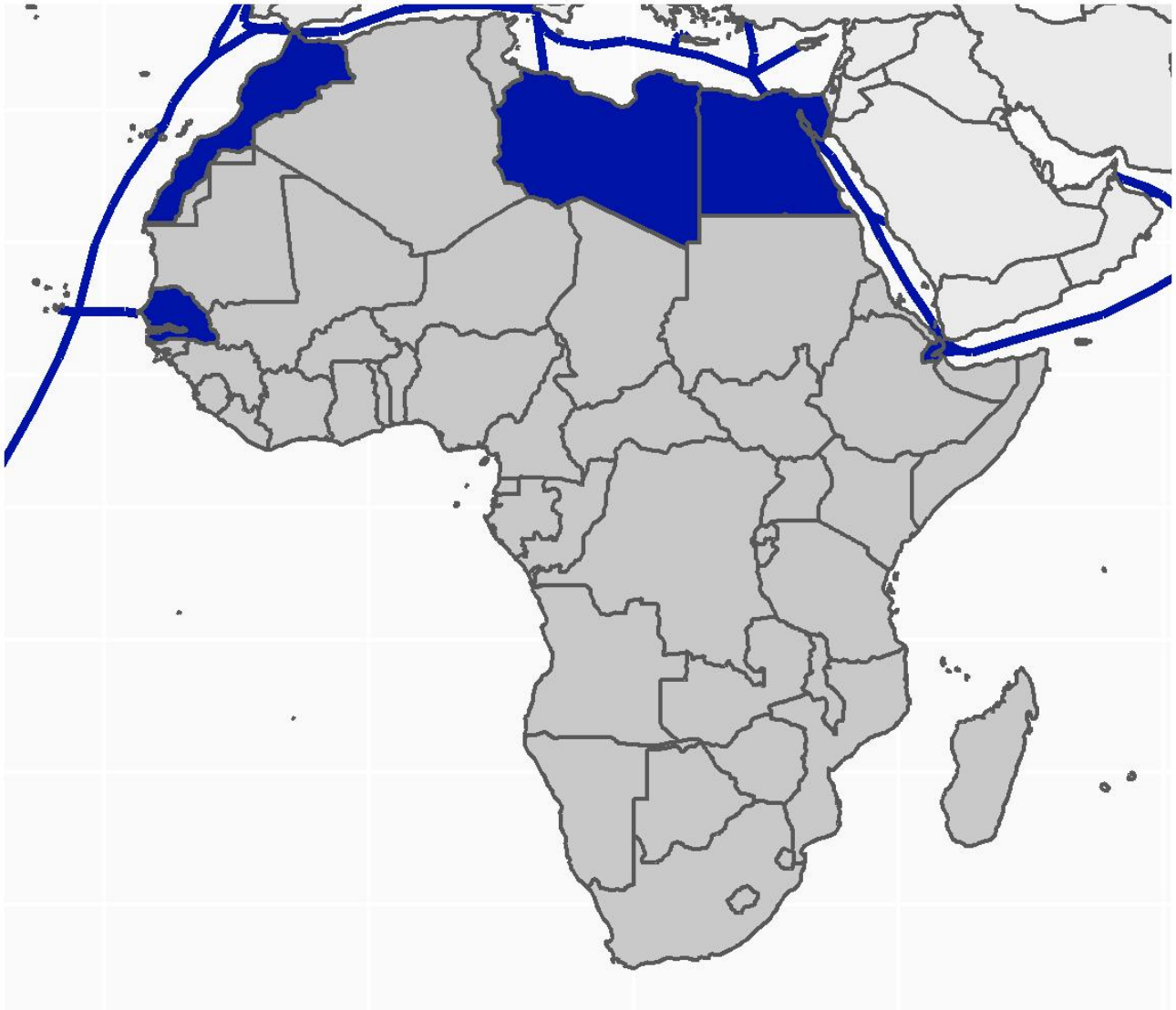
Note: Average unit cost per Mb/s (Detecon, 2013)

Submarine Cable $\rightarrow$ RTGS connection cost **98%**$\downarrow$



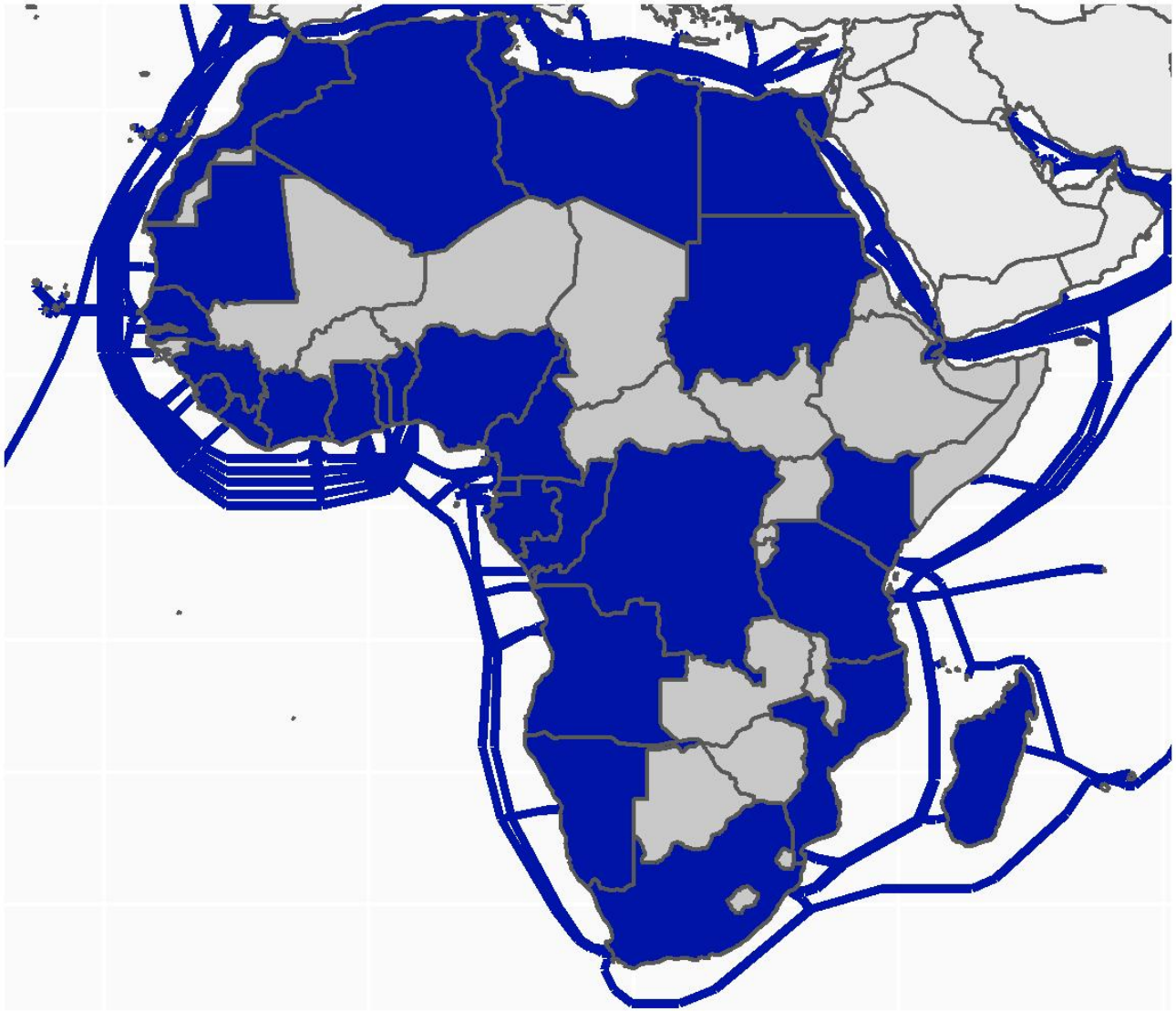
Note: Average unit cost per Mb/s (Detecon, 2013) - **how did the submarine cable staggering take place?**

