Quantities and Covered-Interest Parity

Tobias J. Moskowitz[1] Chase P. Ross[2] Sharon Y. Ross[2] Kaushik Vasudevan[3]

[1]Yale, NBER, and AQR Capital Management

[2]Federal Reserve Board

[3]Purdue Daniels

2024 Washington Area International Finance Symposium
October 11, 2024

The views of this paper do not necessarily reflect the views of
the Board of Governors of the Federal Reserve System, AQR, or their staffs.

Overview

- Expected returns on bank-intermediated arbitrages, called *bases*, have exploded since 2008
  - Main takeaway: post-GFC, arbitrage is costly for intermediaries
- Most work focuses on prices, but little evidence on intermediaries' positions
- Unresolved puzzle: substantial heterogeneity in sign and magnitude of bases within an asset class

Overview

- Expected returns on bank-intermediated arbitrages, called *bases*, have exploded since 2008
  - Main takeaway: post-GFC, arbitrage is costly for intermediaries
- Most work focuses on prices, but little evidence on intermediaries' positions
- Unresolved puzzle: substantial heterogeneity in sign and magnitude of bases within an asset class

Use supervisory regulatory data on quantities to study CIP bases and implications for intermediary asset pricing

Covered-Interest Parity Violations: A Quick Refresher

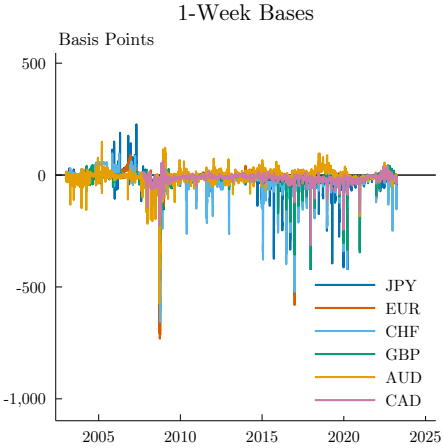
- An investor should be indifferent between
  1. holding USD and earning dollar risk-free rate $y^{\$}_{t,t+n}$
  2. exchanging their USD for foreign currency (s^k_t), investing at the foreign risk-free rate ($y^k_{t,t+n}$), and converting the foreign currency back to USD by buying a forward ($f^k_{t,t+n}$)

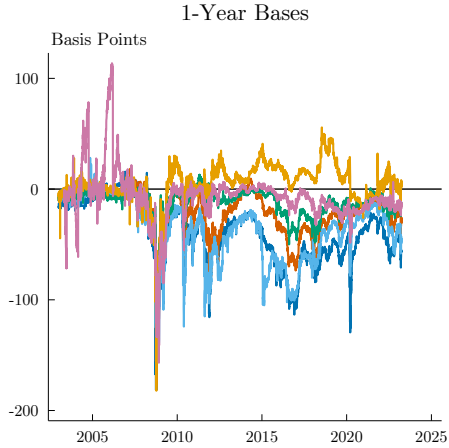
$$\text{Basis}^k_{t,t+n} = \underbrace{y^{\$}_{t,t+n}}_{(1)} - \underbrace{\left(y^k_{t,t+n} - \frac{1}{n}(f^k_{t,t+n} - s^k_t)\right)}_{(2)}$$

CIP Condition: $\text{Basis}^k_{t,t+n} = 0$

Empirically: $Basis^k_{t,t+n} \approx -30bps \Rightarrow$ synthetic dollar funding is expensive

Covered-Interest Parity Violations





Heterogeneity in CIP Bases

1-Year Covered-Interest Parity Violations

Summary Statistics, bps	All	AUD	CAD	CHF	EUR	GBP	JPY
2008–2023							
Mean	−24.1	6.2	−12.8	−46.6	−26.8	−14.7	−49.9
Std. Dev.	28.4	21.9	16.9	24.3	20.3	14.8	23.3
2016–2023							
Mean	−26.3	9.6	−14.3	−45.6	−30.9	−19.4	−57.5
Std. Dev.	27.0	14.8	6.6	22.9	15.1	9.9	20.5

- 15 bps to lend dollars in the UK, versus 50 bps for Japan!

