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

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Abstract

This paper examines customer demand-side factors that affect deviation from covered interest rate parity (CIP) with respect to the dollar (i.e., cross-currency basis), particularly when arbitrageurs are constrained. Using novel detailed daily transaction-level data on the universe of Israeli institutional investors (IIs), we employ a granular instrumental variable (GIV) estimation to investigate how IIs' FX swap demand affects CIP deviation. Our findings demonstrate that a one standard deviation shock to IIs' FX swap demand when capital is abundant has no effect on IIs' basis. However, when capital is scarce, the demand shock produces a significant reduction of 12 basis points in IIs' basis. Our results showcase how limits of arbitrage, together with demand shocks from a large customer base, can drive CIP deviations.

JEL classification: E44,F3,G15,G23

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1 Introduction

The covered interest parity (CIP) condition is a cardinal no-arbitrage principle in international finance, asserting that the interest rate implied by the foreign exchange (FX) swap market equates to the interest rate in the cash market. CIP has held fairly well prior to the 2008-2009 global financial crisis (GFC), even for daily data, but has broken down since the onset of the GFC with the cash market dollar interest rate having been lower than the FX-swap-market-implied dollar interest rate for most currencies (Du et al. (2018), Avdjiev et al. (2019), Cerutti et al. (2021), and Du and Schreger (2022)). Said differently, the literature has concluded that pre-GFC, the supply of FX swaps was perfectly elastic with the price being determined by the CIP condition, whereas now, post-GFC, it is no longer the case (Du and Schreger (2022)).

Much of the existing literature on CIP deviations has focused on the supply side of the FX market. Specifically, how Basel III regulations, implemented after the GFC, increased the costs for financial intermediaries such as banks to arbitrage these deviations away. However, the influence of demand-side factors on these deviations, as well as their interaction with supply-side elements, remains less understood. Our paper aims to fill this gap. To do so, we study the influence of one of the largest demand-side customers, institutional investors (IIs), on deviations from CIP.

In recent years, IIs have increased their share of investments abroad dramatically. Because their assets are subjected to currency risk, they hedge part of it with FX derivatives (Ben Zeev and Nathan (2022) and Du and Huber (2023)). One of their favored derivatives to hedge their FX exposure, which is the focus of our paper, is FX swaps. An FX swap consists of two parts or 'legs'. In the first leg the II receives dollars from an intermediary in exchange for local currency. Simultaneously, the II buys it back from the same intermediary in the forward market at the price of the prevailing forward rate, also known as the second leg of the swap. It is helpful to think of an FX swap as a collateralized dollar loan and a way for the II to receive dollar funding. Importantly, the FX swap hedges the II's exposure to fluctuations in the dollar exchange rate because of the 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 limits of arbitrage (LOA) accompanied by rightward shifts in the demand for FX swaps of local IIs who wish to increase their exposure to foreign assets (without taking on FX risk) can lead to the type of persistent breakdown of CIP observed in the data since the GFC. This LOA-dependent FX swap demand channel builds on the idea that greater LOA imply a steepening of the FX swap supply curve, leading to a more significant widening of cross-currency basis in the presence of a rightward shift in the FX swap demand curve and less FX swap supplied quantities compared to the state when there are no LOA.

To achieve our research objectives, we utilize a unique dataset from the Bank of Israel (BOI) that provides detailed information on the universe of FX swap daily transactions of a panel of IIs over a 14-year period. The panel data enables us to use a granular instrumental variable (GIV) estimation approach, creating an IIs' aggregate demand shock as the difference between the size-weighted- and inverse-variance-weighted-average of idiosyncratic IIs' shocks that are orthogonal to various supply- and demand-related FX swap market factors.

Summary of Main Results. Our results show that a one standard deviation shock to IIs' aggregate FX swap demand in the LOA state, i.e., when arbitrage capital is scarce, leads to a significant reduction of 12 basis points in IIs' cross-currency basis. By contrast, in the no LOA state (i.e., when arbitrage capital is abundant), the aggregate FX swap demand shock produces an economically and statistically insignificant change in IIs' aggregate basis.

While these results agree with our model's predictions, the model also has testable implications for the initial reaction of equilibrium *quantities*, which our detailed transaction-level data can

[1] IIs can also separately buy dollars in the spot market and simultaneously buy their local currency in the forward market. However, this is generally costlier for them because of transaction costs. Note, however, that they can use the forward market to hedge *existing* FX exposure. See Ben Zeev and Nathan (2022) for a detailed discussion on these institutional details.

speak to and where much less is known in the literature. The results show that in the no LOA (linear) state, when arbitrage capital is abundant, a demand shock by IIs moves IIs' aggregate open FX swap position by significantly more than the corresponding effect in the LOA state. These findings further corroborate the predictions of our model and bear out a meaningful LOA-dependent FX swap demand channel.

The paper unfolds in two parts. The first part lays out a simple conceptual framework that builds heavily on the insightful modeling approach from Liao and Zhang (2020) and serves to fix ideas, motivate the empirical analysis, and form a suitable conceptual base for this paper. The second part of this paper conducts the empirical analysis. Before turning to discuss these two parts, we first briefly clarify some terminological issues to streamline this paper's exposition as well as provide some descriptive evidence on the salience of the global FX swap market to further motivate our paper.

Terminology. We define cross-currency basis as the difference between the cash market dollar interest rate and the FX-swap-market-implied (CIP-implied) dollar interest rate. Hence, when the former is lower (higher) than the latter, we refer to the associated basis as being negative (positive). And a 'widening' of the basis refers to its *declining*.

As previously mentioned, FX swap contracts are two-leg FX trades where the first leg is a spot transaction and the second leg is a forward transaction of an equivalent opposite amount. The most common use of FX swaps is for IIs to fund their FX balances and for CIP arbitragers to try to profit from CIP violations (Bergljot and Lian (2010)). 'FX swap demand' throughout this paper refers to demand of local IIs for the purchase of spot dollars (i.e., the first leg) and selling of forward dollars (i.e., second leg) of the same amount. And 'FX swap supply' refers to the opposite end of this trade coming from arbitrageurs. In accordance with our focus on the *dollar* basis, we measure FX swap flows for the USD/ILS currency - where USD/ILS spot and forward rates refer to the market pricing convention of ILS units per USD unit - and ignore non-dollar related swap trades. (85.9% of our local IIs' FX swap volume is done in dollars, with the remaining small 14.1% share almost entirely done in euros (11.4%) and pounds (1.8%).)

Salience of Global FX Swap Market. FX swaps have gained popularity among many market participants in the FX markets in recent years. They are the most commonly traded FX instrument in the global FX market with 3.2 trillion dollars in average daily turnover in April 2019 (the date of the most recent BIS Triennial Survey) that represents a 48.6% share of global FX turnover (Schrimpf and Sushko (2019)).[2] As already mentioned, FX swaps are a popular tool to hedge among IIs. The corresponding numbers for IIs, who use FX swaps to fund their FX investments in an FX-risk-free manner, are also significant at 776.9 billion dollars and 27.3%, respectively. This type of funding with FX swaps produces vast amounts of off-balance sheet debt, or 'missing dollar debt', with the off-balance sheet US dollar debt of non-banks outside the U.S. substantially exceeding their on-balance sheet debt and growing faster - being twice as much in June 2022 after being 1.6 times as much in 2016 (Borio et al. (2022)).

Underlying Framework. This part lays out a simple structural partial equilibrium model of the FX swap market that builds heavily on Liao and Zhang (2020). The backbone of the model is a risk-averse local II that demands FX swaps to increase its (hedged) exposure to foreign assets, maximizing its profit in a mean-variance optimization setting, and a profit-maximizing risk-neutral arbitrageur with a pre-determined level of arbitrage capital that supplies FX swaps. We use this arbitrage capital variable to represent the notion of LOA. The two concepts are intrinsically related in that LOA implies that arbitrageurs are constrained in their ability to arbitrage away price anomalies and arbitrageurs' arbitrage capital is vital to the materialization of this ability. In essence, a constrained level of arbitrage capital is conceptually tantamount to LOA.

Our setting results in the following equilibrium result. Conditional on a positive FX swap demand white noise shock - represented by an exogenous decrease in the level of local II's risk aversion with respect to FX-swap-funded foreign investment,[3] the downward-sloping demand curve of FX swaps shifts rightward along the arbitrageur's upward-sloping supply curve with the

[2]The dollar's dominance in the global FX swap market is overwhelming, being one of the traded currencies in over 90% of FX swap trades.

[3]This demand shock can be viewed as an exogenous shift in the II's geographical preference for investment. E.g., an exogenous decision by a pension fund's investment committee to allocate more funds to foreign investment, with such decision reflecting the committee's perception of foreign investment being more appealing now.

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 interest and its estimation is obtained in two stages. The first extracts a GIV shock from micro-level regressions and the second estimates this shock's LOA-dependent effect on IIs' aggregate basis and swap flows. Our estimation procedure succeeds in generating a panel of idiosyncratic demand shocks for our IIs, possessing an average absolute pairwise correlation among the 13 IIs of 2.4% and a corresponding standard deviation of 2.1%. We control for a variety of aggregate supply- and demand-side factors in the estimation of the idiosyncratic shocks so as to ensure the validity of our identification approach. The difference between the size-weighted- and equal-weighted-average of these shocks is used as the GIV (the aggregate demand shock) in our setting.

Outline. The remainder of the paper is organized as follows. The next section provides a literature review. In the subsequent section the theoretical motivation for this paper is laid out. Section 4 provides a description of the data used in this paper and institutional background for Israeli IIs' FX swap activity. Section 5 provides a description of the methodology used in this paper. Section 6 presents the empirical results. The final section concludes.

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 Bräuning (2020) use novel contract-level data for German banks' forward contracts and exploit regulation-driven quarter-end window-dressing practices - intended to avoid regulatory capital charges on FX exposure from net on-balance-sheet dollar assets - to identify significant CIP violations driven by banks' dollar forward selling. Interpreted through the lens of the FX swap market, which the authors abstract from doing, this interesting forward market mechanism can be reasonably viewed as inducing a leftward shift to banks' FX swap supply in a setting where these banks have substitutability between conducting CIP arbitrage activity and conducting regulation-driven quarter-end window-dressing activity.

Cenedese et al. (2021) use micro (dealer-level) data to show that regulatory changes concerning U.K. banks' leverage ratios have increased CIP deviations for high-leverage U.K. dealers. Anderson et al. (2021) provide evidence from micro data on global banks that the large negative wholesale funding shock from the 2016 U.S. money market mutual fund reform had a significant

[4] CIP deviations' implications, rather than drivers, are also an important avenue of research. E.g., Du et al. (2022) show that innovations to cross-currency bases - proxying for intermediaries' constraints - play a meaningful role in the determination of asset prices; and Keller (2022) uses Peruvian data to show that positive cross-currency basis leads to a decline in local banks' local currency lending as they allocate funds away from local currency lending to fund their CIP arbitrage (the converse takes place when the basis is negative).

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 by differences between corporate credit spreads in different currencies, drawing attention to a mechanism where firms facing high dollar credit spreads can choose to issue non-dollar debt with lower corporate spreads and then swap the issuance's non-dollar proceeds into dollars through an FX swap - which in turn generates demand pressure for FX (dollar) swaps.