2000



2005

2012 - All cables

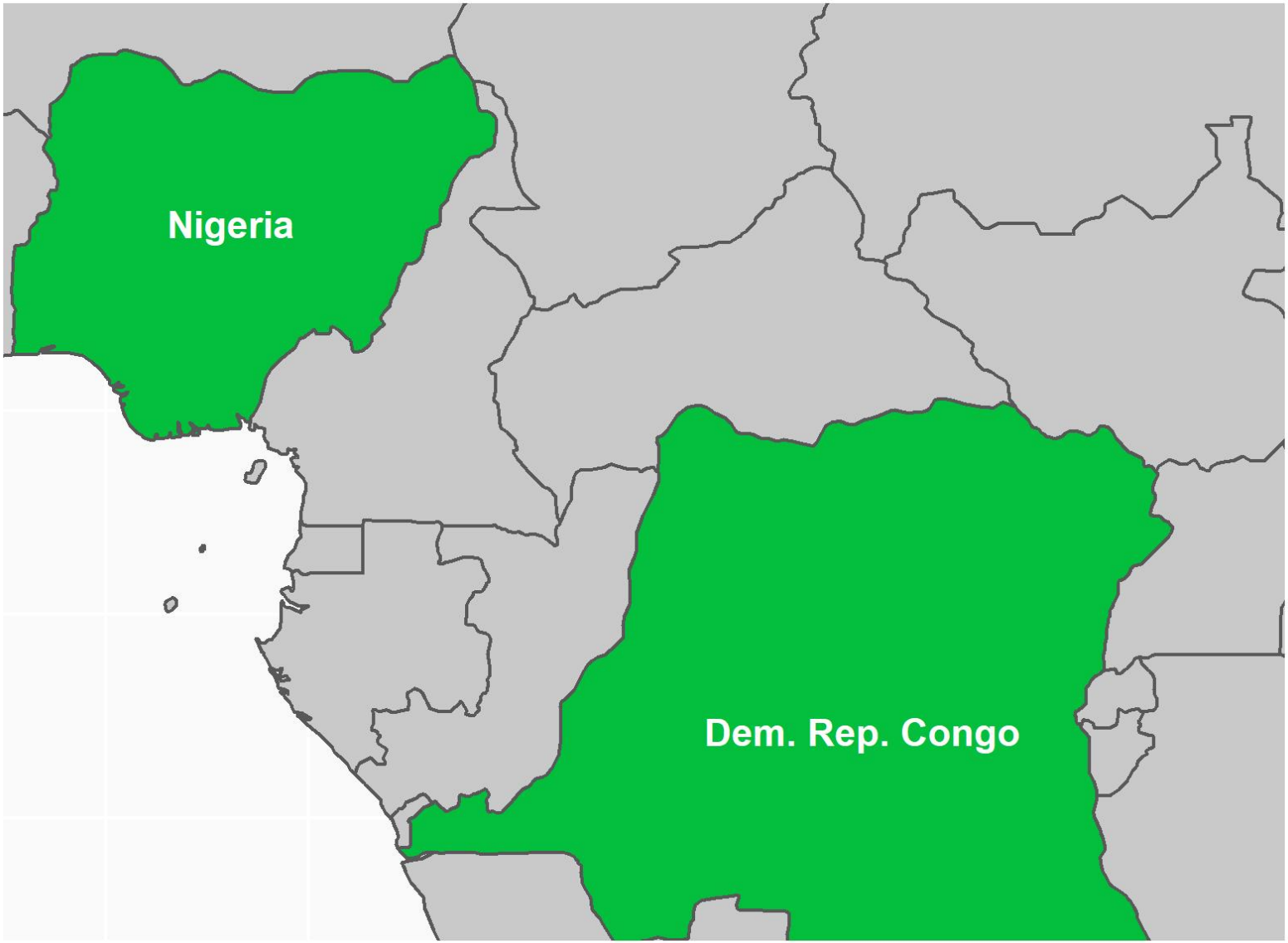


But...

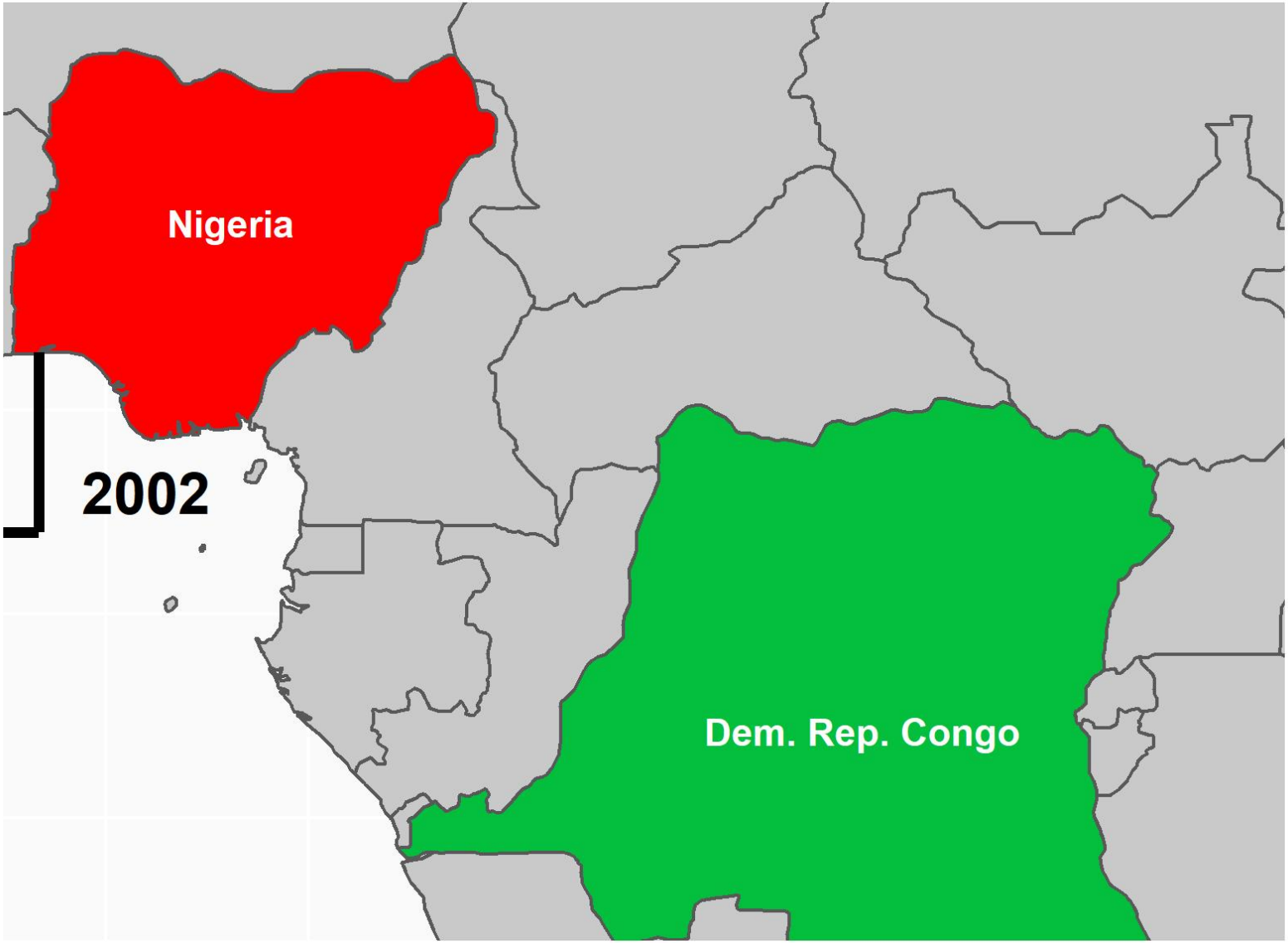
How do you separately identify the effect on supply vs demand?