Our Findings

Three main findings, which we interpret through a toy model:

1. Counter to textbook, banks do not hedge CIP trades with maturity-matched safe assets
   - CIP arbitrage is risky
   - XS-variation in basis associated with XS-variation in synthetic dollar demand
   - Safe Asset Scarcity: safe assets either too hard to find or yields are too low

Our Findings

Three main findings, which we interpret through a toy model:

1. Counter to textbook, banks do not hedge CIP trades with maturity-matched safe assets
   - CIP arbitrage is risky
   - XS-variation in basis associated with XS-variation in synthetic dollar demand
   - Safe Asset Scarcity: safe assets either too hard to find or yields are too low

2. Intermediary segmentation — banks specialize in different markets
   - Evidence that banks focus on markets where they can best manage risk
   - Degree of segmentation and specializing banks' constraints influence prices

Our Findings

Three main findings, which we interpret through a toy model:

1. Counter to textbook, banks do not hedge CIP trades with maturity-matched safe assets
   - CIP arbitrage is risky
   - XS-variation in basis associated with XS-variation in synthetic dollar demand
   - Safe Asset Scarcity: safe assets either too hard to find or yields are too low

2. Intermediary segmentation — banks specialize in different markets
   - Evidence that banks focus on markets where they can best manage risk
   - Degree of segmentation and specializing banks' constraints influence prices

3. Demand concentration — banks face concentrated counterparty risk

Our Findings

Three main findings, which we interpret through a toy model:

1. Counter to textbook, banks do not hedge CIP trades with maturity-matched safe assets
   - CIP arbitrage is risky
   - XS-variation in basis associated with XS-variation in synthetic dollar demand
   - Safe Asset Scarcity: safe assets either too hard to find or yields are too low

2. Intermediary segmentation — banks specialize in different markets
   - Evidence that banks focus on markets where they can best manage risk
   - Degree of segmentation and specializing banks' constraints influence prices

3. Demand concentration — banks face concentrated counterparty risk

Findings highlight risk in ostensibly riskless arbitrage and importance of segmentation

Data

Results

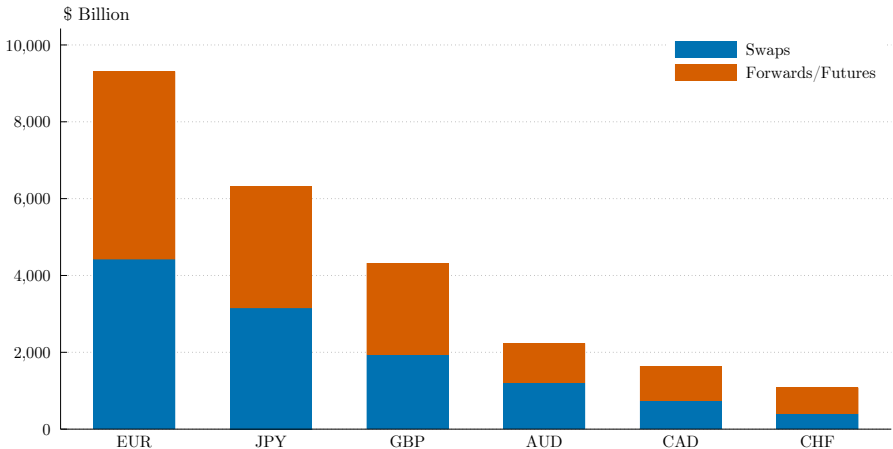
Intermediary Supply Segmentation

Conclusion

Data

1. Federal Reserve 2052a *Complex Institution Liquidity Monitoring Report*
   - Covers balance sheet quantities for large U.S. and foreign banks ($>$ \$700b assets or \$10t AUM)
   - FX sample from January 2016 to March 2023
   - Currencies: AUD, CAD, CHF, EUR, GBP, JPY, USD
   - Covers \$25 trillion gross notional daily, mostly over the counter
     - BIS: total OTC FX $\approx$ \$110 trillion
   - Data on counterparties grouped into buckets
2. CIP Deviations: OIS-based CIP deviations, using data from Bloomberg following Du et al. (2018)