Syrstad and Viswanath-Natraj (2022) construct a daily measure of FX swap order flow - buyer initiated minus seller initiated trades - and show that the basis effect of a one standard deviation change in this measure has increased from less than one basis point prior to 2008 to about five basis points after 2008. (They look at three currency pairs: USD/EUR, USD/CHF, and USD/JPY.) Much like Syrstad and Viswanath-Natraj (2022), we concentrate on the demand side. However, we differ from them in several important ways. First, our data provides valuable insights into the identity of the dealers' customers, namely IIs, which are increasingly influential in the global economy. This adds to the existing literature on the various ways in which IIs affect the financial system (see the last paragraph in the literature review). Second, unlike Syrstad and Viswanath-Natraj (2022), which rely on order flow data from the inter-dealer market and cannot identify customer trades directly, our dataset allows us to identify all IIs in our sample as we directly observe the customer-dealer market, thus allowing us to extract exogenous demand shocks using the GIV and Bartik instrument approaches. By contrast, Syrstad and Viswanath-Natraj (2022)'s data can not speak to the nature of the shocks they are capturing. For example, as noted by the authors, their estimated demand shocks might also reflect instances where dealers seek to increase their inventories, leading to a limited supply of swaps (due to reduced selling activity), which could be interpreted as a negative supply shock that in turn potentially explains a widening of the basis. Third, our theoretical model explores broader implications beyond the effect of demand shocks on prices. Specifically, our theoretical model has testable implications for equilibrium quantities, which can be corroborated using our detailed dataset while this is not the case for Syrstad and

Viswanath-Natraj (2022) who do not observe quantities, further strengthening our confidence in the results.

Papers Looking at Both FX Swap Supply and Demand Channels. Rime et al. (2022) use micro data to contribute to the understanding of the role of both FX swap supply and demand movements as drivers of persistent CIP violations. For the FX swap supply channel, Rime et al. (2022) provide evidence that meaningful risk-free CIP arbitrage opportunities are limited to only a narrow group of top-rated global banks whose balance sheet constraints prevent them from eliminating the associated CIP violations. For the FX swap demand channel, Rime et al. (2022) show that low-rated non-U.S. banks find it difficult to obtain dollar funding in the cash market and hence produce demand pressure for dollar funding via FX swaps. Cerutti et al. (2021) use aggregate data in a vast study of CIP violations' drivers and find evidence supporting meaningful roles for risk-taking capacity, FX market liquidity, unconventional monetary policy, and financial regulation, highlighting an intricate and time-varying role for both supply and demand shifts in the FX swap market as drivers of CIP violations.

The paper that is conceptually closest to ours is Sushko et al. (2016),[5] which in turn builds and expands on ideas laid out in Borio et al. (2016). These ideas pertain to the combination of some form of LOA and hedging demand. Specifically, Sushko et al. (2016) estimate a state space model with a measurement equation linking an FX swap demand proxy to cross-currency basis and a state equation in the unobserved, time-varying elasticity of the basis with respect to hedging demand. They then show this elasticity to be closely correlated with the product of FX option-implied volatility and bank credit spreads, which can be interpreted as being consistent with the notion that the latter elasticity is higher when arbitrage limits are stricter.

We differ from Sushko et al. (2016) along two main dimensions, which are also relevant for understanding the contribution of our paper to the broader literature. The first is our daily transaction-level data on IIs' FX swap flows and prices as well as our use of a daily measure

[5] Bush (2019) employs a similar approach to Sushko et al. (2016) by running monthly frequency panel regressions (for July 2013-November 2017) of 10 emerging markets' bases on proxies for hedging demand as well as the interaction of these proxies with measures of arbitrageurs' balance sheet constraints. Bush (2019) finds significant evidence for a direct basis effect of hedging demand but only mixed evidence for a meaningful interaction effect.

of LOA based on the market leverage of global financial institutions trading in the USD/ILS FX swap market, all of which allow us to identify the LOA-dependent FX swap demand channel quite cleanly.[6] Sushko et al. (2016) use a rough proxy for FX swap demand at a monthly frequency given by the implied cross-currency position of banks, IIs, and corporations, while also lacking a direct measure of these agents' basis. Second, our GIV-based local projection estimation approach allows us to study the LOA-dependent persistence of CIP violations conditional on an arguably exogenous FX swap demand shock that is in turn orthogonal to a rich array of other supply- and demand-related FX swap market factors. As such, it can be interpreted as a pure aggregate demand shock arising from large IIs' idiosyncratic desire to increase their (hedged) exposure to foreign assets.

Papers Looking at the Effect of IIs on Financial Markets. Last, we also contribute to the extant literature investigating the many ways in which IIs affect financial markets (Greenwood and Vayanos (2010), Ellul et al. (2011), O' Hara et al. (2018), Klingler and Sundaresan (2019), Hendershott et al. (2020), Koijen and Yogo (2022), and Pinter (2023) among others). We add to this literature by showing how hedging demand by IIs affects CIP deviations.

3 Theoretical Motivation

In appendix A of the online appendix to this paper, we lay out a simple structural framework which is meant to fix ideas and form a suitable conceptual base for this paper's empirical analysis. The model is not novel and builds heavily on the insightful modeling approach from Liao and Zhang (2020); our aim is simply to use it as an organizing device for our empirical analysis, which constitutes the main contribution of our paper.

[6] The underlying motivation for our LOA measure choice comes from the intrinsic link between intermediaries' funding capacity and LOA (Shleifer and Vishny (1997)), as limits on the former prevent from arbitrageurs to obtain the capital they need to arbitrage away price anomalies. This notion is very well captured by our market leverage measure, which follows the reasoning from He et al. (2017), as global intermediaries' leverage measure reflects the soundness of the financial intermediary sector - representing in large part agency/contracting frictions' severity, regulation strictness, and intermediaries' portfolios' performance; hence, sharp increases in this measure capture well meaningful increases in LOA. (Another important paper emphasizing the intrinsic link between intermediaries' funding capacity and LOA is Anderson et al. (2021), whose data allows them to measure the CIP-relevant arbitrage capital from the amount of global banks' unsecured short-term borrowing that is funded at a lower rate than the CIP-implied one.)

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.

To streamline this paper's exposition, we defer the detailed presentation of the model to appendix A of the online appendix to this paper and only present here the model's main prediction. This prediction, which has strong economic intuition, implies that greater LOA (as measured by lesser availability of funds for arbitrageurs' arbitrage activity) should make arbitrageurs' FX swap supply more rigid and hence make cross-currency basis more responsive to a rightward shift in FX swap demand. Figure 1 qualitatively depicts the LOA-dependent FX swap demand channel, which is the central object of study of this paper. b_t from this figure represents the cross-currency basis measured in the conventional way as difference between the synthetic, CIP-implied foreign (gross) risk-free interest rate and the cash market one. Hence, minus of the cross-currency basis (i.e., $-b_t$ appearing on the y-axis of Figure 1) is the arbitrageur's marginal profit from increasing its FX swap position. As such, the minus of the cross-currency basis can also be economically viewed as the price of the FX swap.

There are two noteworthy facts from this figure. First, to most vividly convey the crux of the LOA-dependent FX swap demand channel, we focus on the two extreme cases of perfectly *elastic* FX swap supply (leftward panel of the figure, i.e., no LOA state) and perfectly *inelastic* FX swap supply (rightward panel of the figure, i.e., LOA state). One can view these cases as reasonable proxies for states of abundant versus scarce levels of initial arbitrage capital. Second, Figure 1 reflects the fact that an LOA state corresponds to both a steeper and a more leftward FX swap supply curve in our model. That is, having an initially lower arbitrage capital implies not only a steeper FX swap supply curve but also a lesser quantity of FX swaps and wider basis. Hence, while the core of our demand channel lies in the effect of LOA on the slope of the FX swap supply curve, for completeness we also reflect LOA's shifting effect on this curve in Figure 1. In our empirical model we will control for the effect of LOA on the quantity of FX swap supply and will be able to estimate the LOA-dependent effects of demand shocks with the aim of testing the prediction that such shocks widen the basis by more conditional on increased LOA (steeper FX swap supply curve).

4 Data and Institutional Background

This section lays out information about the data used in this paper as well as the related institutional information about IIs in Israel and the environment in which they operate in the context of their FX swap activity.

4.1 Data

Our data are daily and cover the period 1/7/2008-3/31/2022. The specific starting and ending points of this approximate 14-year period are dictated by the availability of the Bank of Israel (BOI) proprietary FX swap data. IIs, the objects of focus in this paper, are broadly defined as financial intermediaries who pool funds from numerous investors and invest these funds in various financial assets on behalf of these investors. The BOI's definition of IIs in Israel that guides its collection of the transaction-level II FX flow data treats IIs as the universe of entities that manage the public's long-term savings in Israel. Such entities include pension funds, provident funds, severance pay funds, advanced training funds,[7] and life insurance policies.[8] IIs are important players in the Israeli financial market, managing 770.81 billion dollars on behalf of the public as of December 2021, which is 47% of the public's entire financial asset portfolio and 160% of GDP.

[7] The name 'advanced training fund' is somewhat misleading. In its inception, this fund was designed to be a tax-deductible saving vehicle to further one's education. Nowadays, it serves as a means to invest long-term.

[8] Mutual funds and exchange traded funds, whose investment is mostly for short- and medium-term purposes, are not included in the BOI's definition of IIs. In terms of the type of financial firms (rather than types of funds) which comprise our sample, the universe of investment banks and insurance companies are the entities managing the public's long-term savings in Israel for our sample (i.e., they are the owners of the funds that manage the public's long-term savings). Commercial banks, who have been banned in 2004 from managing the public's long-term savings in Israel, are thus excluded from the list of entities that comprises our sample.

4.1.1 FX Swap Flows and Prices Data

We have proprietary daily transaction-level data covering both quantities and prices (spot and forward rates) for all USD/ILS swap market participants.

FX Swap Flows. We construct from our micro data aggregate FX swap flow series for IIs and five additional sectors: Israeli commercial banks; foreign sector, which includes all foreign firms engaged in financial activity (i.e., foreign commercial and investment banks, pension and insurance funds, mutual funds, exchange traded funds, hedge funds, and proprietary trading firms); Israeli mutual funds and exchange traded funds; Israeli hedge funds and proprietary trading firms; and the real sector, which represents the net FX flows from swap transactions involving Israeli exporters and importers.

The aggregate FX swap flow variable for a specific sector measures (in dollars) the daily net change in the corresponding sector's open swap position. This position is calculated from the net transaction flows from the sector's buying and selling of U.S. dollars on the FX swap market, while accounting for such flows from both legs of the swap trades. A positive (negative) value for this variable for a given observation takes place when the sector was a net buyer (seller) of swap-linked spot dollars on the corresponding day (or, equivalently, a net seller (buyer) of swap-linked forward dollars). While we do not have the starting level of the sectors' open position prior to our sample's inception, and hence the accumulated swap flows are only a proxy for the associated sectoral open position, FX swap flow activity was quite modest prior to 2008 for USD/ILS thereby implying that the latter proxy should be quite accurate. In any case, since we are interested in the *changes* in a sector's open FX swap position (rather than their level) for this paper's purposes, this issue is of null importance to our analysis.

We restrict attention to USD/ILS trades given our literature-consistent focus on the *dollar* basis. (85.9% of our local IIs' FX swap volume is done in dollars, with the remaining small 14.1% share almost entirely done in euros (11.4%) and pounds (1.8%).)

II-Level FX Swap Flows. Our GIV-based identification comes from our ability to observe transaction-level FX swap flows for individual IIs' fund families. There is a total of 14 such IIs' fund families, 13 of which are consistently net buyers of swap-linked spot dollars with the sole net seller constituting on average only 1.1% and 1.5% of the market in terms of absolute FX swap open position and swap volume, respectively. Since our GIV-based identification approach's validity relies on the individual IIs' fund families being demanders (net buyers) of FX swaps - see Section 5.2 for a formal depiction of this reliance - we omit the latter abnormal and small net selling II family fund from our empirical analysis and in turn base our GIV-based identification procedure on the 13 net buying IIs' family funds.[9] These 13 IIs are effectively the universe of asset managers in Israel managing its public's long-term savings and comprise of investment banks and insurance companies. The long-term savings industry in Israel is quite concentrated, as reflected by an average Herfindahl-Hirschman Index of 0.27 and 0.21 for IIs' (absolute) open FX swap positions and swap volumes, respectively.