Exploit Country vs Group Connectedness

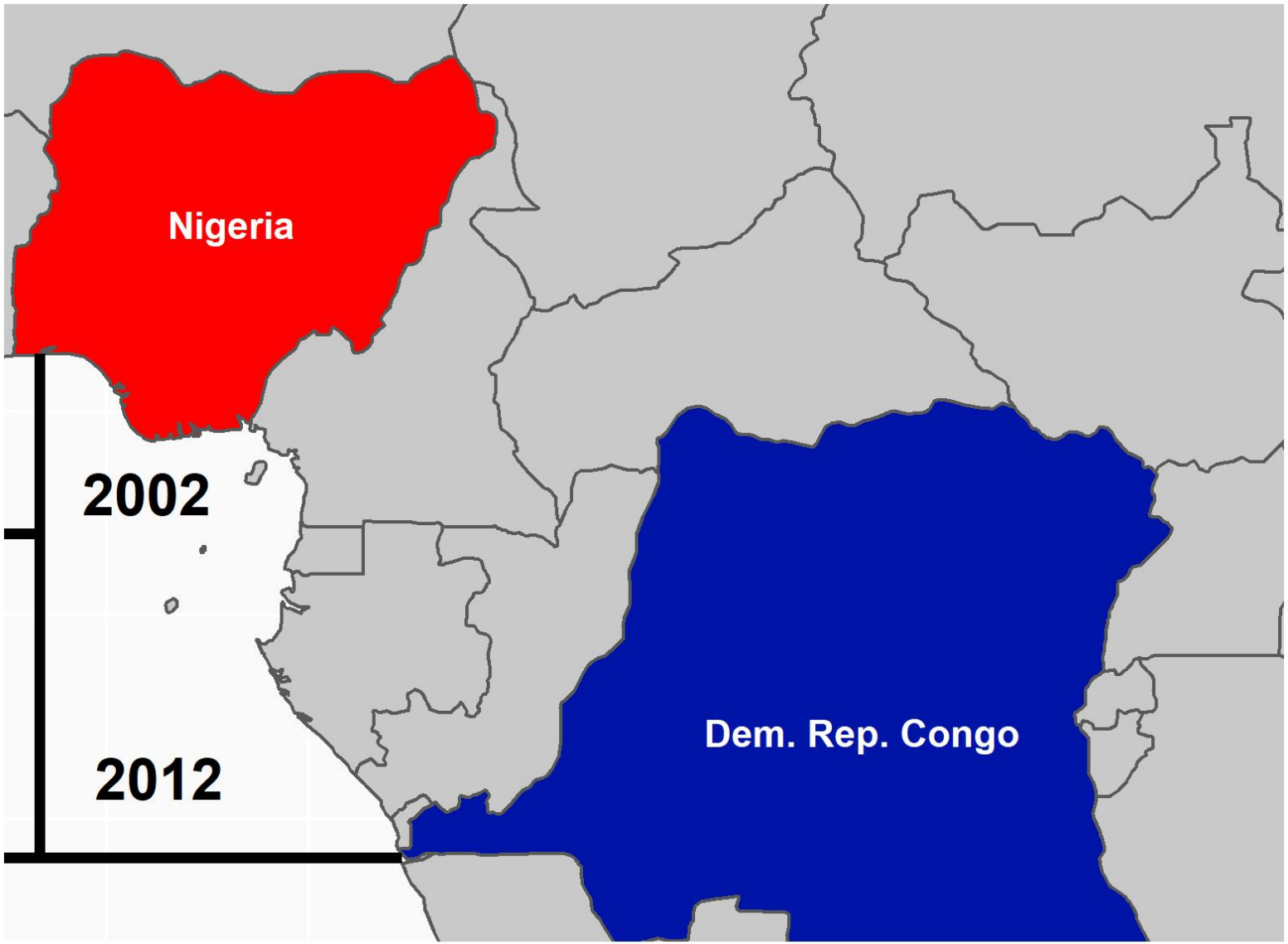
Example: Access bank



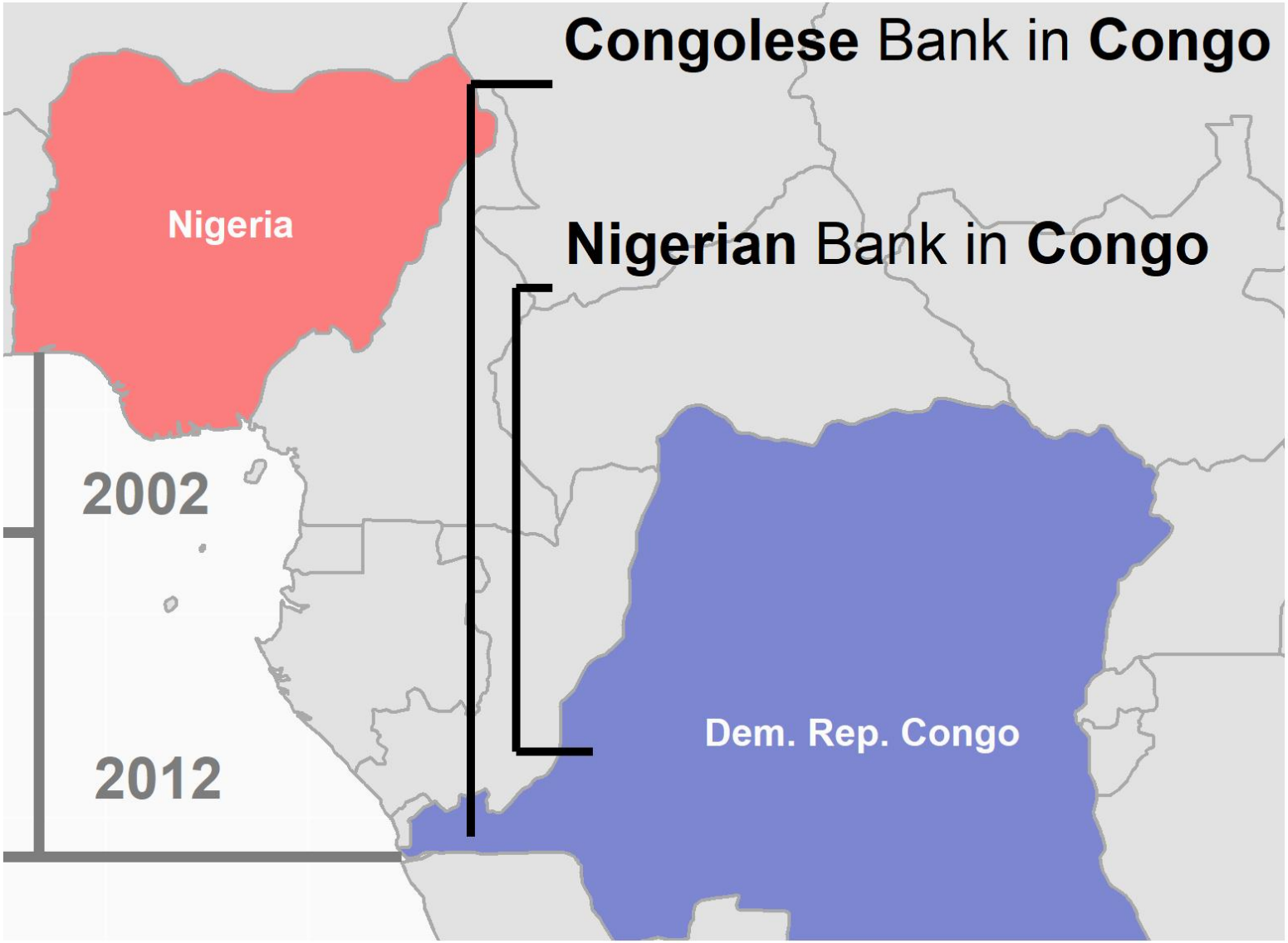
Example: Access bank



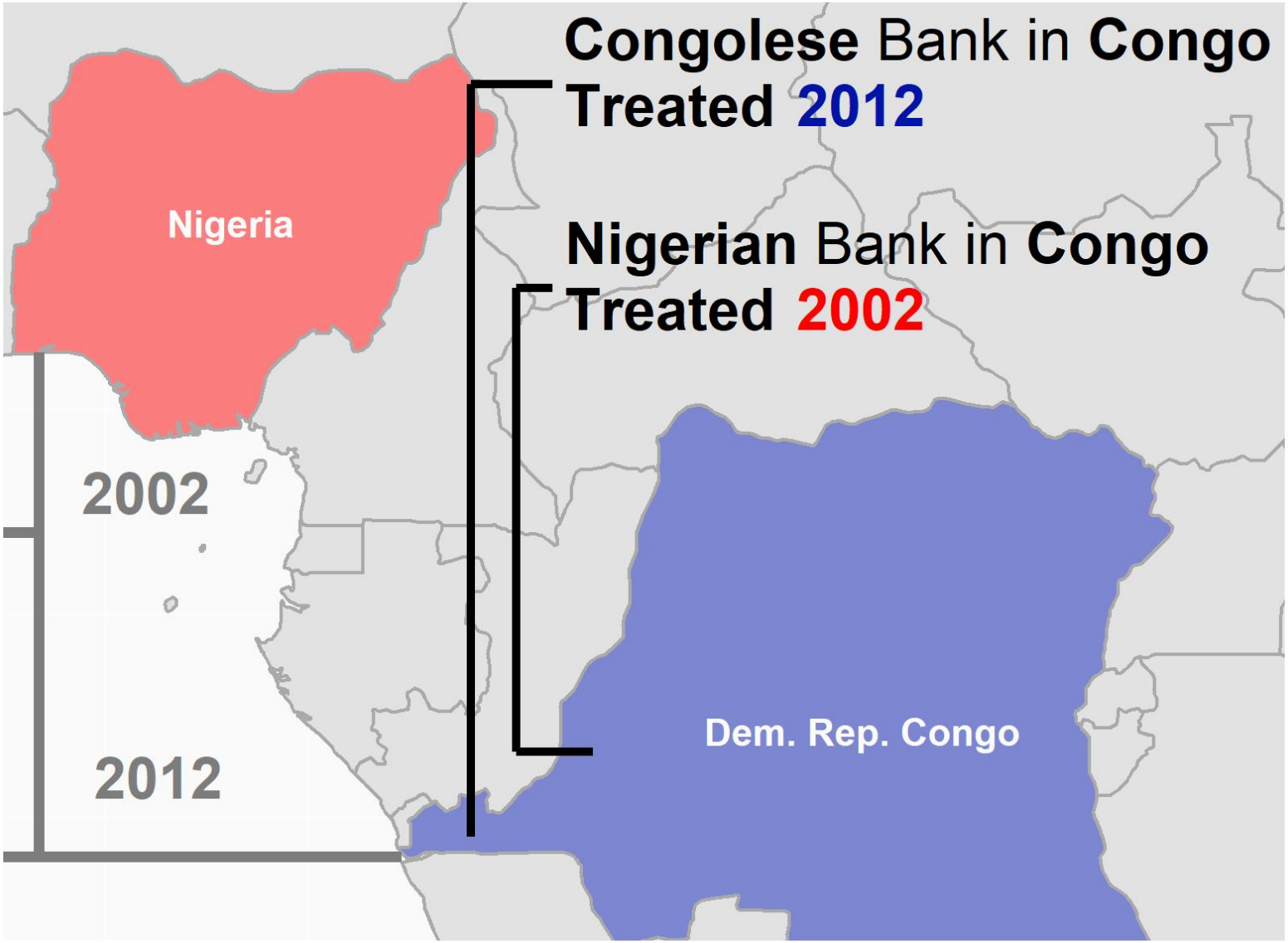
Example: Access bank



Example: Access bank



Example: Access bank



Literature

Financial Technology and Finance

* Goldstein, Jiang and Karolyi (2019), Berg, Burg, Gombović and Puri (2019), Buchak et al. (2018), Fuster et al. (2019)), Bartlett et al. (2018), Tang (2019), Hertzberg et al. (2018), D'Acunto et al. (2019), Abis (2017)
* Payment Systems - Higgins (2019), Benetton et al (2019)
* Cables & Forex - Eichengreen et al (2016), Steinwender (2018)
* Internet & Employment - Hjort & Poulsen (2019)

Liquidity and Interbank Markets

* Diamond and Dybvig, 1983; Bencivenga & Smith, 1991; Diamond and Rajan, 2001; Kashap et al., 2002; Goldstein and Pauzner, 2005;
* Interbank Markets - Townsend, 1979, Diamond, 1984; Allen and Gale, 2000; Heider, Hoerova & Holthausen, 2015, Allen et al., 2018; Craig and Ma, 2019; Coen & Coen, 2019

A Roadmap

1. Interbank Markets & Submarine Cables

2. Data, Machine-Learning & Empirics

3. Robustness Checks

Interbank Markets and Submarine Cables

RTGS 101

Banks make payments to each other (i.e. loans, checks, wires...)