Foreign Exchange Notional Exposure



Data

Results

Intermediary Supply Segmentation

Conclusion

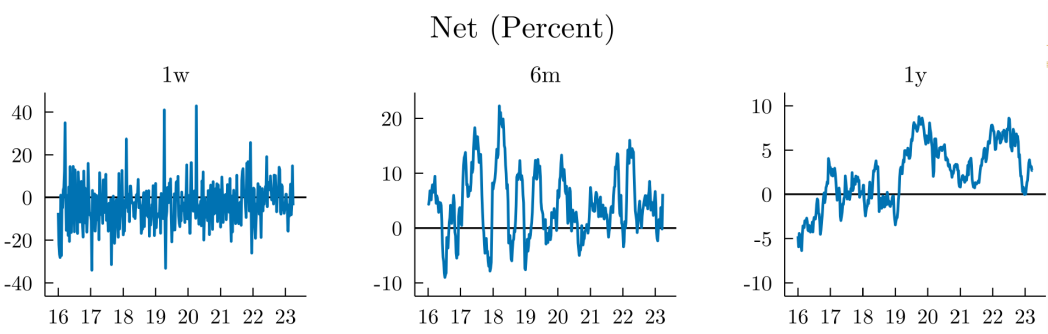
Measuring Banks' Dollar Lending

- Define a market as a tenor $\times$ currency
- Calculate banks' net USD lent from date t to $t+n$ for a given currency pair k via FX swaps:

$$Net^k_{t,t+n} = \frac{(\text{USD in at } t+n) - (\text{USD out at } t+n)}{(\text{USD in at } t+n) + (\text{USD out at } t+n)}$$

- $Net^k_{t,t+n} > 0$: banks are net lending USD (and investing in a foreign safe asset)
- **Magnitude**: banks provide ≈$100bn of dollar funding on the average day

Details


Net (Percent)
1w
6m
1y
40
20
0
-20
-40
20
10
0
-10
10
5
0
-5
-10
16 17 18 19 20 21 22 23

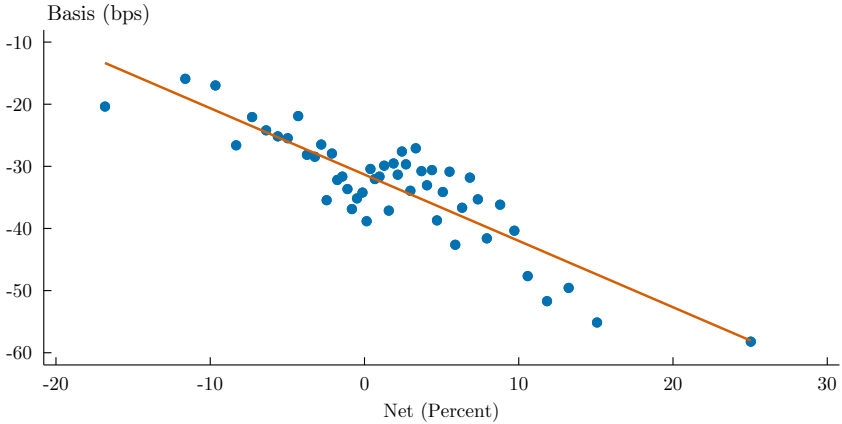
Net Dollar Lending and Bases

- **Finding 1:** Bases are *decreasing* in banks' net dollar lending

$$\text{Basis}^k_{t,t+n} = \alpha + \beta Net^k_{t,t+n} + \gamma' X_t + \epsilon^k_{t,t+n}$$