It reasonable to expect only modest correlation among our 13 IIs' FX swap flows given the high-frequency (daily) nature of our data. This expectation is borne out by the data with an average absolute pairwise correlation among the 13 IIs of 12.1% and a corresponding standard deviation of 8.2%. Importantly, by removing the effects on these flows of various common drivers, our estimation procedure is capable of materially reducing these numbers to 2.4% and 2.1%, respectively. I.e., the high-frequency nature of our data along with the suitability of our estimation procedure facilitate the extraction of daily idiosyncratic II-level FX swap demand shocks where the difference between the size-weighted- and equal-weighted-average of these shocks (i.e., GIV shock) in turn provides a valid aggregate demand shock for the testing and quantification of our LOA-dependent FX swap demand channel.

IIs' FX Swap Prices. We construct a direct measure of IIs' aggregate basis by computing a daily volume-weighted average of their associated transaction-level bases. This is made possible for us by the availability of the spot and forward rates underlying each transaction in our dataset. Transactions' bases are computed the standard way as the difference between the cash market risk-free dollar interest rate at the corresponding maturity and the CIP-implied dollar interest rate (i.e., forward premium multiplied by gross local risk-free rate). Note that these transaction-level bases

[9] Results are similar when including this omitted II family fund in our econometric analysis.

represent the *actual* price incurred by IIs from tapping into the FX swap market for FX funding; hence, the aggregate basis variable at our disposal measures the actual cost of FX swaps facing the IIs sector.

The dollar risk-free interest rate is measured by Libor. To construct the CIP-implied dollar rate, we use the Tel Aviv Inter-Bank Offered Rate (Telbor) as our measure of the Israeli cash market risk-free interest rates. (Telbor is based on interest rate quotes by a number of commercial banks in the Israeli inter-bank market.) As IIs' swap transactions' maturity distribution is fairly continuous, we use linearly interpolated interest rates from the 1-, 3-, 6- and 12-month maturities' Thomson Reuters interest rate values to compute the transaction-specific interest rates.

Descriptive Statistics. Table 1 presents the maturity distribution in the FX swap market for each sector, Table 2 shows summary statistics (mean and standard deviation) for each sector's aggregate (volume-weighted average) basis and aggregate flows, and Table 3 reports the correlation matrix for the time series of the sectoral bases. (Tables 1 and 3 also report the number of FX swap transactions underlying the sectoral computations as well as the number of players belonging to each sector.) The median maturity of IIs' FX swap trades is 54 days whereas that for local banks and foreigners are 7 and 3 days, respectively, highlighting an interesting maturity gap between the major sellers and buyers of swap-linked dollar forwards.[10] Table 2 highlights an engrossing segmentation in the level of basis facing the sectors, with IIs encountering over our sample period the widest basis across the sectors; this gap - which is largest when compared to foreigners' basis, reaching -36 basis points - echoes the notion that IIs' strong demand for swaps bears a meaningful cost. Notwithstanding the latter significant segmentation, the sectoral bases correlation matrix from Table 3 indicates that the sectoral bases possess strong comovement over time.

4.1.2 Additional Macro-Financial Data

We use several daily frequency macro-financial variables in our analysis, all of which cover the baseline empirical sample of 1/7/2008-3/31/2022. Except for the LOA measure, these variables

[10]Local banks, who in addition to their local arbitraging role are also the main market makers in the USD/ILS FX swap market against which IIs conduct the majority of their swap trades (roughly 83% - with the remaining share being conducted against foreign financial firms), face the task of managing the risk from this maturity mismatch.

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 a suitable daily market leverage series that follows the reasoning from He et al. (2017). He et al. (2017)'s intermediary leverage ratio variable is based on the list of Primary Dealer counterparties of the New York Federal Reserve in its implementation of monetary policy.

In particular, He et al. (2017) construct the aggregate leverage ratio for the intermediary sector by matching the New York Fed's primary dealer list with CRSP/Compustat and Datastream data on their publicly traded holding companies (22 in total), resulting in a leverage ratio variable which corresponds to the largest and most sophisticated financial institutions that operate in virtually the entire universe of capital markets. Since likely not all of the 22 primary dealers are effectively operating as arbitrageurs in the USD/ILS FX swap market, the He et al. (2017) measure may be too coarse of a measure for capturing LOA severity *specific* to the USD/ILS FX swap market. Hence, we exploit our granular data to pin down exactly the global dealers that are most active in the USD/ILS FX swap market and construct a value-weighted leverage ratio variable for 12 such intermediaries whose activity (transactions' volume) in the USD/ILS FX swap market accounts for 95% of the entire activity of foreign financial institutions. As such, this LOA measure is appropriate for capturing the severity of LOA that is specifically present in the FX swap market under this paper's study. These 12 intermediaries are a subset of He et al. (2017)'s group of intermediaries.[11]

Figure 5 shows the time series of the leverage ratio that we use. The period of the GFC stands out. However, there were some other noteworthy periods when the measure was high, such as 2011-2012 and the recent COVID-19 turmoil.

VIX. The VIX is a volatility index that measures the near-term expected volatility of the S&P 500 Index and is calculated from real-time S&P 500 Index European options with an average expiration of 30 days. We use its log-first-differences (in lagged and current form) in the micro-level

[11] Specifically, they include BNP; UBS; Deutsche Bank; HSBC; Barclays; Credit Suisse; Societe Generale; Goldman Sachs; JPM; Citigroup; BoFA; and Wells Fargo.

regressions that identify the idiosyncratic FX swap demand shocks to control for global uncertainty shocks.

Broad Dollar Index. The broad dollar index is a trade-weighted U.S. dollar index measuring the value of the dollar relative to other world currencies while updating the weights yearly. We use its log-first-differences (in lagged and current form) in the micro-level regressions that identify the idiosyncratic FX swap demand shocks to control for global risk appetite shocks (Avdjiev et al. (2019)).

S&P 500 and TA-35 Indices. The commonly used S&P 500 is our measure of global stock prices while the TA-35 index is our measure of local stock prices, with the two indices listing the largest 500 and 35 companies in U.S. and Tel-Aviv Stock Exchanges, respectively. We include current and lagged values of the log-first-differences of these two indices in the micro-level regressions that identify the idiosyncratic FX swap demand shocks so as to ensure that these shocks do not capture endogenous demand variation due to variation in stock market performance in the U.S. and Israeli stock markets. Notably, the inclusion of the local stock market return variable also serves to ensure that shocks specific to the Israeli economy are not contaminating our identification.

VTA35. The VTA35 Index is the local counterpart to the VIX index and measures the market's expectation of 30-day volatility implied by at-the-money TA-35 index option prices. We use its log-first-differences (in lagged and current form) in the micro-level regressions that identify the idiosyncratic FX swap demand shocks to control for local uncertainty shocks.

FTSE US Government Bond Index. The FTSE US Government Bond Index measures the performance of fixed-rate US government bonds whose minimum maturity is at least one year. We use its log-first-differences (in lagged and current form) in the micro-level regressions that identify the idiosyncratic FX swap demand shocks to control for global flight-to-quality shocks.

USD/EUR Cross-Currency Bases. To ensure that our FX swap demand shock is unrelated to variation in frictions in the global FX swap market, we control for current and lagged values of the first-differences of the 1- and 12-month USD/EUR cross-currency bases in the micro-level regressions that identify the idiosyncratic FX swap demand shocks. We compute these bases correspondingly to how we compute the USD/ILS ones, taking the 1- and 12-month Euribor rates as the risk-free rates for the Euro. As explained in Footnote 22, these two maturities are sufficient for our purposes given the high correlations between the first differences of the 1- and 3-month bases and the 6- and 12-month bases.

Select Variable Correlations. In Table 4, we present the daily correlations between our LOA measure and the II basis measure as well as the correlation between these two variables and other macro-financial variables described in this section, where all variables are in log-first-differences except for the bases. It is reassuring to observe that the LOA measure exhibits minimal correlation with our II basis measure. This finding, when coupled with our subsequent empirical results, aligns with the notion that the LOA measure adequately captures the steepness of the supply curve while shocks to this measure do not produce meaningful fluctuations in our II basis. It is worth noting that even if the LOA measure did capture meaningful variations in the basis, this would not bias our estimation as we include both the one-day lagged level of our LOA measure as well as the current and lagged values of its first-difference as controls in our regression analysis.[12]

Overall, although the direction of the relationship between the II basis and the other considered and commonly followed financial variables is generally in the expected, theory-consistent direction, the II basis demonstrates somewhat limited daily correlation with these variables. Nevertheless, they are instrumental in aiding us to obtain identification as their inclusion as controls in our estimation of idiosyncratic demand shocks purges IIs' swap flow demand of theory-consistent FX swap market common demand and supply forces. (The variables in Table 4 constitute the bulk

[12] The effect of the one-day lagged level of our LOA measure on IIs' basis, which we report in this paper for completeness (that from the aggregated-based and granular-without-controls specifications in the main text while that from the granular-with-controls ones in Appendix C of the online appendix to this paper), is insignificant for all of our considered specifications. While results are unchanged from excluding this variable from our regressions, we take the conservative approach - that is also consistent with the standard practice of separately including both interacted terms in regressions with interactions - and include it in all of our regressions.

(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, one-day lagged LOA, IIs' swap flows, and the interaction of the latter two variables, increases the R^2 by about 15-fold. (Including just the current values of the controls increases the R^2 by about 5-fold.)

4.2 Institutional Background

Liquidity of the Israeli FX Market. According to the latest BIS triennial survey of 51 countries, as of April 2022, Israel's daily average turnover in the swap market was 5.7 billion dollars, 3.8 times the size of the spot market's daily average turnover of 1.5 billion dollars. This places Israel in the top quartile of the 51 countries for this relative measure (ranking at #12), indicating the swap market is a very liquid market relative to the spot market for the ILS. Compared to other countries, Israel's daily average turnover in the swap market is comparable to New Zealand's (6.7 billion dollars) and sits comfortably in the middle portion of the 51 countries for this measure, ranking at #32. Israel's *total* daily average turnover in the FX market, including spot (1.5), forwards (0.8), FX swaps (5.7), and options (0.3), is 8.3 billion dollars, ranking at #34. Overall, this data suggests that Israel's swap FX market is vibrant and liquid.

Regulatory Background. Until 2003, 70% of pension funds' investments, which comprise roughly 50% of total IIs' investment, were allocated to earmarked government bonds. In a watershed regulatory change, that occurred in 2003, the Israeli government lowered this 70% threshold to 30%, thereby triggering a gradual increase in IIs' investment in foreign assets as a share of total assets. Moreover, in 2008 the Israeli government enacted compulsory pension arrangements for all workers, further increasing the portfolio managed by IIs while pushing them to seek alternatives to their investments in Israel.[13] Against this regulatory backdrop, IIs' have already allocated roughly 10% of their assets to foreign ones in the beginning of our sample (which starts in 2008)

[13] These regulatory changes have taken place against the backdrop of a 2001 regulatory shift from defined benefit to defined contribution pension plans, which is yet another historical regulation-driven growth source for Israeli IIs' portfolios.