Old Tech - *Net Settlement System*

Every period, banks calculate bilateral exposures & net pay

The bank holding a credit faces liquidity & credit risk

Increasing in settlement lags ($\simeq$ 1-2 weeks in AFR)

New Tech - *Real-Time Gross Settlement System*

$+$ **real-time & gross settlement** $-$ **cost of communication**

Data, Machine-Learning & Empirics

Bank Data - Bankscope

Best source on African banks

Focus: commercial banks $\rightarrow$ present this mechanism

Data-cleaning protocol of Duprey & Lé (2016):

1 balance-sheet per bank in million USD (+ more)

Sample: repeated x-section 489 banks, 8 years

Quality check: 1 correlation with confidential data from 4 countries

RTGS Data - A Machine-Learning Approach

Data on RTGS adoption not publicly available (not even in US)

Our approach:

1. collect country & bank reports for 300 banks ($\simeq$ 60% sample)

2. code RTGS adoption year per bank + observables

Predict the year of RTGS adoption through: 1) Elastic net; 2) SVM; 3) Trees; 4) Neural Network.

Top performer: **Bagging** (75%). Mean: 0.466 (0.499).

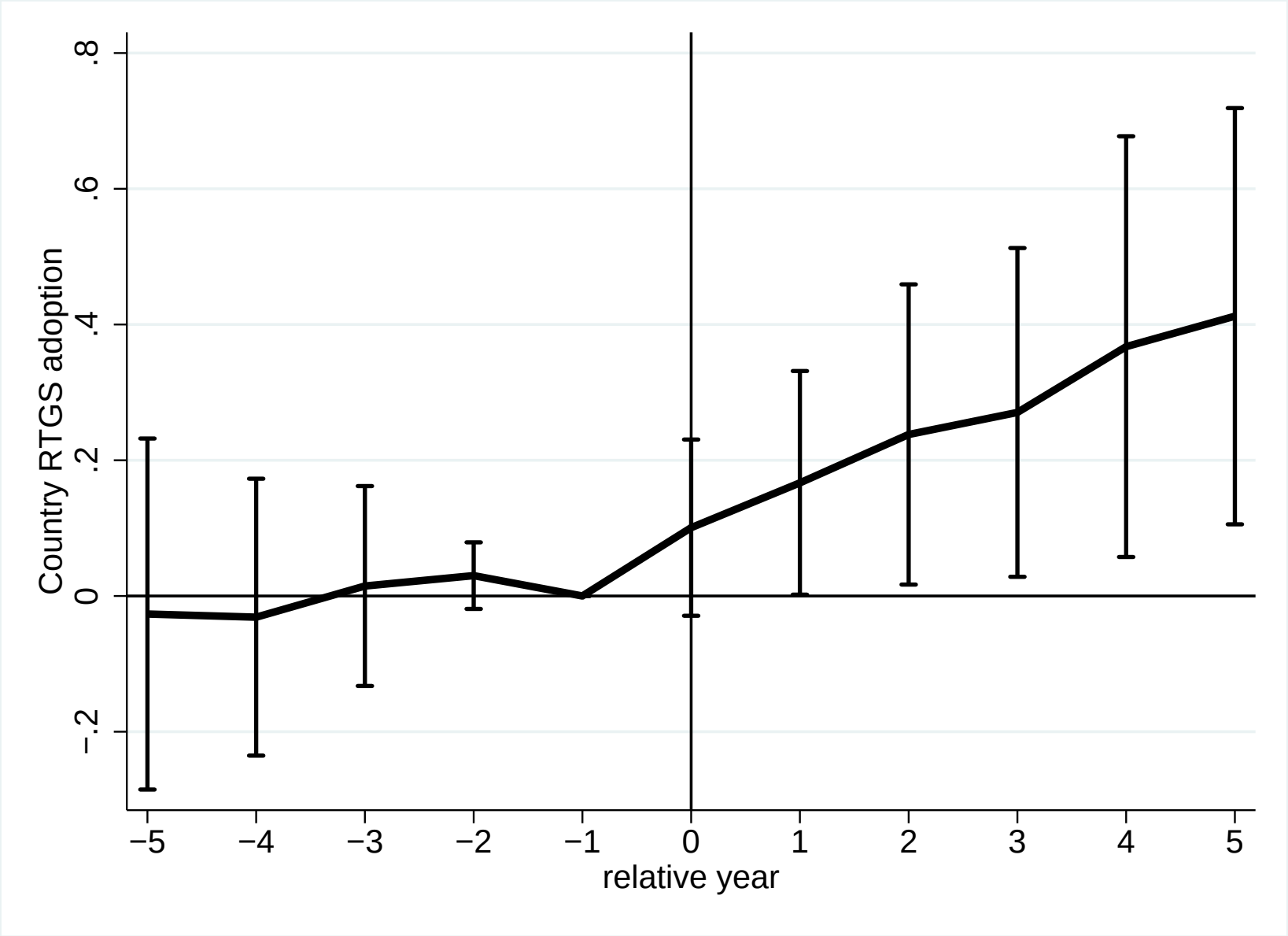
Empirical Analysis

Event Study + Staggered Diff-in-Diff

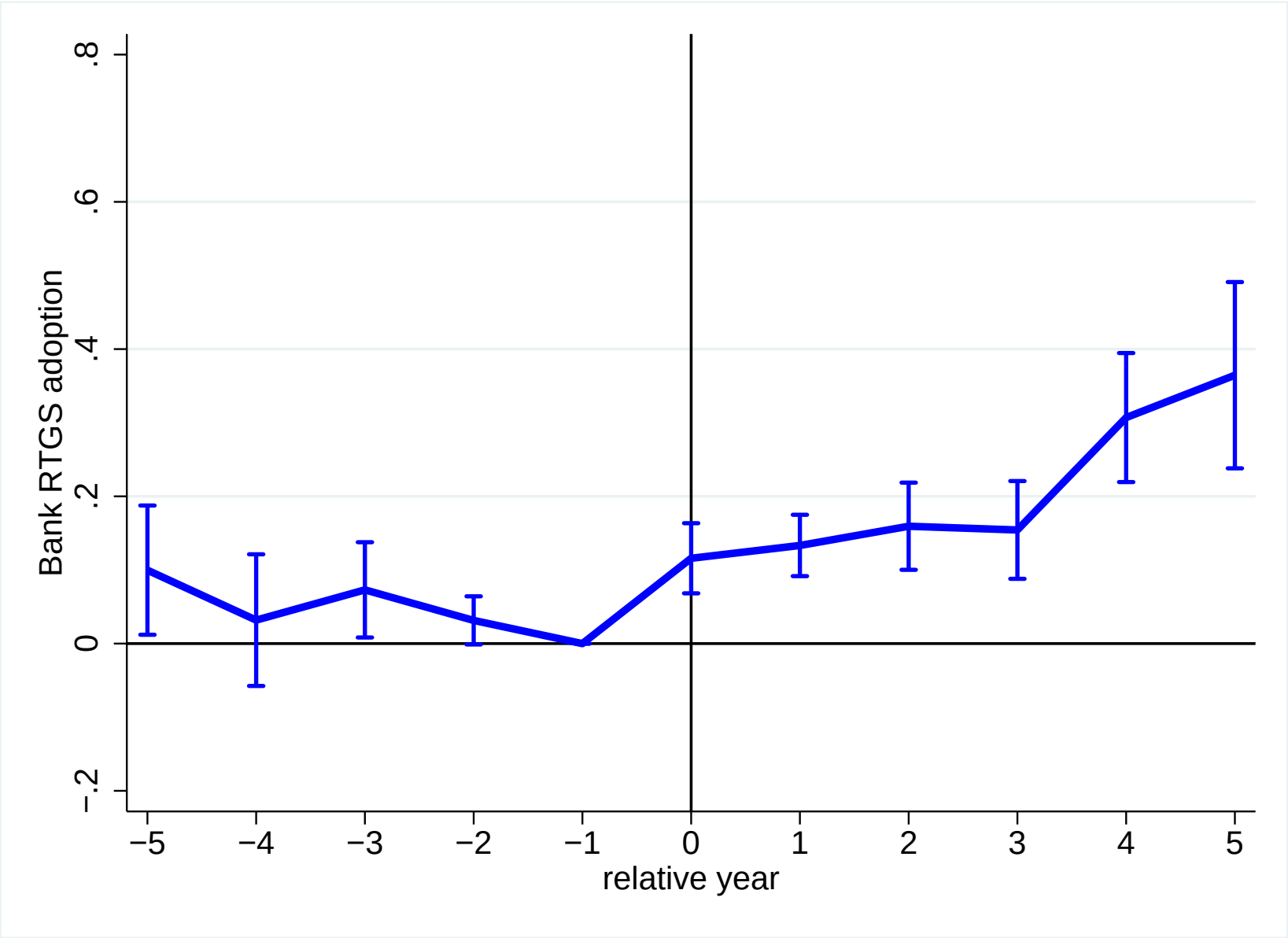
$$Y_{ict} = \alpha_i + \beta_t + \sum_{k=-5}^{5} \gamma_K I\{K_{ct} = k\} + \varepsilon_{ict}$$