- $\beta < 0$: synthetic dollar funding is more expensive where banks lend more USD
  - Recall, $\text{Basis}^k_{t,t+n} < 0$ indicates synthetic dollar funding is expensive
- *Interpretation: Banks' risk increases with the provision of synthetic dollar funding, and they face increasing marginal costs*

Net Dollar Lending versus Bases



Quantitatively: 1 SD increase in $Net^k_{t,t+n}$ corresponds to 4 bps change in the basis (vs. mean basis $\approx$ 25-30 bps)

Interpretation of Finding 1: Relationship between net dollar lending and bases due to foreign safe asset scarcity

Interpretation of Finding 1: Relationship between net dollar lending and bases due to foreign safe asset scarcity

- *Banks substitute into maturity-mismatched and risky assets in cash leg*

Interpretation of Finding 1: Relationship between net dollar lending and bases due to foreign safe asset scarcity

- *Banks substitute into maturity-mismatched and risky assets in cash leg*

$$\text{Safe Asset Ratio}^{k}_{t,t+n} = \frac{\text{Safe Assets}^{k}_{t,t+n}}{Net^{k}_{t,t+n}}$$

Interpretation of Finding 1: Relationship between net dollar lending and bases due to foreign safe asset scarcity

- *Banks substitute into maturity-mismatched and risky assets in cash leg*

$$\text{Safe Asset Ratio}^{k}_{t,t+n} = \frac{\text{Safe Assets}^{k}_{t,t+n}}{Net^{k}_{t,t+n}}$$

- Banks hold approximately \$0.05 of maturity-matched foreign safe assets per net dollar lent
  - \$0.48 when overlooking counterparty risk and *small* maturity mismatches
- Other \$0.52: maturity-mismatched foreign safe assets and foreign risky assets

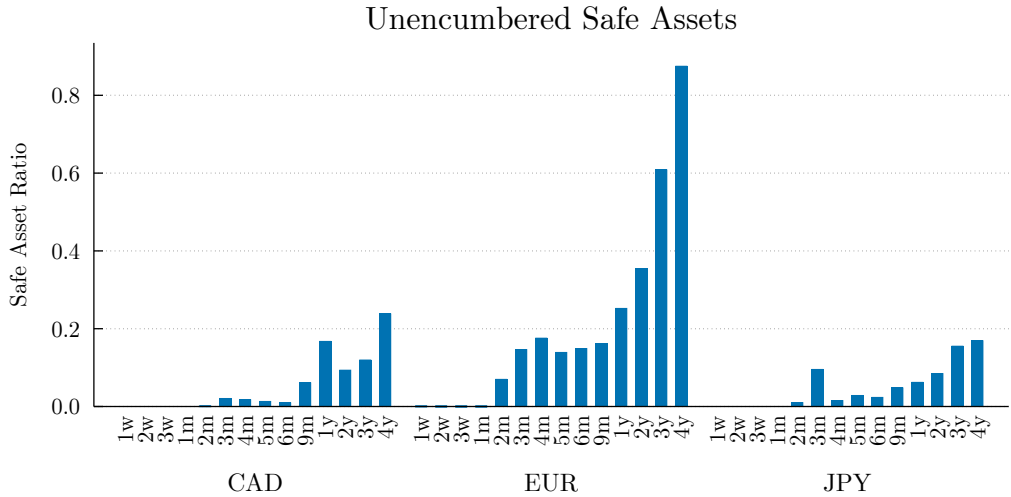
Interpretation of Finding 1: Relationship between net dollar lending and bases due to foreign safe asset scarcity

- *Banks substitute into maturity-mismatched and risky assets in cash leg*

$$\text{Safe Asset Ratio}^{k}_{t,t+n} = \frac{\text{Safe Assets}^{k}_{t,t+n}}{Net^{k}_{t,t+n}}$$