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

IIs' FX Swap and Spot Trading. To fund their foreign investments, IIs can either do spot trades where they sell ILS and buy USD or FX swap trades where they do opposing spot and forward trades. To gain an understanding about which one of these two options is favored by them, Figure 2 shows the evolution of accumulated daily FX swap (solid line) and spot (dashed line) flows for 1/7/2008-3/31/2022. (This sample is chosen to accord with our empirical analysis's baseline sample.) Negative accumulated swap and spot flows' values represent the accumulated spot selling of foreign currency; positive values represent the accumulated buying of foreign currency. In accordance with the literature, this paper's focus is on the *dollar* basis; hence, the FX flows shown in Figure 2 represent only trades in the currency pair USD/ILS.[14]

The FX swap flow series takes into account the offsetting forward flows from the associated second leg of each trade. As such, in accordance with our structural model and the literature's interpretation of the FX swap market as a vehicle for obtaining FX-risk-free collateralized dollar funding, the accumulated flow series represents IIs' FX-swap-market-implied dollar loan balance. Equivalently, this accumulated series can also be interpreted as IIs' FX-swap-induced open position on the dollar, where positive values represent an accumulated selling of swap-linked dollar forwards.[15]

Figure 2 indicates that, for most of the sample, Israeli IIs have obtained dollar funding through spot trades moderately more than through swap trades. But the two alternatives are quite comparable. Towards the end of the sample period, coinciding with the post-COVID bull market phase, there was a notable increase in IIs' foreign asset share, moving from 27% in March 2020 to 34.7% by March 2022. During this time, the importance of FX swaps, a risk-free funding alternative, grew significantly and eventually surpassed the traditional spot-based method. By January 25,

[14]85.9% of IIs' FX swap flow volume is in dollars. The remaining share is almost entirely in euros (11.4%) and pounds (1.8%). 87.8% of IIs' FX spot volume is done in dollars, with the remaining share also almost entirely done in euros (9.7%) and pounds (1.6%).

[15]While we do not have the starting level of IIs' open position prior to our sample's inception, and hence the accumulated swap flows are only a proxy for the associated open position, FX swap flow activity was quite modest prior to 2008 thereby implying that the latter proxy should be quite accurate. In any case, since we are interested in the *changes* in IIs' open FX swap position (rather than their level) for this paper's purposes, this issue is of null importance to our analysis.

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 aggregate FX swap flows for 1/7/2008-3/31/2022 for five additional sectors on top of the IIs sector (which, for completeness, is also included in the figure): Israeli commercial banks; foreign sector, which includes all foreign firms engaged in financial activity (i.e., foreign commercial and investment banks, pension and insurance funds, mutual funds, exchange traded funds, hedge funds, and proprietary trading firms);[17] Israeli mutual funds and exchange traded funds; Israeli hedge funds and proprietary trading firms; and the real sector, which represents the net FX flows from swap transactions involving Israeli exporters and importers.

Figure 3 demonstrates that the sole effective net buyers of dollar swaps among market participants are IIs, against which the two dominant sellers of dollar swaps are the Israeli banking and foreign sectors. The real sector is a net buyer of dollar swaps but its activity is negligible. The local mutual fund and exchange traded fund sector as well as the local hedge fund and proprietary trading firm sector are net sellers of dollar swaps, with the latter sector becoming such net seller particularly in the later part of the sample; but it is nevertheless clear that these sectors' net selling of dollar swaps is dwarfed by the Israeli banking and foreign sectors. In sum, that financial firms both domestically and abroad act as net sellers of dollar swaps is consistent with the modeling approach taken in the structural framework from Appendix A of the online appendix to this paper which assumes that arbitrageurs are IIs' counterparties, supplying IIs' their demanded FX swaps.

IIs' Aggregate Cross-Currency Basis. We end this section with an exposition of the aggregate cost of IIs' FX swaps, as measured by the cross-currency basis and defined in the usual way as

[16] Outright forwards constitute an additional FX trade category that IIs use and is not shown here due to its irrelevance to this paper's analysis. This irrelevance is rooted in cross-currency basis being the price of FX swaps, thus rendering the understanding of the drivers of CIP deviations tantamount to the understanding of the workings of the FX swap market (see Du and Schreger (2022) and references therein). IIs use outright forwards to hedge against the FX risk from increases in their foreign stocks portfolio, an hedging mechanism that underlies the equity hedging channel of exchange rate determination (Ben Zeev and Nathan (2022)).

[17] The foreign *real* sector's FX swap volume is negligible and is therefore excluded from Figure 3.

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 shows the evolution of the latter measure of IIs' aggregate basis. For comparison purposes we also depict in this figure the 1-, 3-, and 6-month USD/ILS cross-currency bases constructed from spot and forward rate data from Thomson Reuters.[18]

It is clear that Israeli IIs, as did many of their international counterparts, faced a meaningful cost of obtaining dollar funding from the FX swap market for our considered sample period. The mean of IIs' aggregate basis is -42.8 basis points. Our transaction-level based IIs' basis is similar to the Thomson Reuters based ones in *levels*, with correlations between our basis and the 1-, 3-, and 6-month bases standing at 84.7%, 93.9%, and 90.4%, respectively. (The means of the Thomson Reuters based bases are -43.9, -44, and -37 basis points.) However, when considered in *first-differences* form these correlations materially drop to 35.2%, 34.3%, and 23.6%, respectively, stressing the importance of utilizing our granular data to measure the specific basis facing the swap demanding IIs for identification of the LOA-dependent FX swap demand channel.[19]

IIs' meaningful average basis also embodies significant volatility, with the basis actually being positive early on in the sample but then starting to become negative in early 2009. While the basis remains in this negative territory throughout the vast majority of the sample, it is clear that the most significant widening of the basis takes place following the GFC period with this material widening being very persistent lasting for roughly 4 years. We then observe some relatively short-lived and modest bouts of basis widening until the COVID-ridden period where more significant and more persistent basis widening again takes place (albeit to a much lesser extent than the post-

[18]We construct the Thomson Reuters USD/ILS cross-currency bases for the 1-, 3-, and 6-month maturities in the standard way, i.e., as the difference between the cash market risk-free dollar interest rate at the corresponding maturity and the CIP-implied dollar interest rate (i.e., forward premium multiplied by gross local risk-free rate). To construct these bases, we use the Thomson Reuters 4:00 PM London time spot and forward rate data as well as Thomson Reuters end-of-day quotes for USD and ILS interest rates (Libor and Telbor).

[19]These rather limited correlations can be potentially accounted for by market segmentation as well as by the fact that Thomson Reuters' bases data are derived from quotes rather than actual transactions. Given these low correlations and their underlying aforementioned potential explanations, it is not surprising that these bases - while widening in the LOA state in response to the GIV shock and even significantly so for the 3-month basis by -3.3 basis points - do so in a much less meaningful manner than IIs' basis.

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

Aggregate-Without-Controls Estimation. A sensible kick-start to our empirical analysis is a plain-vanilla OLS estimation of the LOA-dependent effects of IIs' swap flows on IIs' basis which abstracts from endogeneity issues and simply looks at the LOA-dependent relationship between our aggregate quantity and price swap series. This amounts to estimating the regression

$$\Delta b_t = \alpha + \Xi_L \Delta SP_t + \Xi_I LOA_{t-1} \Delta SP_t + \beta LOA_{t-1} + u_t, \quad (1)$$

where t indexes time at daily frequency; Δb_t is the first-difference of aggregate (volume-weighted average) IIs' cross-currency basis; α is the intercept; ΔSP_t is IIs' aggregate FX swap flows, i.e., the first-difference of IIs' aggregate open FX swap position (normalized to have a unit standard deviation); and LOA_{t-1} is the deviation of the logged intermediary leverage ratio variable at $t-1$ from its mean divided by this variable's standard deviation.

We define the effect of the swap flows in the LOA state as $\Xi_L + 2\Xi_I$, i.e., the summation of the linear effect and twice the interactive effect. This definition is based on the notion that being two standard deviation above the average value of LOA reasonably corresponds to being in a state of meaningful LOA which in turn should reflect a meaningfully more rigid FX swap supply curve. Since the LOA distribution percentile corresponding to the 2 standard deviations quantile is 96.4%, we symmetrically define the effect in the no LOA state as $\Xi_L - 1.4\Xi_I$ as the $1 - 96.4\% = 3.6\%$ percentile corresponds to the -1.4 standard deviations quantile. (The minimal value of the LOA series is -1.8 standard deviations, making it all the more important to define the no LOA state symmetrically with respect to the LOA state given that this series never possesses a -2 value.)

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 we add a rich set of controls as a first attempt to alleviate the concern that the LOA-dependent effects estimated from Equation (1) are driven by supply and demand shocks distinct from the sought-after idiosyncratic changes in IIs' demand. This extension is given by

$$\Delta b_t = \alpha + \Xi_L \Delta SP_t + \Xi_I LOA_{t-1} \Delta SP_t + \beta LOA_{t-1} + X_t' \delta_L + LOA_{t-1} X_t' \delta_I + u_t, \tag{2}$$

where X_t is a vector of controls (to be discussed in detail below) with corresponding coefficient vector δ_L when linearly entered in the regression and δ_I when entered in interaction with one-day lagged LOA. We continue to define the effects in the LOA and no LOA states as $\Xi_L + 2\Xi_I$ and $\Xi_L - 1.4\Xi_I$, respectively.

X_t includes day-dummies for Monday through Thursday as well as a dummy variable that takes the value of 1 on the 14th, 15th, and 29th-31st calendar dates;[20] time trend; lagged values of ΔSP_t; lagged values of Δb_t; and the current and lagged values of the following rich set of FX swap market supply and demand related controls:[21] log-first-differences of S&P 500 and TA-35 indices and first-difference of the spread between the 3-month Libor and Telbor rates, whose inclusion controls for foreign and local equity price and interest rate spread changes; log-first-difference of VIX and broad dollar index, whose inclusion controls for global uncertainty and risk appetite shocks, respectively; log-first-difference of VTA35, whose inclusion controls for local uncertainty shocks; first-differences of USD/EUR 1- and 12-month cross-currency bases,[22] whose inclusion

[20]The middle- and end-of-month dummy variable is meant to capture the strong seasonality on the associated dates in regards to IIs' drawdown of their open swap positions and is in line with the well-established evidence on monthly-payment-cycle-induced cash needs facing IIs (Etula et al. (2019)). Section 6.5 discusses this seasonality in detail and exploits it as an adverse demand shifter to further establish the presence of a meaningful LOA-dependent FX swap demand channel.

[21]The number of lags for swap flows and other variables in X is common and chosen to be 6 in the estimation, determined as the average of the chosen lag specifications from the AIC, corrected AIC, BIC, and HQIC lag length criteria tests.

[22]While results are robust to including the first-differences of the 3- and 6-month USD/EUR bases, the former has a 70% correlation with the 1-month basis and the latter has an 85% correlation with the 12-month basis. Hence, the 1- and 12-month bases appear to be sufficient for capturing the frictions present in the global FX swap market. (The correlation between these two variables is 41%.)

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 (Bartik and GIV) that can potentially remove the latter unobserved components. We begin by presenting such estimation without controls, after which we turn to the one with controls which we present in a separate section given its role as the preferred estimation approach in this paper.

Granular-Without-Controls Estimation. As highlighted by our structural model from Appendix A of the online appendix to this paper, the structural demand shocks we seek to identify in this paper for studying the LOA-dependent channel of FX swap demand are idiosyncratic demand shocks capturing idiosyncratic changes in IIs' geographical portfolio preferences. This conceptual setting clamors for the use of the granular data we have on individual IIs as such idiosyncratic shocks can only be recovered from individual IIs' behavior.

