The Widening of Cross-Currency Basis: When Increased FX Swap Demand Meets Limits of Arbitrage*

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1 Introduction

forward part of the transaction.[1]

To conceptualize the effect the demand side has on CIP deviations and to discipline our subsequent empirical analysis, we develop a simple and tractable partial equilibrium model with testable implications for both prices and quantities. A theoretically appealing explanation for CIP violations that may be related to the notable demand by local IIs is that periods of significant limspeak to and where much less is known in the literature. The results show that in the no LOA (lin-

Salience of Global FX Swap Market.

steepness of the latter supply curve being shaped by the level of the arbitrageur's arbitrage capital. In particular, the lower this arbitrage capital is (i.e., the greater LOA), the steeper the arbitrageur's FX swap supply curve. Hence, the ability of the rightward shift in the FX swap demand curve to produce a negative cross-currency basis is increasing in LOA severity.

The second part of the paper tests the model's prediction, i.e., that an increase in local IIs' demand for FX swaps leads to greater widening of the basis when LOA is greater. This prediction is the essence of the LOA-dependent FX swap demand channel.

Econometric Model. The second part of the paper (whose results have already been summarized above) studies the LOA-dependent effect of increased IIs' FX swap demand on their USD / ILS cross-currency basis, where we construct the latter as the volume-weighted average of IIs' transaction-level bases. Our identification strategy relies on a GIV estimation procedure which we present in Section 5.2.1.

The impact LOA-dependent response of cross-currency basis is this paper's main object of

2 Related Literature

To the best of our knowledge, this paper constitutes the first empirical investigation of the LOA-dependent FX swap demand channel that uses daily transaction-level FX swap flow and price data along with a daily measure of LOA to quantify this channel. The granular dimension and daily frequency of our data allow us to quite cleanly identify this channel.

The persistent violations of CIP since the GFC have attracted significant research in recent years on the potential drivers of these violations,[4] focusing on the separate as well as joint role of FX swap supply and demand factors as potential drivers of these violations. Our work is motivated by this research and is a part of the burgeoning literature associated with it.

FX Swap Supply. Du et al. (2018) and Avdjiev et al. (2019) use aggregate data to provide evidence that regulatory balance sheet constraints are an important driver behind CIP violations through their adverse effects on global banks' capacity to supply FX forward and swap contracts. Puriya and Br¨

widening effect on USD/JPY cross-currency basis. And Obstfeld and Zhou (2022) and Cerutti and Zhou (2023) find evidence which stresses the role of global risk appetite and funding stress in driving CIP deviations in emerging markets and developing economies.

FX Swap Demand. Liao (2020) use micro data to show that CIP deviations are mainly driven

Viswanath-Natraj (2022

Understanding the drivers of CIP deviations is tantamount to understanding the workings of the FX swap market (see Du and Schreger (2022) and references therein). Accordingly, the structural framework we use is a partial equilibrium of the FX swap market consisting of two time periods and two agents. The first agent is a risk-neutral arbitrageur who supplies FX swaps. The second is a risk-averse local institutional investor (II) who demands FX swaps to obtain FX-risk-free foreign currency funding. This foreign currency funding is used by the local II to increase its (hedged) exposure to foreign assets.

model we will control for the effect of LOA on the quantity of FX swap supply and will be able

fund families, 13 of which are consistently net buyers of swap-linked spot dollars with the sole net

are taken from Bloomberg and their values are end-of-day quotes.

LOA Measure. Building on the intrinsic link between intermediaries' funding capacity and LOA (Shleifer and Vishny (1997)) (also see discussion from Footnote 6), we measure LOA with

USD/EUR Cross-Currency Bases.

(8 of 10) of the exogenous macro-financial controls we use in our regression analysis.) To drive this point home, note that adding the current and lagged values of these controls (both linearly and interacted with one-day lagged LOA) to our most basic regression of the II basis on a constant,

and have steadily raised this share to over 29% at the end of our sample.

IIs' FX Swap and Spot Trading.

2022, the total accumulated value of these swaps reached 80.1 billion dollars, in stark contrast to the 49.9 billion dollars accumulated in spot transactions.[16]

Sectoral Comparison of FX Swap Flows. Figure 3 shows the evolution of accumulated daily the difference between the dollar Libor rate and CIP-implied rate, facing IIs over our sample. The availability of both spot and forward rates in our transaction-level dataset allows us to construct this IIs-specific basis as the daily volume-weighted average of the associated transaction-level bases. Figure 4

GFC dynamics).