- Banks hold approximately \$0.05 of maturity-matched foreign safe assets per net dollar lent
  - \$0.48 when overlooking counterparty risk and *small* maturity mismatches
- Other \$0.52: maturity-mismatched foreign safe assets and foreign risky assets
- Safe Asset Ratios have substantial across-market heterogeneity
  - **Corollary**: XS differences in Safe Asset Ratios explains XS-variation in bases

Safe Asset Ratios



Banks aren't using "enough" safe assets in their basis trades

Banks' safe asset holdings and convenience yields

	Safe Asset Ratio			Risky Asset Ratio		
	(1)	(2)	(3)	(4)	(5)	(6)
$CY^k_{t,t+n}$	-0.490^{**}	-0.568^{**}	-0.319	0.120^{***}	0.143^{***}	0.134^{***}
	(-2.64)	(-2.63)	(-1.50)	(3.07)	(3.29)	(3.20)
Risky Asset Ratio$^k_{t,t+n}$	4.072^{***}	4.067^{***}	3.047^{***}			
	(4.25)	(4.31)	(2.84)			
Safe Asset Ratio$^k_{t,t+n}$				0.196^{***}	0.198^{***}	0.219^{***}
				(16.92)	(15.69)	(6.95)
N	321	321	321	321	321	321
R^2	0.80	0.81	0.67	0.80	0.81	0.68
Tenor FE	No	Yes	Yes	No	Yes	Yes
Time FE	No	Yes	Yes	No	Yes	Yes
Weighted	No	No	Yes	No	No	Yes

- Banks hold fewer safe assets when safe asset yields are low

Supply Segmentation

Finding 2: Size of the basis is increasing in *Intermediary Segmentation*

- Define supply segmentation using

$$\text{Supply HHI}^{k}_{t,t+n} = \sum_{i \in \text{Bank}} (\text{Market Share}^{k,i}_{t,t+n})^2$$

- *Impeded risk-sharing and market power may both play a role*

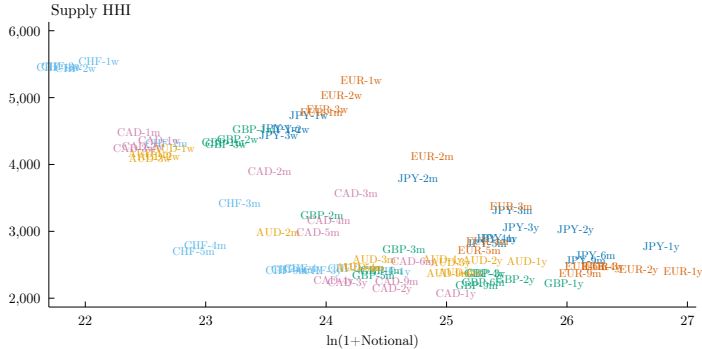
Supply Segmentation

Finding 2: Size of the basis is increasing in *Intermediary Segmentation*

- Define supply segmentation using

$$\text{Supply HHI}^{k}_{t,t+n} = \sum_{i \in \text{Bank}} (\text{Market Share}^{k,i}_{t,t+n})^2$$

- *Impeded risk-sharing and market power may both play a role*



Demand Concentration

Finding 3: Size of the basis is increasing in *Demand Concentration*

- Measure demand concentration using FX swap counterparties

$$\text{Demand HHI}^{k}_{t,t+n} = \sum_{j \in \text{Counterparty Type}} (\text{Market Share}^{k,j}_{t,t+n})^2$$

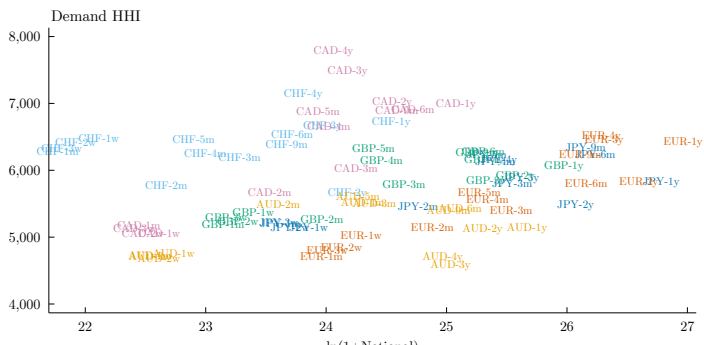
- *Compensation for counterparty risk*

Finding 3: Size of the basis is increasing in *Demand Concentration*

- Measure demand concentration using FX swap counterparties

$$\text{Demand HHI}^{k}_{t,t+n} = \sum_{j \in \text{Counterparty Type}} (\text{Market Share}^{k,j}_{t,t+n})^2$$