We begin our granular-based analysis in plain vanilla form with an estimation of Equation (1) where we replace ΔSP_t with two well-received instruments from the literature. (The next section describes the extended, granular-with-controls estimation procedure.) The first is based on the recent granular instrumental variable (GIV) approach from Gabaix and Koijen (2023) and the second is based on the Bartik (1991) instrument, which is also known as shift-share estimator and constitutes an established and widely used identification approach in economics (see, e.g., Blanchard and Katz (1992), Autor et al. (2013), Adão et al. (2019), Goldsmith-Pinkham et al. (2020), and Borusyak et al. (2021)).

Following Gabaix and Koijen (2023), we define the GIV as the difference between the size- and equal-weighted-average of the 13 idiosyncratic II-level swap flows, where II-level sizes are calculated from the shares of swap flows' average volume of each II in total IIs' average volumes, and define the Bartik instrument as the equal-weighted-average of the 13 idiosyncratic II-level swap flows. We only remove II-specific linear trends from our 13 idiosyncratic swap flow series prior to using them in the construction of the GIV and Bartik instruments,[23] in line with the no-controls-case under focus here, and denote the linearly detrended II-level swap flows by $\tilde{SP}_{i,t}$ where $i = 1, ..., 13$. Specifically, for the GIV case, we replace ΔSP_t in Equation (1) with $\Delta SP_{t,GIV} = \sum_{i=1}^{13} \Delta \tilde{SP}_{i,t} w_i - \sum_{i=1}^{13} \Delta \tilde{SP}_{i,t} \frac{1}{13}$, where w_i is II i's share of swap flows' average volume in the sum of IIs' average volumes; and for the Bartik case we replace ΔSP_t in Equation (1) with $\Delta SP_{t,Bartik} = \sum_{i=1}^{13} \Delta \tilde{SP}_{i,t} \frac{1}{13}$. We scale the effects of the GIV and Bartik shocks such that their linear effects from a quantity regression analogous to Regression (1) - i.e., one that uses IIs' aggregate FX swap flows as the dependent variable - are equal to one standard deviation of IIs' aggregate swap flows (542.5 millions dollars).

Gabaix and Koijen (2023) define and compare the Bartik instrument in relation to their GIV instrument and emphasize that the two instruments should be viewed as complementary identification approaches. Specifically, while the GIV approach seems to be the natural and preferable method for identification when there are large idiosyncratic shocks driving the aggregate, the Bartik instrument may be more suitable when there are no such large shocks. In the presence of large idiosyncratic shocks driving the aggregate, as is the case in our swap flow data which possess rather high average Herfindahl-Hirschman Indices of 0.27 and 0.21 for IIs' (absolute) open FX swap positions and swap volumes, respectively, the GIV approach has a clear advantage over the Bartik one because it removes any variation driven by common shocks through the subtraction of the equal-weighted-average from the size-weighted-average. This is a crucial point that we will go back to in the next section when we formally establish the validity of our extended GIV estimation approach and its superiority over the Bartik one.

[23] As the starting dates of our IIs' swap activity differ across the cross section, we explicitly account for the resulting differences in sample coverage in computing these linear trends as well as in our baseline econometric analysis described in the next section.

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 more intricate and suitable than the previous section's estimation approaches for obtaining valid identification. Like the granular-without-controls approach, this section's granular-with-controls approach also relies on the GIV and Bartik identification approaches. As will be established later in this section, the GIV-with-controls approach is superior to the Bartik-with-controls approach and will therefore serve as our preferred estimation approach in this paper.

5.2.1 Econometric Model

Data Generating Process for $\Delta SP_{i,t}$. We consider the following data generating process (DGP) for our individual IIs' FX swap flows ($\Delta SP_{i,t}$):

$$\Delta SP_{i,t} = \mathbb{C}_t' \gamma_{i,L} + LOA_{t-1} \mathbb{C}_t' \gamma_{i,I} + \epsilon_{i,t} + \zeta_i LOA_{t-1} \epsilon_{i,t}, \tag{3}$$

where i and t index IIs and time at daily frequency; $\mathbb{C}_t$ is a vector of observable controls that includes the fixed effect, time trend, day-dummies for Monday through Thursday, lagged values of $\Delta SP_{i,t}$, and current and lagged values of a rich array of demand and supply related FX swap market drivers discussed already above in the context of the controls in Equation (2); LOA_{t-1} is the deviation of the logged intermediary leverage ratio variable at $t-1$ from its mean divided by this variable's standard deviation; and $\epsilon_{i,t} \sim i.i.d.\ N(\mathbf{0}, \sigma_{i,\epsilon}^2)$ is the sought-after true idiosyncratic FX swap demand shock for II i where $\sigma_{i,\epsilon}$ is its standard deviation.

There are four important elements From DGP (3) worth highlighting. First, $\Delta SP_{i,t}$ represents the actual amount of swap-linked spot dollars purchased by *demander* II i, whose role as demander of such dollars validates the assumption that $\epsilon_{i,t}$ is an idiosyncratic demand shock for this II.[24]

[24] Such a demander role is assumption for IIs is borne out by both numerous discussions we have had with relevant traders as well as by the fact (as detailed in Section 4.1.1) that out of 14 IIs 13 are consistently net buyers of swap-linked spot dollars with the sole net seller (which we omit from our empirical analysis for being as such) constituting on average only 1.1% and 1.5% of the market in terms of absolute FX swap open position and swap volume, respectively.

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 $\epsilon_{i,t}$, are driving $\Delta SP_{i,t}$ 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, a sensible assumption given the likely heterogeneity in sensitivities of IIs' swap flows to controls vector $\mathbb{C}_t$ as well as to its interaction with one-day lagged LOA.

Estimation of $\epsilon_{i,t}$ from DGP (3). This paper's main objective is to obtain exogenous variation from the $\epsilon_{i,t}$s so that the LOA-dependent effect of this variation can be estimated. This in turn delivers a way to test and quantify the LOA-dependent channel of FX swap demand - which constitutes the next and final step of the estimation procedure - as such exogenous variation is demand-driven in coming from idiosyncratic demand shocks. Hence, a necessary step in our extended granular-based estimation is to estimate DGP (3) for each of our 13 IIs and extract from each the corresponding $\epsilon_{i,t}$.

Toward this end, we proceed with two estimation steps. First, we estimate via OLS 13 II-level regressions corresponding to DGP (3) which are given by

$$\Delta SP_{i,t} = \mathbb{C}_t'\gamma_{i,L} + LOA_{t-1}\mathbb{C}_t'\gamma_{i,I} + v_{i,t}, \tag{4}$$

where $v_{i,t}$ is the regression's residual with $v_{i,t} = \epsilon_{i,t} + \zeta_i LOA_{t-1}\epsilon_{i,t}$.[25] To assess the merit of Regression (4), Table 5 shows the R^2s for the 13 regressions sorted (in descending order) by each II's size in terms of its share of average swap volume in total average IIs' volume. This table shows that Regression (4) does a fairly good job of explaining the variation in IIs' swap flows, with mean and standard deviation of R^2s across the 13 regressions of 26% and 10.2%.

Second, denoting the estimated residual of Equation (4) by $\hat{v}_{i,t}$, we formulate the relation between $\hat{v}_{i,t}$ and the sought-after true idiosyncratic demand shock $\epsilon_{i,t}$ as a time-varying state-space

[25] The number of lags for swap flows and exogenous controls in $\mathbb{C}_t$ is common and determined as the average of the chosen lag specifications from the AIC, corrected AIC, BIC, and HQIC lag length criteria tests for each II-level regression. The mean and standard deviation of lags across the 13 regressions are 4.5 and 1.6, respectively.

model:

$$\hat{v}_{i,t} = \epsilon_{i,t} + \zeta_i LOA_{t-1}\epsilon_{i,t} + \eta_{i,t}, \tag{5}$$

$$\epsilon_{i,t} = \mu_{i,t}, \tag{6}$$

where Equation (5) is the model's measurement equation and Equation (6) is the model's state equation; $\eta_{i,t}$ is a zero-mean independently and identically normally distributed variable with variance $\sigma_{i,\eta}$; and $\mu_{i,t}$ is a zero-mean independently and identically normally distributed variable with variance $\sigma_{i,\epsilon}$ which represents the DGP for the unobserved $\epsilon_{i,t}$. The time-varying dimension of this state-space model expresses itself through the time-varying nature of $\zeta_i LOA_{t-1}$ which can be viewed as a time-varying coefficient on $\epsilon_{i,t}$.

We estimate state-space Model (5)-(6) by applying the Kalman filter to this model to find the values for ζ_i, $\sigma_{i,\eta}$, and $\sigma_{i,\mu}$ that maximize the likelihood function for $\{\epsilon_{i,2}, ..., \epsilon_{i,T}\}$ ($\mathbb{P}(\{\epsilon_{i,2}, ..., \epsilon_{i,T}\} \mid \zeta_i, \sigma_{i,\eta}, \sigma_{i,\mu}, \{LOA_{i,1}, ..., LOA_{i,T-1}\}, \{\hat{v}_{i,2}, ..., \hat{v}_{i,T}\})$). Our interest lies in the MSE-optimal smoothed $\epsilon_{i,t}$ estimate, which we denote by $\hat{\epsilon}_{i,t}$, obtained from applying this Kalman filter estimation procedure. We now turn to a presentation of the Bartik- and GIV-based approaches to achieve our objective of estimating the LOA-dependent effects of exogenous variation from the $\epsilon_{i,t}$s.

Estimation of LOA-Dependent Effects of Bartik Shock. Following Gabaix and Koijen (2023), who (as discussed in the previous section) define and compare the Bartik instrument in relation to their GIV instrument, we define the Bartik shock (denoted by $\varrho_{Bartik,t}$) as the equal-weighted-average of the estimated idiosyncratic shocks, i.e., $\varrho_{Bartik,t} = \sum_{i=1}^{13} \hat{\epsilon}_{i,t} \frac{1}{13}$. So long that $\hat{\epsilon}_{i,t}$ captures well $\epsilon_{i,t}$ for all is, the Bartik shock represents exogenous variation from the $\hat{\epsilon}_{i,t}$s that can be utilized to properly estimate the LOA-dependent channel of FX swap demand. Specifically, this is done by estimating the regression given by

$$\Delta b_t = \alpha + \Xi_L \varrho_{Bartik,t} + \Xi_I LOA_{t-1}\varrho_{Bartik,t} + \beta LOA_{t-1} + u_t. \tag{7}$$

Note that this equation is the same as Equation (1) only that ΔSP_t from the latter equation is now replaced by $\varrho_{Bartik,t}$. As in Equation (1), we continue to define the effects in the LOA and no LOA states as $\Xi_L + 2\Xi_I$ and $\Xi_L - 1.4\Xi_I$, respectively. But now these estimated effects are obtained 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 (2023), we define the GIV shock (denoted by $\varrho_{GIV,t}$) as the difference between the size-weighted- and equal-weighted-average of the estimated idiosyncratic shocks, i.e., $\varrho_{GIV,t} = \sum_{i=1}^{13} \hat{\epsilon}_{i,t} w_i - \sum_{i=1}^{13} \hat{\epsilon}_{i,t} \frac{1}{13}$, where w_i is II i's share of swap flows' average volume in the sum of IIs' average volumes. And the GIV-based regression corresponding the Bartik one is

$$\Delta b_t = \alpha + \Xi_L \varrho_{GIV,t} + \Xi_I LOA_{t-1} \varrho_{GIV,t} + \beta LOA_{t-1} + u_t. \tag{8}$$

If $\hat{\epsilon}_{i,t}$ captures well $\epsilon_{i,t}$ for all is, the GIV shock represents exogenous variation from the $\hat{\epsilon}_{i,t}$s that can be utilized to properly estimate the LOA-dependent channel of FX swap demand from Equation (8) (with the effects in the LOA and no LOA states defined in the usual way as $\Xi_L + 2\Xi_I$ and $\Xi_L - 1.4\Xi_I$, respectively). But, as opposed to the Bartik shock, even if there still remains an unobserved common component in the $\hat{\epsilon}_{i,t}$s, the GIV shock construction removes this common component and ensures that the GIV shock is still valid in that it represents exogenous variation coming from the $\epsilon_{i,t}$s. Specifically, assume some unobserved common component φ_t (some composite of unobserved white noise swap demand and supply shocks) is driving some of the variation in $\hat{\epsilon}_{i,t}$s such that for all is $\hat{\epsilon}_{i,t} = \epsilon_{i,t} + \varphi_t$. In this setting the GIV shock $\varrho_{GIV,t} = \sum_{i=1}^{13}(\epsilon_{i,t} + \varphi_t) w_i - \sum_{i=1}^{13}(\epsilon_{i,t} + \varphi_t)\frac{1}{13} = \sum_{i=1}^{13} \hat{\epsilon}_{i,t} w_i - \sum_{i=1}^{13} \hat{\epsilon}_{i,t} \frac{1}{13}$ still represents exogenous variation coming from the true idiosyncratic demand shocks since the common shock gets cancelled out in the subtraction of the equal-weighted-average from size-weighted-average. By contrast, the Bartik shock $\varrho_{Bartik,t} = \sum_{i=1}^{13}(\epsilon_{i,t} + \varphi_t)\frac{1}{13}$ is now the sum of the common shock and the average of the idiosyncratic demand shocks.