$$Y_{ict} = \alpha_i + \beta_t + \gamma D_{ct} + \varepsilon_{ict}$$

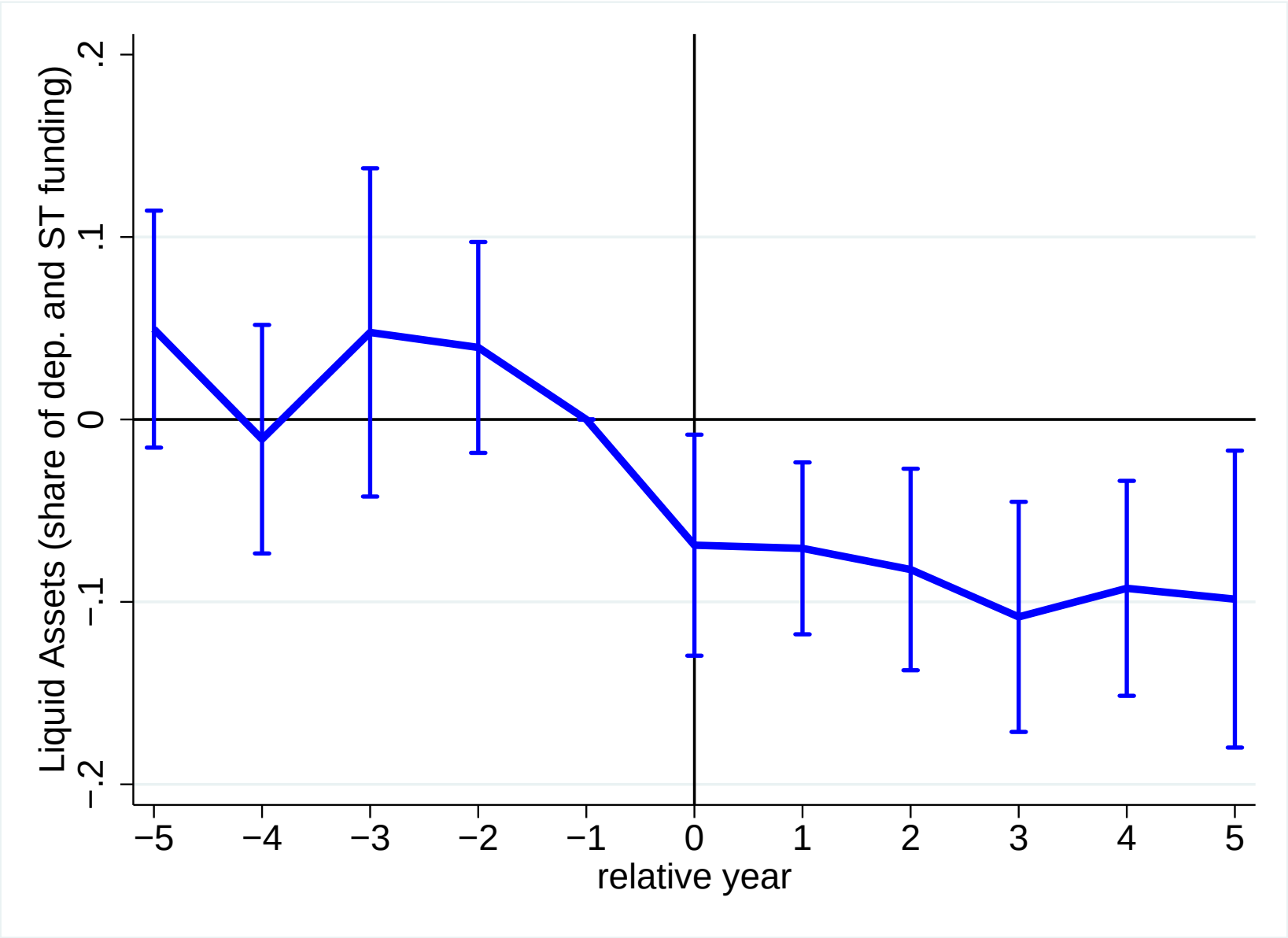
RTGS Adoption - **Country** Level ↑



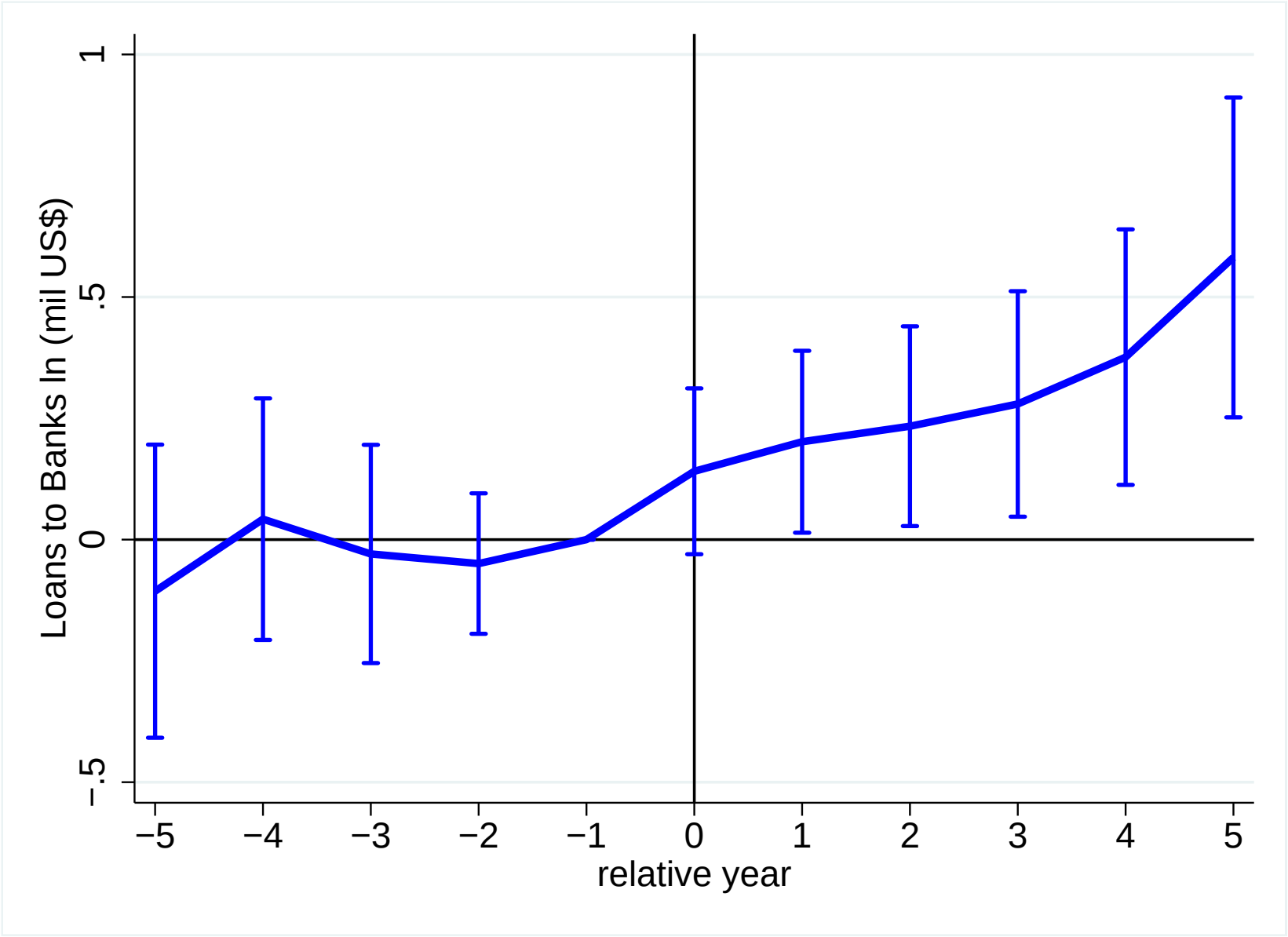
RTGS Adoption - **Bank** Level ↑



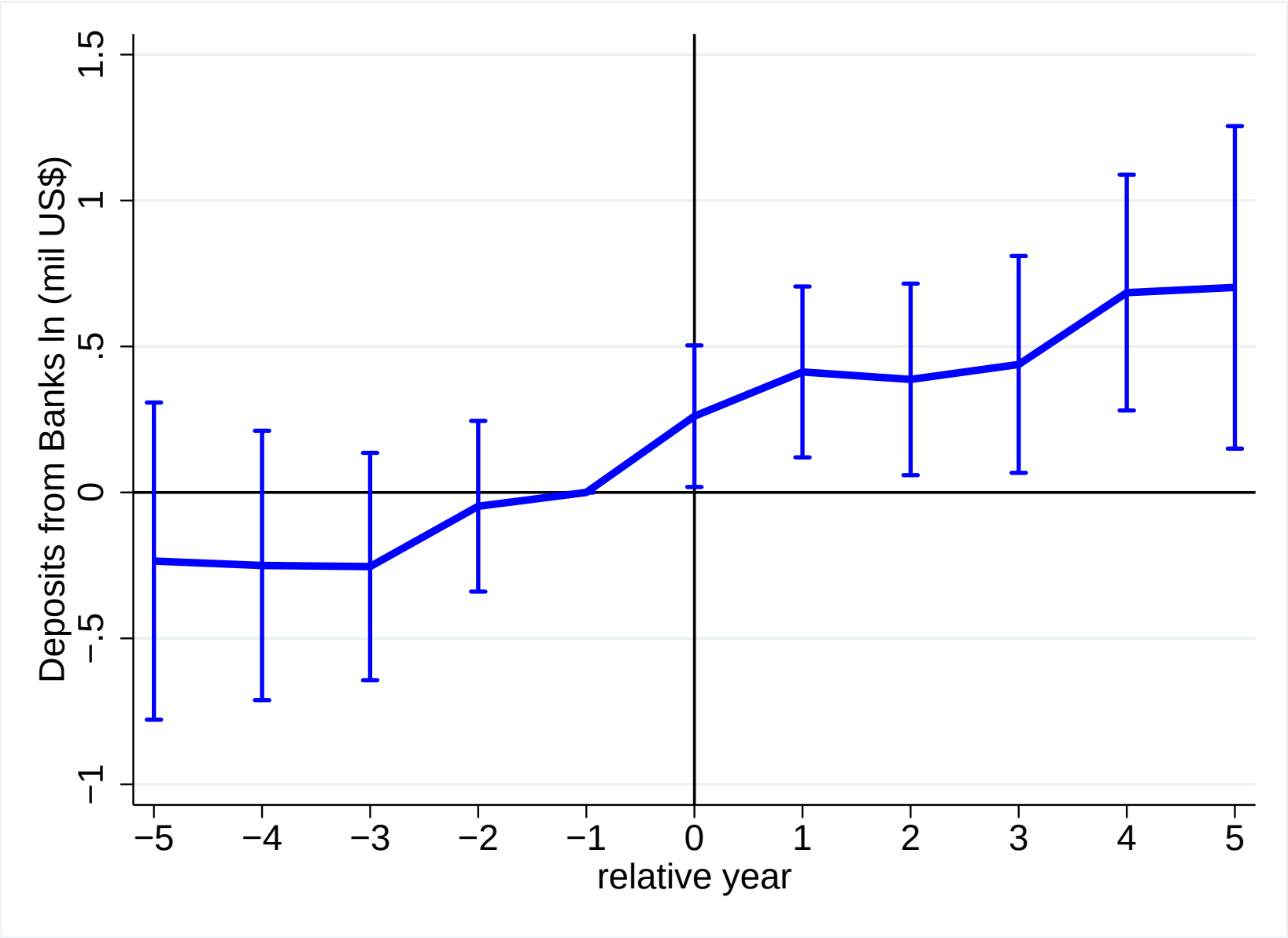
Liquidity Hoarding ↓



Interbank Assets ↑



Interbank Liabilities ↑



Lending ↑

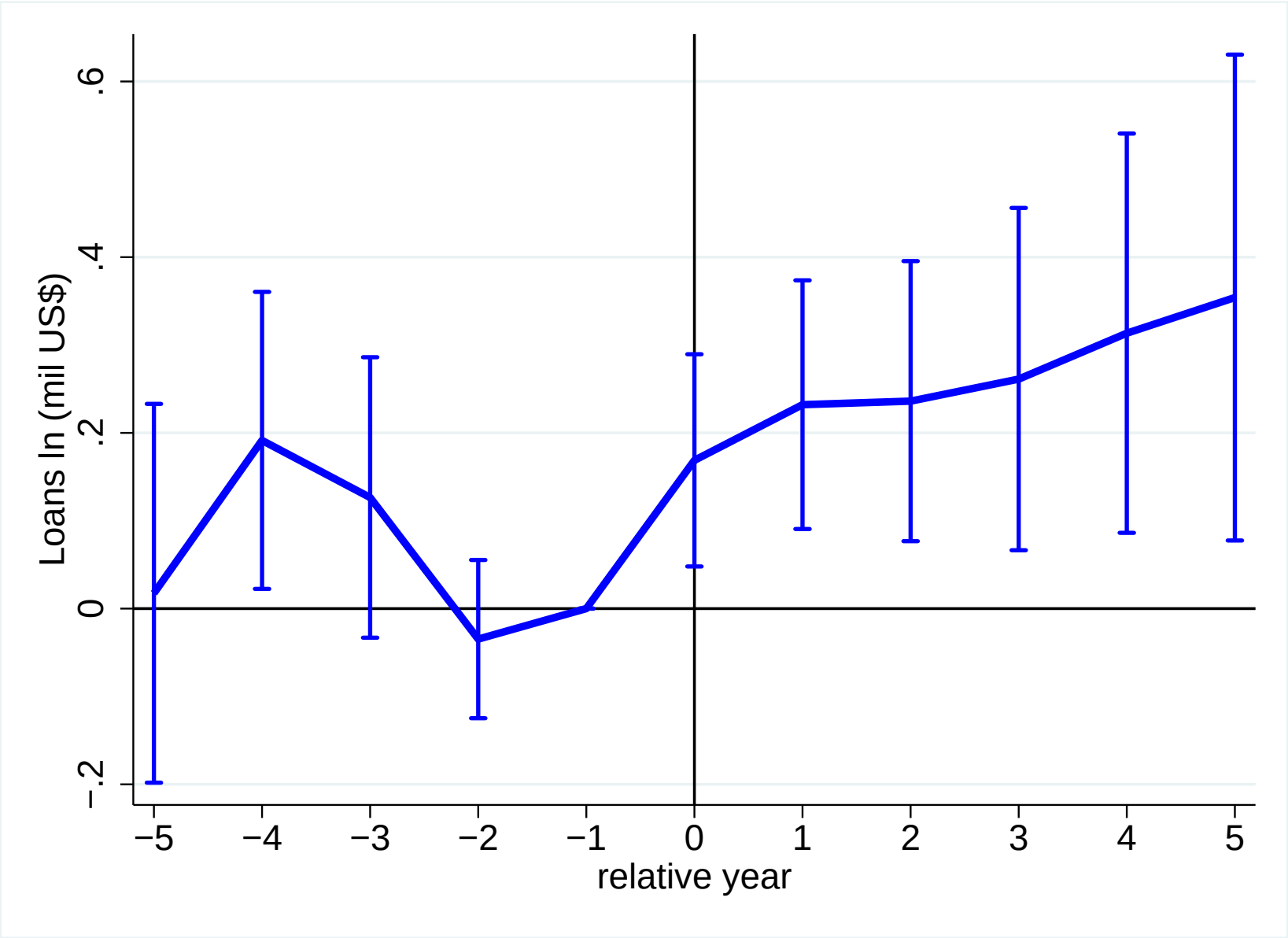


Table 2: Staggered Diff-in-Diff and RTGS adoption

Variables	(1) RTGS Country-Level	(2) RTGS Bank-Level
$Submarine_{ct}$	0.141*	0.0642***
	(0.079)	(0.0241)
Country FE	Yes	No
Bank FE	No	Yes
Year FE	Yes	Yes