- *Compensation for counterparty risk*



Decomposing Deviations from Covered-Interest Parity

We run the following regression, scaling independent variables to modified z-scores using their median and standard deviation:

$$
\begin{aligned}
|\text{Basis}^k_{t,t+n}| = \alpha &+ \beta_1 \left(\text{Safe Asset Ratio}^k_{t,t+n} \times \mathbb{I}(Net^k_{t,t+n} \geq 0)\right) \\
&+ \beta_2 \left(\text{Safe Asset Ratio}^k_{t,t+n} \times \mathbb{I}(Net^k_{t,t+n} < 0)\right) \\
&+ \beta_3 \left(\text{Supply HHI}^k_{t,t+n} \times \mathbb{I}(Net^k_{t,t+n} \geq 0)\right) \\
&+ \beta_4 \left(\text{Supply HHI}^k_{t,t+n} \times \mathbb{I}(Net^k_{t,t+n} < 0)\right) \\
&+ \beta_5 \left(\text{Demand HHI}^k_{t,t+n} \times \mathbb{I}(Net^k_{t,t+n} \geq 0)\right) \\
&+ \beta_6 \left(\text{Demand HHI}^k_{t,t+n} \times \mathbb{I}(Net^k_{t,t+n} < 0)\right)
\end{aligned}
$$

Decomposing Deviations from Covered-Interest Parity

Dependent Variable: $\lvert\text{Basis}^k_{t,t+n}\rvert$	(1)	(2)
Safe Asset Scarcity		
Safe Asset Ratio$^k_{t,t+n} \times \mathbb{I}(Net^k_{t,t+n} \geq 0)$	-7.77^{*}	-9.34^{*}
	(-1.94)	(-1.97)
Safe Asset Ratio$^k_{t,t+n} \times \mathbb{I}(Net^k_{t,t+n} < 0)$	-0.50	-0.36
	(-1.39)	(-1.15)
Supply Segmentation		
Supply HHI$^k_{t,t+n} \times \mathbb{I}(Net^k_{t,t+n} \geq 0)$	10.81^{***}	10.12^{***}
	(6.00)	(6.05)
Supply HHI$^k_{t,t+n} \times \mathbb{I}(Net^k_{t,t+n} < 0)$	13.75^{***}	11.65^{***}
	(6.63)	(6.23)
Demand Concentration		
$\widehat{\text{Demand HHI}}^k_{t,t+n} \times \mathbb{I}(Net^k_{t,t+n} \geq 0)$		7.42^{***}
		(3.37)
$\widehat{\text{Demand HHI}}^k_{t,t+n} \times \mathbb{I}(Net^k_{t,t+n} < 0)$		1.27
		(0.82)

Data

Results

Intermediary Supply Segmentation

Conclusion

Intermediary Supply Segmentation

- Dig deeper with two additional sets of analyses

1. Intermediary segmentation driven by expertise in managing risk in a market
   - Market shares are persistent
   - Intermediaries specialize in counterparty segments (e.g., Asian Sovereign Wealth Funds or Canadian Insurance companies)
   - Intermediaries hold large loan portfolios in the markets they specialize in

2. **Finding 4:** Bases reflect specializing banks' risk-bearing capacity
   - Evidence from SVB Bank Run

Intermediary Supply Segmentation: Evidence from SVB

Finding 4: specializing banks' risk-bearing capacity matter for currency k's basis