The bias for the Bartik shock from unobserved common shocks demonstrated above emphasizes an important advantage possessed by the GIV shock approach (for which such bias is eliminated) relative to the Bartik one in our setting. Since the USD/ILS FX swap market is rather concentrated, bearing an average Herfindahl-Hirschman Index of 0.27 and 0.21 for IIs' (absolute) open FX swap positions and swap volumes, respectively, it can deliver sufficient exogenous variation 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 $\hat{\epsilon}_{i,t}$s do not appear to contain a material such unobserved common component, possessing an average absolute pairwise correlation of 2.4% and a corresponding standard deviation of 2.1%, thus indicating that the Bartik shock approach is likely to suffer from only a moderate bias. Nevertheless, the concentrated structure of the swap market under study and the GIV shock approach's ability to remove even moderate biasing variation coming from unobserved common shocks both lead us to favor the GIV shock approach over the Bartik one as this paper's preferred method for the estimation of the LOA-dependent channel of FX swap demand.

As in the granular-without-controls case, we scale the effects of the GIV and Bartik shocks such that their linear effects from quantity regressions analogous to Regressions (8) and (7)- i.e., ones that use IIs' aggregate FX swap flows as the dependent variable - are equal to one standard deviation of IIs' aggregate swap flows (542.5 millions dollars).

Local Projection Extension. Our paper is focused on the *impact* LOA-dependent effect of demand shocks. This is a natural and warranted choice given that the LOA-dependent channel of FX swap demand can effectively only be reliably tested and estimated at the impact horizon where the identified demand shock operates on a differentially sloped FX swap supply curve across the LOA and no LOA states. At later horizons this is no longer necessarily the case as more factors may come into play, e.g., differential persistence of the demand shock across the two states and differential response of arbitrageurs to the widening of the basis (potentially altering the initially differential FX swap supply slope) across the two states, in turn sullying the identification of our LOA-dependent demand channel.

Nevertheless, it still seems worthwhile to also explore the dynamic nature of the LOA-dependent channel of FX swap demand as this would inform us about this channel's persistence. Toward this end, and having established our GIV-with-controls approach as our preferred method for estimation of the LOA-dependent channel of FX swap demand, we provide a dynamic extension of the latter approach which allows for estimation of dynamic effects (impulse responses) and forecast error variance (FEV) contributions for our GIV shock. We implement this extension by jointly estimating 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]

For ease of exposition, the details and results of our dynamic extension and its associated estimation and inference procedure are presented in Appendix B of the online appendix to this paper. The main takeaway from this dynamic analysis is that there is a short-lived basis response in the LOA state which remains significant for 3 days; the response difference across the LOA and no LOA states remains significant for 2 days. This short-lived basis response accords with the short-lived nature of IIs' open FX swap position's response in the LOA state, which remains continuously significant for only the first 6 days after the shock, losing significance for the next 2 days before regaining it for one more day and becoming insignificant again after 10 days. I.e., the low persistence of the GIV shock in the LOA state can serve as a sensible explanation for the temporary basis widening in this state.[27]

6 Empirical Evidence

This section presents the main results of the paper. The presentation is structured as follows. First, we show results for IIs' basis from our three plain-vanilla estimation approaches: aggregate-without-controls; aggregate-with-controls; and granular-without-controls, which includes results

[26]The Bayesian approach we take is in the spirit of a long tradition in the literature on impulse response estimation (see, e.g., Del Negro and Schorfheide (2011)) that has recently also caught on in the local projections literature (see, e.g, Miranda-Agrippino and Ricco (2021) and Ben Zeev (2023)).

[27]Also, the contribution of the GIV shock to the variation of the basis in the LOA state is low, standing at 3.3% on impact and peaking at 5.8% after 7 days. We do not view these low shares as evidence going against this paper's message given that our claim is not that the LOA-dependent FX swap demand channel explains the bulk of the variation in the basis but rather that our data allows us to meaningfully uncover the presence of this channel in the data.

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 message about the superior validity of the GIV-with-controls estimation approach, we present additional results from this approach: a sectoral swap flow analysis and results from various robustness checks as well as a narrative analysis of the GIV shock series. And fourth, we end the section with a complementary identification approach which uses a seasonal demand shifter framework to bolster the main message of this paper.

We scale all of the demand effects in our empirical analysis such that the linear response of the IIs' aggregate FX swap flow variable is equal to one standard deviation of this variable (542.5 millions dollars). For completeness, in addition to showing the LOA-dependent demand effects which are the central objects of our analysis, we present the linear and interaction coefficients underlying the construction of the latter effects as well as the coefficient on the interacting variable LOA_{t-1}. (Those from the aggregated-based and granular-without-controls specifications are presented in the main text while those from the granular-with-controls ones are presented in Appendix C of the online appendix to this paper.)

6.1 Aggregate and Granular-Without-Controls Estimation Results

Table 6 shows the LOA-dependent effects on IIs' aggregate (volume-weighted average) basis for the aggregate-without-controls (first column), aggregate-with-controls, GIV-without-controls, and Bartik-without-controls estimations. The first twos rows show the effects in the LOA and no LOA states and the third row shows the difference between these effects. For completeness, Table 7 presents the estimates of the linear coefficient (Ξ_L), interaction coefficient (Ξ_I), and coefficient on interacting variable LOA_{t-1} (β) from the corresponding regressions. Standard errors for both tables, as well as all subsequent tables, are computed from the heteroskedasticity- and autocorrelation-consistent procedure of Newey and West (1987) with the truncation lag selected from the data-driven procedure from Andrews (1991).

The results demonstrate a significant widening of the basis in the LOA state for all four considered estimations. While the GIV-without-controls estimation yields the largest such basis widening, standing at -10.6 basis points, the other estimation approaches also produce meaningful basis widening in the range of -5.9 - -6.3 basis points. By contrast, there is an economically and statically insignificant basis response in the no LOA state with the response difference across the two states significant for all four considered estimations. These inceptive results support the idea that when LOA are meaningful, FX swap supply is sufficiently rigid such that a rise in aggregate FX swap demand causes a significant widening of the basis, as opposed to when LOA are not meaningful, in which case FX swap supply is sufficiently elastic so as to prevent from the rise in aggregate FX swap demand shock to widen the basis.

6.2 Granular-With-Controls Estimation

IIs' Aggregate Basis. The first panel of Table 8 shows the LOA-dependent effects on IIs' aggregate (volume-weighted average) basis for the GIV-with-controls (first column) and Bartik-with-controls (second column) estimations with Table 8's expositional structure following that of Table 6. For completeness, the first panel of Table 1 from Appendix C of the online appendix to this paper presents the estimates of the linear coefficient (Ξ_L), interaction coefficient (Ξ_I), and coefficient on interacting variable LOA_{t-1} (β) from the corresponding regressions.

The results demonstrate a significant widening of the basis in the LOA state for both the GIV shock (-12 basis points) and the Bartik shock (-7.6 basis points). By contrast, there is an economically and statistically insignificant basis response in the no LOA state. And the differences between the responses in the LOA and no LOA states are statistically significant, continuing to support the presence of a meaningful LOA-dependent FX swap demand channel.

IIs' Aggregate Swap Flows. The second panel of Table 8 shows the LOA-dependent effects on IIs' aggregate FX swap flows of the GIV and Bartk shocks with this panel's expositional structure following that of Table 6. For completeness, the second panel of Table 1 from Appendix C of the online appendix to this paper presents the estimates of the linear coefficient (Ξ_L), interaction coefficient (Ξ_I), and coefficient on interacting variable LOA_{t-1} (β) from the corresponding regressions.

According to the LOA-dependent FX swap demand channel, we expect to see a significantly 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 dollars relative to 339.3 million dollars) and Bartik (712.5 million dollars relative to 304 million dollars) shocks, respectively. These significant response differences support the interpretation of the results from Table 8 as being driven by an LOA-dependent FX swap demand channel as the more rigid FX swap supply curve in the LOA state generates a smaller demand-shock-induced rise in swap flows.

6.3 GIV-With-Controls: Additional Analysis

Sectoral FX Swaps. Table 9 presents the LOA-dependent responses of our considered sectors' swap flow series to the GIV shock. For completeness, IIs' swap flows' responses are presented in the first column of the table, followed by the corresponding response for local banks (second column); foreigners (third column); mutual funds (MFs) and exchange trade funds (ETFs) (abbreviated by MFs in the fifth column); hedge funds and proprietary trading firms (abbreviated by HFs in the fifth column); and the real sector (seventh column). For completeness, Table 2 from Appendix C of the online appendix to this paper presents the estimates of the linear coefficient (Ξ_L), interaction coefficient (Ξ_I), and coefficient on interacting variable LOA_{t-1} (β) from the corresponding regressions.

In the LOA state, foreigners and HFs are the only sectors significantly selling swap-linked spot dollars against the significant buying undertaken by IIs. This implies that foreign financial institutions and local hedge funds and proprietary trading firms are the sole liquidity providers in the USD/ILS swap market in times of distress and increased demand from IIs. It is noteworthy that foreigners take a much more meaningful such provisional role, exhibiting a response of -180.7 million dollars compared to -67.4 million dollars for the hedge funds and proprietary trading firms sector. But both responses are significant and sit well with the notion that both sectors' financial institutions act as important liquidity-supplying arbitrageurs in the LOA state conditional on a rise in IIs' swap demand. (While local banks also supply swap-linked spot dollars with a response of -93.3 million dollars, this selling is statistically insignificant.)

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 supplier of swap-linked spot dollars against IIs' increased demand when arbitrage capital is abundant but they appear to entirely forego this role in the LOA state, being replaced mainly by foreigners who seem to seize the arbitrage opportunity that presents itself in the LOA state. These results accord with the easily perceived view that local banks are expected to grapple with global dollar shortages much more than large foreign financial institutions.