Obs.	466	3863
Adj. R^2	0.652	0.772
M.D.V.	0.405	0.468

Notes: Standard errors in parentheses, clustered at country level in (1) and bank level in (2)

Table 3: Staggered Diff-in-Diff and Banking

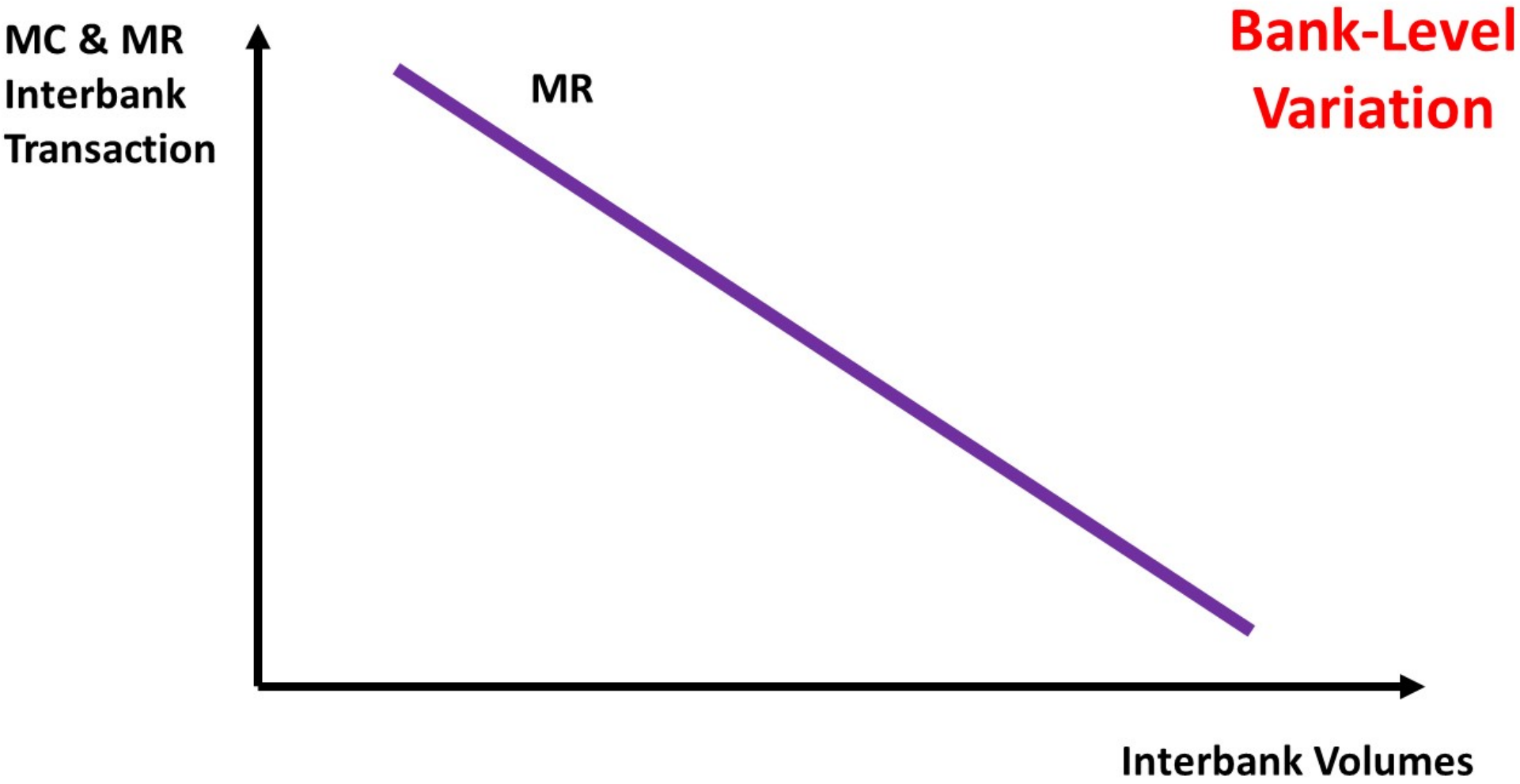
	Liquid Assets (share DST)	Loans to Banks ln(milUS$)	Deposits from Banks ln(milUS$)	Priv.Sector Loans ln(milUS$)
$Submarine_{ct}$	-0.0961***	0.139	0.411***	0.157**
	(0.0220)	(0.0894)	(0.132)	(0.0687)
Obs.	3837	3536	2754	3821
Bank FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Adj. R^2	0.430	0.828	0.715	0.891
M.D.V.	0.463	3.744	2.690	4.872