5 Methodology

This section elucidates the methodology used in the empirical analysis undertaken in this paper, presenting the general lines of the estimation. Further technical details of our estimation approach are shown in Appendix B of the online appendix to this paper.

5.1 Aggregate and Granular-Without-Controls Estimations

The difference between the effects in the LOA and no LOA states is thus meant to capture the differential effect of swap flows on the basis across the rigid and elastic FX swap supply states.

Aggregate-With-Controls Estimation. We also consider an extension of Equation (1) where controls for frictions in the global FX swap market; first-differences of the LOA variable (logged leverage ratio of global financial intermediaries trading in the USD / ILS FX swap market), whose inclusion controls for shocks to LOA; and log-first-difference of the FTSE US Government Bond Index, whose inclusion controls for global flight-to-quality shocks.

The idea behind the inclusion of rich control vector X is to purge the estimated LOA-dependent effects of variation that is unrelated to that sought after in this paper, i.e., that coming from local idiosyncratic demand shocks. Nevertheless, one can still argue that this purging still leaves a potentially meaningful component of unobserved common demand and supply shocks. Hence, a natural second attempt to address potential bias concerns is to turn to granular-based estimation

5.2 Granular-With-Controls Estimation

So far, we have presented three plain vanilla estimations where the first (aggregate without controls) was the most basic one and the second (aggregate with controls) and third (granular without controls) can be viewed as our first and second endeavors, respectively, to address potential bias concerns. This section presents an extended granular-based estimation approach which is

Second, this unobserved demand shock jointly drives the corresponding II's swap flows along with various theory-consistent, observed driving variables. Third, this DGP is nonlinear in a state-dependent sense: all RHS variables, both observed ones and unobserved demand shock $e_{i,t}$, are driving $DSP_{i,t}$ both linearly and nonlinearly through their interaction with one-day lagged LOA. Fourth, all of the coefficients in each II's DGP vary with i. This heterogenous coefficient setting implies that IIs' swap flows are allowed to respond differentially to the variables that drive them, model:

$$\hat{v}_{i,t} = e_{i,t} + z_i LOA_{t \quad 1}$$

from exogenous variation in IIs' idiosyncratic demand shocks and are theretofore more reliable estimates of the LOA-dependent channel of FX swap demand.

Estimation of LOA-Dependent Effects of GIV Shock. Following Gabaix and Koijen (

ation from large IIs' idiosyncratic demand shocks to properly identify the LOA-dependent channel of FX swap demand with this variation not being susceptible to a bias from any remaining unobserved common shocks. Our $\hat{e}_{i,t}$

timating a local projection regression counterpart to Equation (8) with Equations (4), (5), and (6) in a way that accounts for estimation uncertainty surrounding all of these equations. As such, in addition to informing us about the persistence of the demand channel studied in this paper, this extension also serves to alleviate the concern that our impact-based results are sensitive to abstracting from estimation uncertainty surrounding the extraction of the GIV shock. We use a Bayesian estimation and inference procedure as it provides a convenient numerical way to produce confidence intervals that account for estimation uncertainty in each of the four equations underlying our GIV estimation procedure (Equations (4)-(6) and 8)).[26]

from the GIV- and Bartik-without-controls estimations. Second, we present results for IIs' basis and swap flows from our extended, granular-with-controls estimation approach which includes results from the GIV- and Bartik-with-controls estimations. Third, considering Section 5.2.1's mes-

larger rise in swap flows in the no LOA state given the more elastic FX swap supply curve in this state relative to the LOA state. This expectation is borne out by the data with swap flows rising by 2 and 2.3 times as much in the no LOA state than in the LOA state for the GIV (687.3 million

In the no LOA state, local banks are effectively the sole suppliers of swap-linked spot dollars against IIs' increased demand, selling the significant amount of 615.9 million dollars against IIs' buying of 687.3 million dollars. Foreigners supply a much smaller and statistically insignificant amount of 38.7 million dollars. Taken together, Table 9 shows that local banks act as the sole sup-

6.5 Seasonal Demand Shifter

To address potential concerns regarding our identification strategy and enhance the robustness of our conclusions, in this section we have employed an additional identification approach that complements our previous analysis. In Section 5.2 and associated Footnote 20, we discussed the middle- and end-of-month dummy variable - taking as one on the 14th, 15th, and 29th-31st dates

Seasonal-Without-Controls Estimation.