Robustness Checks. The first and second panels of Table 10 show IIs' basis and swap flow response results from examination of the robustness of our baseline results along four dimensions.[28] First, constructing an alternative intermediary leverage ratio variable as our LOA measure by replacing our baseline USD/ILS-swap-market-specific measure with the one from He et al. (2017) (first column). Second, excluding the GFC period by beginning the sample in 2010 (Second column). Third, excluding the COVID period by truncating the sample at the end of February of 2020 (third column).[29] And fourth, altering the lag specifications underlying Equation (3), with the fourth and fifth columns of Table 10 showing results from halving and doubling the number of lags from Equation (3), respectively.

The results are similar to the baseline ones and continue to support the presence of a meaningful LOA-dependent FX swap demand channel. In all considered specifications, the basis significantly widens in the LOA state while insignificantly moving in the no LOA state with response difference both economically and statistically significant. IIs' swap flows also response similarly to the baseline case, rising by significantly more in the no LOA state than in the LOA state for all considered specifications.

[28]These panels' expositional structure follows that of Table 6. For completeness, Table 3 from Appendix C of the online appendix to this paper presents the estimates of the linear coefficient (Ξ_L), interaction coefficient (Ξ_I), and coefficient on interacting variable LOA_{t-1} (β) from the corresponding regressions.

[29]Note that the pre-COVID period has less observations (2,204) than the post-GFC one (2,392) because the USD/ILS FX swap market was much less active early in the sample (in particular in 2008) than in the post-COVID part of the sample.

6.4 Narrative Analysis

To better our understanding of the nature of the idiosyncratic demand shocks identified in this paper, Table 11 provides a narrative analysis of the latter shocks that builds on the MAYA website which gathers all TASE public company disclosures of out-of-the-ordinary events (available at https://maya.tase.co.il/reports/company). The proprietary nature of our date prevents us from identifying the IIs in Table 11 by name and other companies' names in the associated events. We do include in the table, however, each relevant II's size (in terms of swap volume share). Our narrative account covers a total of 6 large IIs whose swap volume activity accounts for 81.7% of the total IIs' volume. The table depicts a total of 15 events and their dates along with a narration of their connection to corresponding idiosyncratic demand shock realizations (in millions of dollars). (For completeness, the corresponding GIV shock (in standard deviations units) is also shown.) 13 of the events represent favorable demand shocks, i.e., increased demand for swap-linked spot dollars, and 2 correspond to lesser such demand.

Our narrative analysis highlights several characteristics that underlie the idiosyncratic shocks' nature. First, favorable demand shocks can directly arise from a decision to conduct foreign investment, which can in turn emerge from either a partnership with a global company or the II's independent decision to conduct such investment. Second, favorable demand shocks often arise as a result of the II in question receiving out-of-the-ordinary local currency receipts which in turn provide additional cash collateral for swap trades. These positive local currency cash inflows can come from the selling of various local assets as well as from proceeds from equity private placement/IPO. And third, adverse demand shocks appear to arise from the II's use of swaps as a deleveraging tool. More generally, the paying off of local debt can be funded by the drawing down of open swap positions as this generates ILS cash inflows in return for dollar cash outflows.

In sum, our narrative analysis underscores the fundamental use of FX swaps as FX-risk-free funding for foreign investment. This use is intrinsically linked to FX swaps being tantamount to collateralized dollar loans where the collateral is ILS cash. And this equivalence also underlies the use of FX swaps to pay off local liabilities as the winding down of the swap positions generates local currency cash inflows.

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 of each month - that we use as a control variable in our regression analysis. The institutional details warranting this seasonal control inclusion have their roots in the well-established evidence on monthly-payment-cycle-induced cash needs facing IIs (Etula et al. (2019)) which in turn arise from the often semi-monthly nature of IIs' payment cycle.

To vividly see this seasonality in IIs' swap flow behavior, Figure 6 shows the sum of IIs' swap flows across daily calendar dates for our baseline sample. Values on the y-axis are in millions of dollars, with positive (negative) values representing IIs' buying (selling) of swap-linked spot dollars. The mid-month and month-end seasonality in IIs' selling of swap-linked spot dollars (i.e., reductions in IIs' open swap positions which in turn provide IIs with ILS liquidity) is salient, with IIs' choosing to do the vast majority of the winding down of their positions on the 14th, 15th, and 29th-31st dates. (Increases in II's positions do not appear to posses similar seasonality patterns, with the associated positive swap flow values not being limited to certain dates but rather quite dispersed.)

Etula et al. (2019)'s robust finding that U.S. IIs' monthly-payment-cycle-induced seasonality has significant effects on asset prices - effects that are likely driven by LOA - begs the question of whether the apparent seasonality from Figure 6 has implications for IIs' basis. In other words, since the salient winding down of IIs' positions on the 14th, 15th, and 29th-31st dates represents a negative swap demand shifter, we can exploit this seasonal demand shifter to further examine the relevance of the LOA-dependent FX swap demand channel. In what follow we lay out the two regression equation we estimate for this examination.

Seasonal-Without-Controls Estimation. We start by estimating an analogous regression to the baseline aggregate regression from Equation (1), given by

$$\Delta b_t = \alpha + \Xi_L \mathbb{S}_t + \Xi_I LOA_{t-1} \mathbb{S}_t + \beta LOA_{t-1} + u_t, \tag{9}$$

where t indexes time at daily frequency; Δb_t is the first-difference of aggregate (volume-weighted average) IIs' cross-currency basis; α is the intercept; $\mathbb{S}_t$ is a dummy variable that takes the value of one on the 14th, 15th, and 29th-31st dates of each month; and LOA_{t-1} is the deviation of the logged intermediary leverage ratio variable at $t-1$ from its mean divided by this variable's standard deviation. The only difference between Equation (9) and Equation (1) is that the former replaces ΔSP_t with $\mathbb{S}_t$. We continue to define the effects in the LOA and no LOA states as $\Xi_L + 2\Xi_I$ and $\Xi_L - 1.4\Xi_I$, respectively, where these effects now capture the LOA-dependent effects of the seasonal demand shifter.

The first column of the first and second panels of Table 12 show Equation (9)'s LOA-dependent effects of seasonal demand shifter $\mathbb{S}_t$ on IIs' aggregate basis and swap flows, respectively. For completeness, the first column of the first and second panels of Table 4 from Appendix C of the online appendix to this paper present the estimates of the linear coefficient (Ξ_L), interaction coefficient (Ξ_I), and coefficient on interacting variable LOA_{t-1} (β) from the corresponding regressions. To obtain the estimated LOA-dependent effect on swap flows, we simply replace outcome variable Δb_t with ΔSP_t and add a time trend to the RHS of the regression.

The results indicate that the seasonal demand shifter produces a significant narrowing of the basis in the LOA state, raising (i.e., narrowing) it by 21.7 basis points, while insignificantly moving swap flows. By contrast, in the no LOA state, swap flows reduce significantly by 861.7 million dollars while failing to narrow the basis. These results accord with the presence of a meaningful LOA-dependent FX swap demand channel where FX swap supply is inelastic in the LOA state thus preventing a fall in swap flows while facilitating a significant narrowing of the basis.

Seasonal-With-Controls Estimation. One may argue that our seasonal demand shifter's estimated effects from Equation (9) may be contaminated by distinct, common FX swap market demand and supply factors. To address this concern, we now show results from augmenting

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

$$\Delta b_t = \alpha + \Xi_L \mathbb{S}_t + \Xi_I LOA_{t-1} \mathbb{S}_t + \beta LOA_{t-1} + X_t' \delta_L + LOA_{t-1} X_t' \delta_I + u_t. \tag{10}$$

The second column of the first and second panels of Table 12 show the results from this estimation. For completeness, the second column of the first and second panels of Table 4 from Appendix C of the online appendix to this paper present the estimates of the linear coefficient (Ξ_L), interaction coefficient (Ξ_I), and coefficient on interacting variable LOA_{t-1} (β) from the corresponding regressions.

The controls-inclusive LOA-dependent effects of seasonal demand shifter $\mathbb{S}_t$ on IIs' aggregate basis and swap flows continue to support a meaningful LOA-dependent FX swap demand channel: in the LOA state, the adverse demand shift significantly narrows the basis by 22.5 basis points while bringing upon no significant drop in swap flows; in the no LOA state, however, the adverse demand shift fails to narrow the basis while significantly reducing swap flows. Taken together, we consider this section's results as providing important support and validation for our baseline results in putting forward additional evidence in favor of a meaningful LOA-dependent FX swap demand channel.

7 Conclusion

The evidence provided in this paper supports a meaningful LOA-dependent FX swap demand channel. In particular, we show that the effect of an FX swap demand shock that shifts IIs' aggregate demand for swaps rightward meaningfully depends on the initial LOA state: when LOA are meaningful, the FX supply curve is rigid thereby resulting in a significant widening of IIs' cross-currency basis; by contrast, when LOA are immaterial, the FX supply curve is elastic thereby preventing a widening of the basis.

We have obtained these results by using a bottom-up, GIV-based econometric approach that constructs the aggregate FX swap demand shock as the difference between the size-weighted- and equal-weighted-average of estimated idiosyncratic demand shocks of individual IIs. Our IIs' basis measure is also based on micro data, constructed as the volume-weighted average of the *actual* basis incurred by individual IIs, as is our LOA measure which we construct as the leverage ratio of the large global dealers operating in the USD/ILS FX swap market (which we identify as such from our micro data). That our daily shock, LOA, and outcome variables are founded on our unique transaction-level FX swap data strengthens our confidence in the validity of this paper's results.

We hope this paper's results can advance our understanding of how cross-currency basis can significantly widen in the presence of favorable FX swap demand shocks. While our results are based on Israeli data, our view is that they can be externally valid for a much broader sample of economies which posses a developed FX swap market in which local IIs are central demanders for swap-linked spot dollars.

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

Percentile	IIs	Local Banks	Foreigners	MFs	HFs	Real	All
5th	3	1	1	3	1	2	1
25th	21	3	2	5	3	4	2
50th	54	7	3	7	5	10	6
75th	84	41	22	24	9	24	32
95th	198	147	70	223	99	124	128
# Of Players	13	11	7,829	14	314	1,200	9,381
Obs	109,854	568,131	197,024	286,314	340,313	146,486	1,648,122

Notes: This table presents the maturity distribution (5th, 25th, 50th, 75th, and 95th percentiles) for FX swap transactions in our transaction-level dataset broken down by sector - with the last column's 'All' corresponding to the entire sample - as well as the number of players in each sector and number of FX swap transactions underlying our sectoral computations ('Obs'). Maturities are in terms of days. On top of the IIs sector, this table includes five additional sectors: local commercial banks; foreign sector, which includes all foreign firms engaged in financial activity (i.e., foreign commercial and investment banks, pension and insurance funds, mutual funds, exchange traded funds, hedge funds, and proprietary trading firms); local mutual funds and exchange traded funds - abbreviated by MFs in the table; local hedge funds and proprietary trading firms - abbreviated by HFs in the table; and local real sector, which represents Israeli exporters and importers. Data are from the BOI and cover 1/7/2008-3/31/2022.