Shock to constraints — SVB bank run on March 9, 2023

- Reallocation of deposits: +$120 billion to large banks ($\approx 1.1\%$ of deposits), Net^k_{t+n} changes by about 0.6%

Finding 4: specializing banks' risk-bearing capacity matter for currency k's basis

Shock to constraints — SVB bank run on March 9, 2023

- Reallocation of deposits: +$120 billion to large banks ($\approx 1.1\%$ of deposits), Net^k_{t+n} changes by about 0.6%
- We exploit the differential impact based on deposit inflows
- We calculate a market's value-weighted change in deposits to capture how much market k's specializing banks are affected by the shock

$$\Delta Deposits^k_{t+n} = \sum_{i \in \text{bank}} w^{i,k}_{t+n} \Delta Deposits^i$$

Intermediary Supply Segmentation: Evidence from SVB

$$|\text{Basis}^k_{t,t+n}| = \alpha + \gamma_1 \mathbb{I}(Post) + \gamma_2 \Delta Deposits^k_{t+n} + \gamma_3 \Delta Deposits^k_{t+n} \times \mathbb{I}(Post) + \epsilon^k_{t,n}$$

Intermediary Supply Segmentation: Evidence from SVB

$$|\text{Basis}^k_{t,t+n}| = \alpha + \gamma_1 \mathbb{I}(Post) + \gamma_2 \Delta Deposits^k_{t+n} + \gamma_3 \Delta Deposits^k_{t+n} \times \mathbb{I}(Post) + \epsilon^k_{t,n}$$

	Dependent Var.: $\lvert Basis^k_{t,t+n}\rvert$			Dependent Var.: $Net^k_{t,t+n}$		
	(1)	(2)	(3)	(4)	(5)	(6)
$\mathbb{I}$(Post)	14.59***	14.96***	14.52***	-1.78***	-1.89***	-1.90***
	(7.82)	(7.94)	(7.47)	(-3.93)	(-3.30)	(-3.13)
$\Delta Deposits^k_{t+n}$	16.38***	23.70***	21.11***	-0.26	1.65	1.63
	(6.10)	(6.96)	(5.21)	(-0.29)	(1.51)	(1.34)
$\mathbb{I}(\text{Post}) \times \Delta Deposits^k_{t+n}$	-2.11***	-2.37**	-1.95*	0.53**	0.60*	0.60
	(-3.21)	(-2.23)	(-1.98)	(2.52)	(1.73)	(1.61)
Supply $\text{HHI}^k_{t,t+n}$			11.60			0.10
			(1.54)			(0.05)
Constant	10.07***	3.56	7.68*	5.66***	4.01***	4.04**
	(4.72)	(1.06)	(1.79)	(4.63)	(3.10)	(2.57)
N	959	959	959	959	959	959
R^2	0.51	0.54	0.55	0.01	0.04	0.04
Tenor FE	No	Yes	Yes	No	Yes	Yes
Weighted	Yes	Yes	Yes	Yes	Yes	Yes

Interpretation: 1 SD change in deposits → 10% change in magnitude of basis

Data

Results

Intermediary Supply Segmentation

Conclusion

Conclusion

- Several frictions important for understanding bank-intermediated arbitrage trades:
  1. Riskiness of arbitrage: in CIP, stems from foreign safe asset scarcity
  2. Segmentation: intermediaries specialize in markets, leads to inelasticity
  3. Counterparty risk: a less diverse mix of counterparties leads to larger bases
- Our work highlights importance of segmentation and risk, even in ostensibly riskless arbitrage

Conclusion

- Several frictions important for understanding bank-intermediated arbitrage trades:
  1. Riskiness of arbitrage: in CIP, stems from foreign safe asset scarcity
  2. Segmentation: intermediaries specialize in markets, leads to inelasticity
  3. Counterparty risk: a less diverse mix of counterparties leads to larger bases
- Our work highlights importance of segmentation and risk, even in ostensibly riskless arbitrage

Thank you!