Equation (9) with our baseline controls vector X_t which now of course only excludes the seasonal demand shifter. This extension is given by

$$\mathrm{D}b_t = a + \mathrm{X}_L \mathrm{S}_t + \mathrm{X}_I LOA_{t \quad 1}$$

actual basis incurred by individual IIs, as is our LOA measure which we construct as the leverage

Borio, C., McCauley, R. N., McGuire, P. and Sushko, V.: 2016, Covered interest parity lost: under-

Miranda-Agrippino, S. and Ricco, G.: 2021, The transmission of monetary policy shocks, *American Economic Journal: Macroeconomics* **13**(3), 74–107.

Newey, W. K. and West, K. D.: 1987, A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix, *Econometrica* **55**(3), 703–708.

Table 1: **FX Swap Market Transactions' Maturity Distribution by Sector.**

Table 2: **Sectoral FX Swap Prices and Quantities.**

	Sectoral Aggregate Basis (in Basis Points)

Table 3: **Correlation Matrix of Sectoral Bases.**

Percentile	IIs	Local Banks	Foreigners	MFs	HFs	Real

Table 4: **Correlation Matrix of Select Variables.**

Variable	DS&P 500	DTA35	DBroad Dollar	DVTA	DVIX	DII Basis	D1 Month USD / EUR Basis	DInterest Rate Spread
DLOAD	-78.1%	-47.2%	36.4%	25.6%	50.4%	-3.7%	-15.9%	0.3%

Table 5: **R^2s for II-level Regressions.**

Regression	1	2	3	4	5	6	7	8	9	10	11	12	13
Size	20.9%	19.2%	12.1%	12.0%	11.0%	10.8%	7.7%	1.7%	1.4%	1.2%	0.9%	0.8%	0.2%
R^2	32.4%	14.4%	30.7%	24.5%	7.6%	31.8%	27.5%	13.1%	19.2%	36.7%	44.8%	26.9%	28.0%

Notes: This table shows the R^2s for the 13 regressions from Equation (4) sorted (in de-

Table 8: **Granular-With-Controls Estimation Results: LOA-Dependent Effects.**

	IIs' Aggregate Basis (in Basis Points)	
Response	GIV-With-Controls	Bartik-With-Controls
sul Td 3 0 Td :-250(7831(-12.0***)-989)377.6***sul insul No3 0 TdTd 3 0 Td :-250(7204(2.3-11648(		

Table 9: **GIV-With-Controls Estimation Results: Sectoral Swap Flows: LOA-Dependent Effects.**

Response	IIs	Local Banks	Foreigners	MFs	HFs	Real
LOA State	339.3***	-93.3	-180.7**	-8.4	-67.4**	21.9
	(49.9)	(92.4)	(85.6)	(7.8)	(32.5)	(16.6)

Table 10: **GIV-With-Controls Estimation Results: Robustness Checks: LOA-Dependent Effects.**

	IIs' Aggregate Basis (in Basis Points)				
Response	Alternative LOA	Post-GFC	Pre-COVID	Shorter Lags	Longer Lags
LOA State	-10.0***	-9.3***	-8.6***	-10.7**	-11.8***
	(3.3)	(3.0)	(3.0)	(4.8)	(4.4)
No LOA State	0.8	2.2*	0.4	1.8	1.9
	(1.1)	(1.3)	(1.6)	(1.6)	(1.5)
Difference	-10.8***	-11.4***	-9.0**	-12.5**	-13.7**
	(3.9)	(4.0)	(4.3)	(6.2)	(5.7)
R^2					

Table 11:

10/16/12	3.2	690.5	20.9%	200 million ILS cash injection from parent company's selling of subsidiary U.S.-based insurance

01/20/22	1.5	57.1	7.7%	Entering a partnership with a 2 billion ILS worth oil and natural gas exploration and production company for foreign investment in renewable energy projects.	Foreign investment funding from swaps.
09/22/21	0.9	163.1	7.7%	600 million ILS proceeds from selling of local residential real estate assets.	Additional ILS cash collateral for foreign-investment-funding swaps.