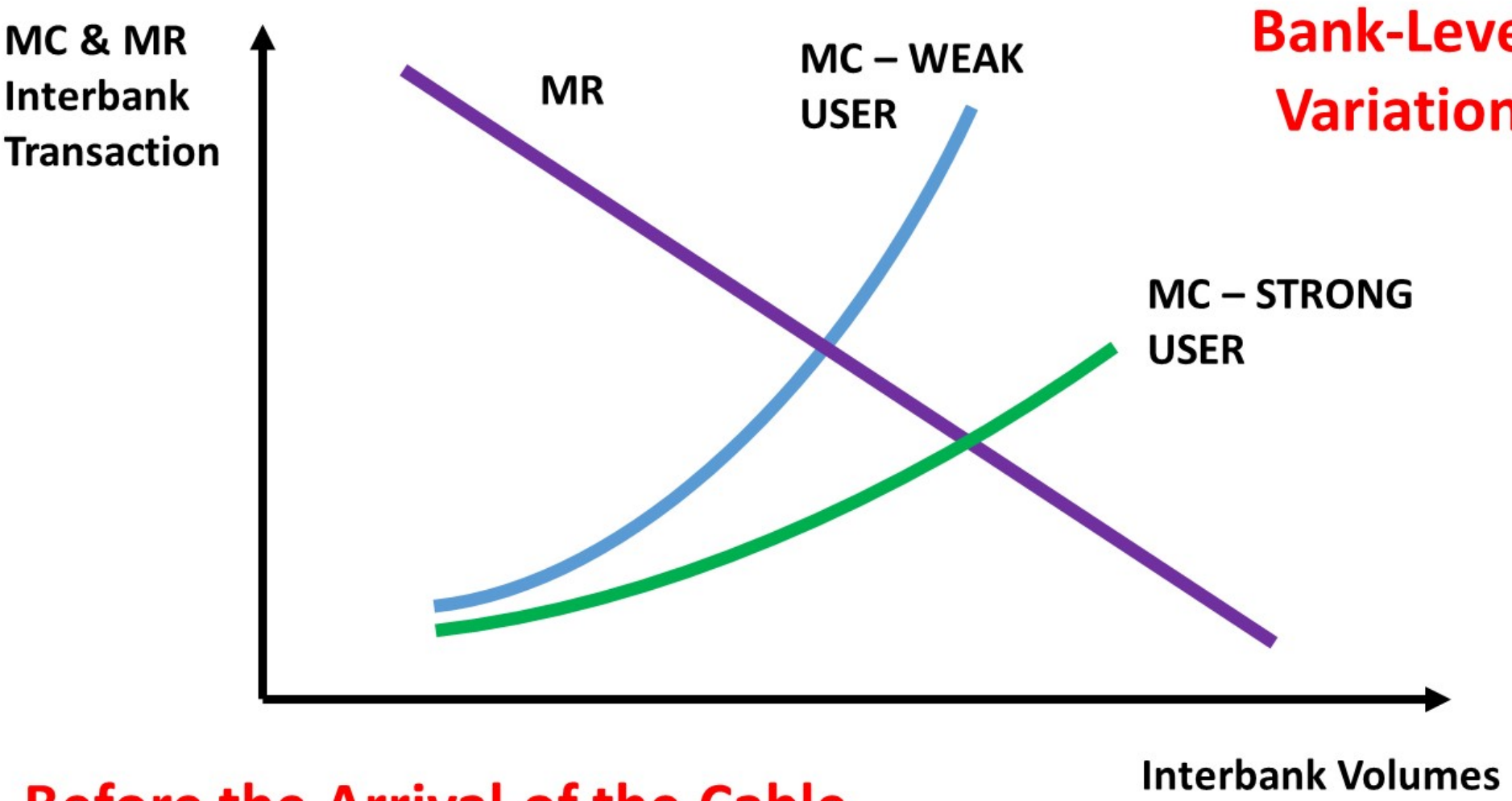
Notes: Standard errors in parentheses, clustered at bank level

Staggered Diff-in-Diff + Heterogeneity

$$Y_{ict} = \alpha_i + \beta_t + \gamma_1 D_{ct} \times \mathbf{X_i} + \gamma_2 D_{ct} + \varepsilon_{ict}$$

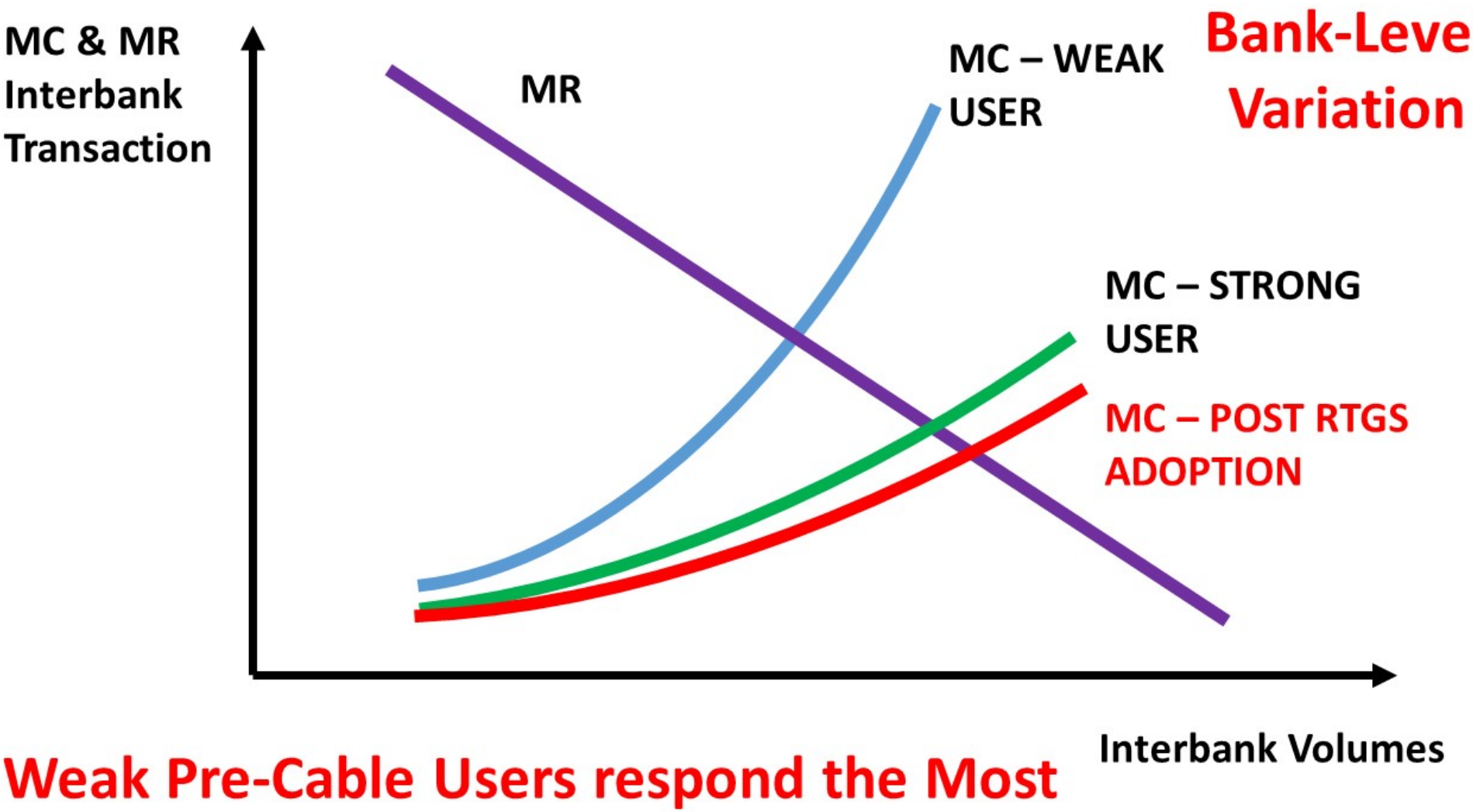
What is the interpretation of this?


MC & MR
Interbank
Transaction
MR
Bank-Level
Variation
Interbank Volumes



Bank-Level Variation

Before the Arrival of the Cable



Weak Pre-Cable Users respond the Most

Table 4: Heterogeneity and Banking

	Liquid Assets (share DST)	Loans to Banks ln(milUS$)	Deposits from Banks ln(milUS$)	Priv.Sector Loans ln(milUS$)
$Submarine_{ct}$	-0.049*	-0.080	0.052	-0.0401
	(0.025)	(0.111)	(0.148)	(0.0944)
$Submarine_{ct} \times$	-0.099***	0.447***	0.772***	0.378***
$Weak_{iT_{PRE}}$	(0.033)	(0.162)	(0.221)	(0.121)
Obs.	3720	3514	2710	3715
Bank FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Adj. R^2	0.475	0.830	0.717	0.892
M.D.V.	0.463	3.744	2.690	4.872

Notes: Standard errors in parentheses, clustered at bank level.

Heterogeneity is robust to **Country-Year FEs**

Demand vs Supply - replace D_{ct} with D_{gt}

$$Y_{igct} = \alpha_i + \beta_t + \gamma D_{gt} + \psi_1 D_{gt} \times \mathbf{X_{ic}} + \varepsilon_{igct}$$

Identifying HP: demand shock not differential across banks within the *same group (country) and year* & with weak/strong usage ex ante

Table 6: Internet and the Supply of Liquidity

	Liquid Assets (share DST)	Loans to Banks ln(milUS$)	Deposits from Banks ln(milUS$)	Priv.Sector Loans ln(milUS$)
$Submarine_{gt} \times$	-0.0253	-0.103	0.209	0.131*
	(0.0224)	(0.117)	(0.147)	(0.0714)
$Submarine_{gt} \times$	-0.0847**	0.364***	0.623***	0.231**
$Weak_{iT_{PRE}}$	(0.0373)	(0.135)	(0.191)	(0.0930)
Obs.	3720	3514	2710	3715
Bank FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Adj. R^2	0.471	0.829	0.716	0.892
M.D.V.	0.461	3.750	2.696	4.933

Notes: Standard errors in parentheses, clustered at bank level

Heterogeneity is robust to **Group-Year FEs** & **Country-Year FEs**

Firms

$$Y_{fct} = \alpha_c + \beta_t + \gamma_1 D_{ct} \times \mathbf{X_c} + \gamma_2 D_{ct} + \varepsilon_{it}$$

Table 9: Firms, Cables and Interbank Markets

Variables	Access Finance Dummy	Bank Credit Dummy	Sale ln(USD)	Workforce ln(N)	Maturities ln(Months)
$Submarine_{ct}$	0.043	-0.001	0.185	-0.231	0.587**
	(0.061)	(0.047)	(1.108)	(0.202)	(0.214)
$Submarine_{ct} \times$	0.160**	0.097**	3.158**	0.356**	0.418*
$Weak_{cT_{PRE}}$	(0.065)	(0.035)	(1.173)	(0.148)	(0.238)
Country FE	Yes	Yes	Yes	Yes	No
Year FE	Yes	Yes	Yes	Yes	Yes
Obs.	25389	25222	24314	12637	1139
Adj. R sq.	0.0965	0.127	0.362	0.129	0.127
M.D.V.	0.638	0.211	16.43	3.198	3.008

Notes: Standard errors in parentheses, clustered at country level

Robustness Checks

Robustness Checks

1. Include landlocked countries
2. Longer bank dataset (2000 to 2018) - $\neq$ datasets
3. Restrict a bank & firm sample
4. Re-offer bank evidence with country FEs
5. Account for observables - bank & country controls, bank evidence
6. Cluster bank regressions at country & country-year link
7. Account for observables - country controls, firm evidence1
8. Many more (event study with 3-year window etc etc etc).

Concluding Remarks

1. Evidence that Financial Technology $\rightarrow$ Bank Liquidity Management

   $\rightarrow$ High-Speed Internet promotes Interbank Markets in Africa

2. What do we learn?

   $\rightarrow$ FinTechs shape the business of banks "inside"

   $\rightarrow$ FinTechs alleviate frictions & improve capital allocation

   $\rightarrow$ Infrastructure investment improves risk sharing

3. Future

   $\rightarrow$ More work on "designing financial institutions for development"

   $\rightarrow$ Starting a new webinar on "Finance & Development" (with G. Barboni, J. Cai & S. Higgins) **Get in touch & stay tuned!**

Thank You

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Table E1: Staggered Diff-in-Diff - Landlocked countries

Variables	(I) Liquid Assets (share DST)	(II) Loans to Banks ln(milUS$)	(III) Deposits from Banks ln(milUS$)	(IV) Private loans ln(milUS$)
$Submarine_{ct}$	-0.0808***	0.158*	0.362***	0.109*
	(0.0199)	(0.0891)	(0.126)	(0.0633)
Bank FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Obs.	4983	4615	3519	4978
Adj. R^2	0.422	0.809	0.696	0.892
M.D.V.	0.458	3.565	2.535	4.684

Back

Table E2: Staggered Diff-in-Diff - Updated Sample

Variables	(I) Liquid Assets (share DST)	(II) Loans to Banks ln(milUS$)	(III) Deposits from Banks ln(milUS$)	(IV) Private loans ln(milUS$)
$Submarine_{ct}$	-0.0874***	0.194**	0.455***	0.181**
	(0.0197)	(0.0949)	(0.147)	(0.0809)
Bank FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Obs.	5389	5077	4029	5379
Adj. R^2	0.364	0.763	0.663	0.864
M.D.V.	0.444	3.820	2.860	5.104

Back

Table E3: Staggered Diff-in-Diff - Restricted Sample

Variables	(I) Liquid Assets (share DST)	(II) Loans to Banks ln(milUS$)	(III) Deposits from Banks ln(milUS$)	(IV) Private loans ln(milUS$)
$Submarine_{ct}$	-0.114***	0.291**	0.743***	0.336***
	(0.0229)	(0.134)	(0.176)	(0.104)
Bank FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Obs.	1415	1415	1415	1415
Adj. R^2	0.618	0.865	0.769	0.939
M.D.V.	0.376	4.205	3.046	5.631

Back

Table I1: Staggered Diff-in-Diff - Firms Restricted Sample

Variables	(I) Access Finance (dummy)	(II) Bank Credit (dummy)	(III) Sales ln(USD)	(IV) Maturity ln(Months)
$Submarine_{ct}$	0.159***	0.134**	2.290	0.862***
	(0.0384)	(0.0530)	(1.780)	(0.273)
Country FE	Yes	Yes	Yes	No
Year FE	Yes	Yes	Yes	Yes
Obs.	20032	20032	19811	1010
Adj. R^2	0.0929	0.124	0.280	0.118
M.D.V.	0.635	0.240	12.16	3.050

Back

Table G1: Staggered Diff-in-Diff Country Fixed Effects

Variables	(I) Liquid Assets (share DST)	(II) Loans to Banks ln(milUS$)	(III) Deposits from Banks ln(milUS$)	(IV) Private loans ln(milUS$)
$Submarine_{ct}$	-0.0965***	0.195*	0.353**	0.198**
	(0.0226)	(0.0999)	(0.147)	(0.0901)
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Obs.	3861	3565	2794	3845
Adj. R^2	0.166	0.392	0.324	0.449
M.D.V.	0.466	3.735	2.675	4.861

Back

Table F4: Staggered Diff-in-Diff - All controls

Variables	(I) Liquid Assets (share DST)	(II) Loans to Banks ln(milUS$)	(III) Deposits from Banks ln(milUS$)	(IV) Private loans ln(milUS$)
$Submarine_{ct}$	-0.0820***	0.130	0.431***	0.0921
	(0.0227)	(0.0992)	(0.130)	(0.0682)
Controls:				
Country indicators	Yes	Yes	Yes	Yes
Regulatory quality	Yes	Yes	Yes	Yes
Bank indicators	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Obs.	3538	3244	2561	3512
Adj. R^2	0.425	0.835	0.730	0.913
M.D.V.	0.458	3.788	3.702	4.048

Back

Table H2: Staggered Diff-in-Diff - Cluster country

Variables	(I) Liquid Assets (share DST)	(II) Loans to Banks ln(milUS$)	(III) Deposits from Banks ln(milUS$)	(IV) Private loans ln(milUS$)
$Submarine_{ct}$	-0.0961***	0.139	0.411**	0.157
	(0.0336)	(0.115)	(0.197)	(0.140)
Bank FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Obs.	3837	3536	2754	3821
Adj. R^2	0.430	0.828	0.715	0.891
M.D.V.	0.463	3.744	2.690	4.872

Back

Table H3: Staggered Diff-in-Diff - Cluster country-year

Variables	(I) Liquid Assets (share DST)	(II) Loans to Banks ln(milUS$)	(III) Deposits from Banks ln(milUS$)	(IV) Private loans ln(milUS$)
$Submarine_{ct}$	-0.0961***	0.139*	0.411***	0.157*
	(0.0236)	(0.0744)	(0.124)	(0.0810)
Bank FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Obs.	3837	3536	2754	3821
Adj. R^2	0.430	0.828	0.715	0.891
M.D.V.	0.463	3.744	2.690	4.872

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Table I2: Staggered Diff-in-Diff - Weak Interbank, Country controls

Variables	(I) Access Finance (dummy)	(II) Bank Credit (dummy)	(III) Sales ln(USD)	(IV) Maturity ln(Months)
$Submarine_{ct}$	-0.203	-0.0517	-0.075	-0.289
	(0.120)	(0.0935)	(1.656)	(0.289)
Submarine	0.279***	0.196***	3.305**	0.629**
$\times$ *Weak Intb*$_{ct}$	(0.0770)	(0.0587)	(1.557)	(0.242)
Controls:				
Country indicators	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	No
Year FE	Yes	Yes	Yes	Yes
Obs.	22696	22550	21867	1139
Adj. R^2	0.0937	0.126	0.343	0.193

Table I4: Staggered Diff-in-Diff - Weak Interbank, Cluster survey

Variables	(I) Access Finance (dummy)	(II) Bank Credit (dummy)	(III) Sales ln(USD)	(IV) Maturity ln(Months)
$Submarine_{ct}$	0.0437	-0.00197	-0.168	0.587**
	(0.0436)	(0.0338)	(0.881)	(0.214)
Submarine	0.160***	0.0977***	3.821***	0.418*
$\times$ *Weak Intb*$_{ct}$	(0.0460)	(0.0256)	(0.922)	(0.238)
Country FE	Yes	Yes	Yes	No
Year FE	Yes	Yes	Yes	Yes
Obs.	25389	25222	24064	1139
Adj. R^2	0.0965	0.127	0.334	0.127
M.D.V.	0.638	0.211	12.11	3.008