Figure 1: **Diagrammatic Depiction of LOA-Dependent FX Swap Demand Channel**.

FX Swap Market: No LOA State.

Q_t

Figure 2:

Figure 3: **Time Series of Accumulated FX Swap Flows by Sector.**

Notes: This figure presents the time series of accumulated daily FX swap flows by sector. Since FX swap flows are changes in the corresponding sector's open FX swap position, their shown accumulated series can be viewed as the corresponding sector's open FX

Figure 4:

Figure 5: **Time Series of Intermediaries' Aggregate Leverage Ratio.**

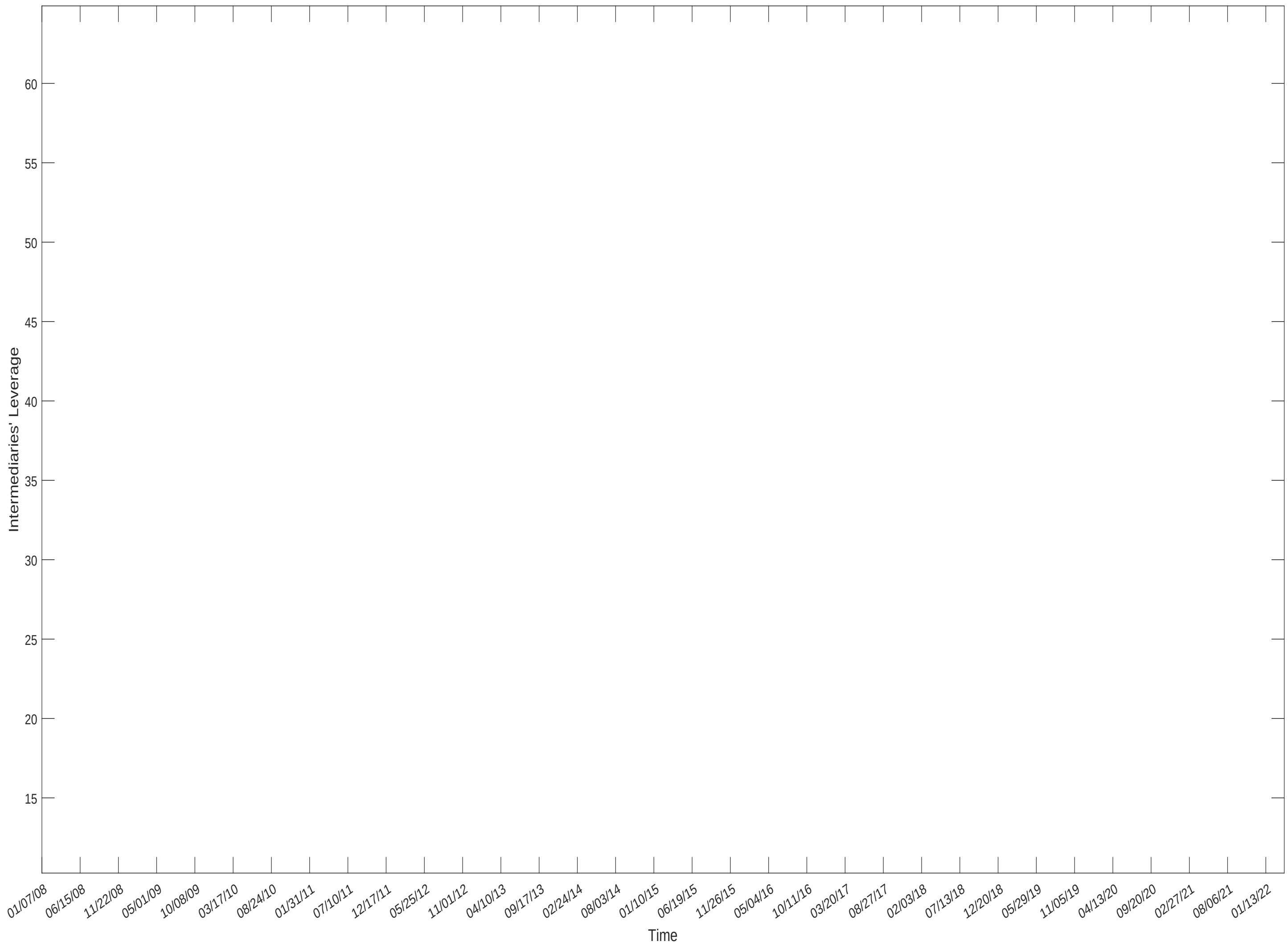
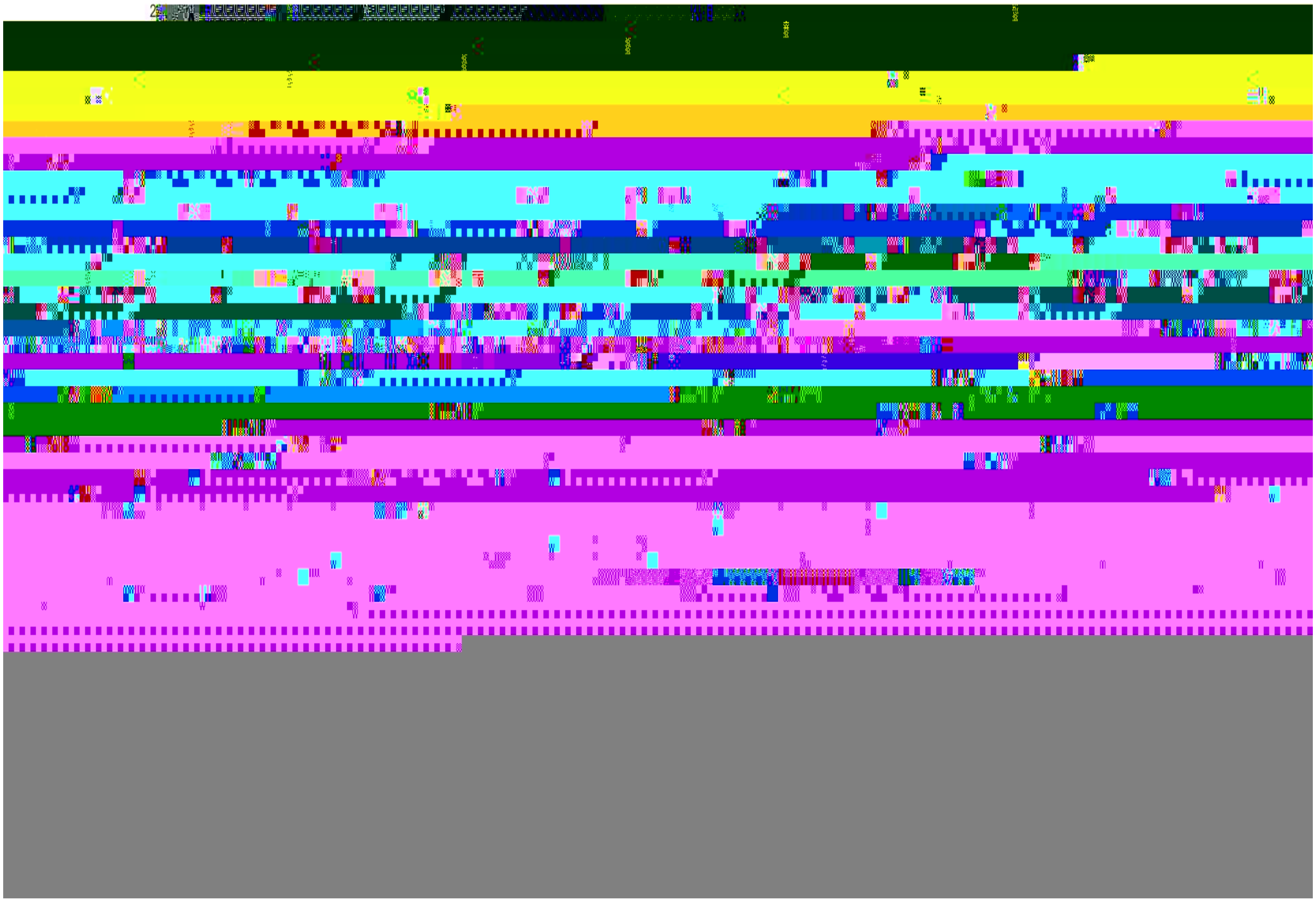


Figure 6: **IIs' FX Swap Flows Across Dates.**



Notes