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

	Sectoral Aggregate Basis (in Basis Points)					
	IIs	Local Banks	Foreigners	MFs	HFs	Real
Volume-Weighted Average	-43	-19	-7	-27	-19	-16
Standard Deviation	51	55	78	46	59	49
# Of Players	13	11	7,829	14	314	1,200
Obs	109,854	568,131	197,024	286,314	340,313	146,486
	Sectoral Aggregate Swap Flows (in Millions of Dollars)					
	IIs	Local Banks	Foreigners	MFs	HFs	Real
Average	21	-10	-10	-1	0	1
Standard Deviation	543	1,033	606	147	440	191
# Of Players	13	11	7,829	14	314	1,200
Obs	109,854	568,131	197,024	286,314	340,313	146,486

Notes: This table presents averages and standard deviations for sectoral aggregate FX swap prices and quantities as well as the number of players in each sector and number of FX swap transactions underlying our sectoral computations ('Obs'). The prices - shown in the first panel - are the sectors' daily volume-weighted averages of their FX swap transactions' cross-currency bases and the quantities - shown in the second panel - are the daily changes in the sectors' open FX swap positions (i.e., sectoral swap flows - where positive (negative) values represent buying (Selling) of swap-linked spot dollars). On top of the IIs sector, this table includes five additional sectors: local commercial banks; foreign sector, which includes all foreign firms engaged in financial activity (i.e., foreign commercial and investment banks, pension and insurance funds, mutual funds, exchange traded funds, hedge funds, and proprietary trading firms); local mutual funds and exchange traded funds - abbreviated by MFs in the table; local hedge funds and proprietary trading firms - abbreviated by HFs in the table; and local real sector, which represents Israeli exporters and importers. Data are from the BOI and cover 1/7/2008-3/31/2022.

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

Percentile	IIs	Local Banks	Foreigners	MFs	HFs	Real
IIs		73.8%	58.6%	76.4%	73.5%	75.4%
Local Banks	73.8%		68.4%	79.3%	88.1%	78.9%
Foreigners	58.6%	68.4%		56.1%	60.1%	55.8%
MFs	76.4%	79.3%	56.1%		79.1%	78.1%
HFs	73.5%	88.1%	60.1%	79.1%		75.6%
Real	75.4%	78.9%	55.8%	78.1%	75.6%	
# Of Players	13	11	7,829	14	314	1,200
Obs	109,854	568,131	197,024	286,314	340,313	146,486

Notes: This table presents the correlation matrix of sectoral bases as well as the number of players in each sector and number of FX swap transactions underlying our sectoral correlation computations ('Obs'). Sectoral bases are the sectors' daily volume-weighted averages of their FX swap transactions' cross-currency bases. On top of the IIs sector, this table includes five additional sectors: local commercial banks; foreign sector, which includes all foreign firms engaged in financial activity (i.e., foreign commercial and investment banks, pension and insurance funds, mutual funds, exchange traded funds, hedge funds, and proprietary trading firms); local mutual funds and exchange traded funds - abbreviated by MFs in the table; local hedge funds and proprietary trading firms - abbreviated by HFs in the table; and local real sector, which represents Israeli exporters and importers. Data are from the BOI and cover 1/7/2008-3/31/2022.

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

Variable	ΔS&P 500	ΔTA35	ΔBroad Dollar	ΔVTA	ΔVIX	ΔII Basis	Δ1 Month USD/EUR Basis	ΔInterest Rate Spread
ΔLOA	-78.1%	-47.2%	36.4%	25.6%	50.4%	-3.7%	-15.9%	0.3%
ΔII Basis	0.8%	3.6%	-3.0%	-5.1%	-2.5%		7.9%	10.9%

Notes: This table presents daily correlations of variables in our sample, where all variables are in log-first-differences except for the basis variables and interest rate spread (difference between 3-month Libor and Telbor rates) which are in first-differences. The first row shows the daily correlation between our LOA measure and IIs' aggregate (volume-weighted average) basis as well as the additional macro-financial variables which we control for in the regression analysis. The second row shows the daily correlation between IIs' aggregate (volume-weighted average) basis and the other variables. See Section 4.1 for the definitions and sources of the data. The data cover 1/7/2008-3/31/2022.

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 descending order) by each II's size in terms of its share of average swap volume in total average IIs' volume.

Table 6: **Aggregate and Granular-Without-Controls Estimations: LOA-Dependent Effects.**

Response	Aggregate-Without-Controls	Aggregate-With-Controls	GIV-Without-Controls	Bartik-Without-Controls
LOA State	-6.1**	-6.3***	-10.6*	-5.9**
	(2.8)	(1.9)	(6.0)	(2.8)
No LOA State	-0.2	-0.2	1.5	-0.2
	(0.7)	(0.7)	(1.5)	(0.7)
Difference	-5.9*	-6.1**	-12.1*	-5.7*
	(3.4)	(2.4)	(7.3)	(3.5)
R^2	1.1%	38.5%	1.8%	1.1%
Obs	2,650	2,650	2,648	2,648

Notes: The first and second columns of this table present the LOA-dependent effects from estimation of Equations (1) and (2), respectively; the third and fourth columns show LOA-dependent effects from estimation of Equation (1) where IIs' aggregate swap flow variable is replaced by the difference between the size-weighted- and equal-weighted-average of linearly detrended II-level swap flows (third column) and the equal-weighted-average of linearly detrended II-level swap flows (fourth column). The LOA (no LOA) state corresponds to the LOA variable being 2 (1.4) standard deviations above (below) its mean. Numbers in parentheses represent standard errors computed from the heteroskedasticity- and autocorrelation-consistent procedure of Newey and West (1987) with the truncation lag selected from the data-driven procedure from Andrews (1991). *, **, and *** represent significance levels at the 10%, 5%, and 1% levels.

Table 7: **Aggregate and Granular-Without-Controls Estimations: Coefficient Estimates.**

Coefficient	Aggregate-Without-Controls	Aggregate-With-Controls	GIV-Without-Controls	Bartik-Without-Controls
Linear Coefficient	-2.7***	-2.7***	-3.6**	-2.6***
	(0.9)	(0.6)	(1.7)	(0.9)
Interaction Coefficient	-1.7*	-1.8**	-3.5*	-1.7*
	(1.0)	(0.7)	(2.1)	(1.0)
LOA_{t-1} Coefficient	-0.0	0.0	-0.2	-0.1
	(0.2)	(1.3)	(0.2)	(0.2)
R^2	1.1%	38.5%	1.8%	1.1%
Obs	2,650	2,650	2,648	2,648

Notes: The first and second columns of this table present the estimates of the linear coefficient (Ξ_L), interaction coefficient (Ξ_I), and coefficient on interacting variable LOA_{t-1} (β) from estimation of Equations (1) and (2), respectively; the third and fourth columns show the corresponding coefficients from estimation of Equation (1) where IIs' aggregate swap flow variable is replaced by the difference between the size-weighted- and equal-weighted-average of linearly detrended II-level swap flows (third column) and the equal-weighted-average of linearly detrended II-level swap flows (fourth column). Numbers in parentheses represent standard errors computed from the heteroskedasticity- and autocorrelation-consistent procedure of Newey and West (1987) with the truncation lag selected from the data-driven procedure from Andrews (1991). *, **, and *** represent significance levels at the 10%, 5%, and 1% levels.

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

	IIs' Aggregate Basis (in Basis Points)	
Response	GIV-With-Controls	Bartik-With-Controls
LOA State	-12.0***	-7.6***
	(4.6)	(2.5)
No LOA State	2.3	0.6
	(1.6)	(1.0)
Difference	-14.3**	-8.2**
	(6.0)	(3.3)
R^2	1.8%	1.2%
Obs	2,648	2,648
	IIs' Aggregate Swap Flows (in Millions of Dollars)	
Response	GIV-With-Controls	Bartik-With-Controls
LOA State	339.3***	304.0***
	(49.9)	(29.1)
No LOA State	687.3***	712.5***
	(40.1)	(26.0)
Difference	-347.9***	-408.5***
	(79.1)	(49.7)
R^2	37.3%	55.9%
Obs	2,648	2,648

Notes: The first panel of this table presents the LOA-dependent effects of the GIV and Bartik shocks on IIs' aggregate (volume-weighted average) basis from estimation of Equations (8) and (7), respectively, where the two shocks are the difference between the size-weighted- and equal-weighted-average (GIV) and the equal-weighted-average (Bartik) of the idiosyncratic II-level demand shocks estimated from Equations (4)-(6). The second panel of the table shows the corresponding responses of IIs' aggregate swap flows obtained by replacing the basis variable in Equations (8) and (7) with the swap flow one and adding a time trend to the RHS of these equations. The LOA (no LOA) state corresponds to the LOA variable being 2 (1.4) standard deviations above (below) its mean. Numbers in parentheses represent standard errors computed from the heteroskedasticity- and autocorrelation-consistent procedure of Newey and West (1987) with the truncation lag selected from the data-driven procedure from Andrews (1991). *, **, and *** represent significance levels at the 10%, 5%, and 1% levels.

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)
No LOA State	687.3***	-615.9***	-38.7	-1.9	26.2	1.6
	(40.1)	(70.9)	(45.3)	(9.4)	(48.0)	(11.4)
Difference	-347.9***	522.6***	-142.0	-6.6	-93.5	20.2
	(79.1)	(140.7)	(122.2)	(14.2)	(66.9)	(20.7)
R^2	37.3%	4.9%	0.8%	0.1%	0.1%	0.1%
Obs	2,648	2,648	2,648	2,648	2,648	2,648

Notes: This table presents the LOA-dependent effects of the GIV shock on sectoral aggregate swap flows from estimation of Equation (8) where the basis variable in this equation is replaced with each sector's swap flow variable and a time trend is added to the RHS of these equations. The two shocks are the difference between the size-weighted- and equal-weighted-average (GIV) and the equal-weighted-average (Bartik) of the idiosyncratic II-level demand shocks estimated from Equations (4)-(6). For completeness, IIs' swap flows' responses are presented in the first column of the table, followed by the corresponding responses for local banks (second column); foreigners (third column); mutual funds (MFs) and exchange trade funds (ETFs) (abbreviated by MFs in the fourth column); hedge funds and proprietary trading firms (abbreviated by HFs in the fifth column); and the real sector (seventh column). The LOA (no LOA) state corresponds to the LOA variable being 2 (1.4) standard deviations above (below) its mean. Numbers in parentheses represent standard errors computed from the heteroskedasticity- and autocorrelation-consistent procedure of Newey and West (1987) with the truncation lag selected from the data-driven procedure from Andrews (1991). *, **, and *** represent significance levels at the 10%, 5%, and 1% levels.

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	1.3%	1.4%	0.9%	1.7%	1.7%
Obs	2,648	2,392	2,204	2,652	2,640

	IIs' Aggregate Swap Flows (in Millions of Dollars)				
Response	Alternative LOA	Post-GFC	Pre-COVID	Shorter Lags	Longer Lags
LOA State	294.6***	353.0***	296.2***	334.5***	343.3***
	(35.8)	(45.6)	(51.4)	(52.5)	(51.3)
No LOA State	704.4***	676.7***	714.4***	690.8***	684.3***
	(31.9)	(34.6)	(41.0)	(40.6)	(35.9)
Difference	-409.8***	-323.8***	-418.2***	-356.3***	-341.0***
	(61.6)	(69.9)	(81.1)	(83.0)	(76.8)
R^2	39.2%	34.8%	33.9%	42.2%	35.2%
Obs	2,648	2,392	2,204	2,652	2,640

Notes: The first panel of this table presents the LOA-dependent effects of the GIV shock on IIs' aggregate (volume-weighted average) basis from estimation of Equation (8) for various alternative specifications. The first uses an alternative LOA measure taken from He et al. (2017); the second excludes the GFC period by beginning the sample in 2010; the third excludes the COVID period by truncating the sample at the end of February of 2020; and the fourth and fifth halve and double the number of lags from Equation (3), respectively. The second panel of the table shows the corresponding responses of IIs' aggregate swap flows obtained by replacing the basis variable in Equation (8) with the swap flow one and adding a time trend to the RHS of these equations. The LOA (no LOA) state corresponds to the LOA variable being 2 (1.4) standard deviations above (below) its mean. Numbers in parentheses represent standard errors computed from the heteroskedasticity- and autocorrelation-consistent procedure of Newey and West (1987) with the truncation lag selected from the data-driven procedure from Andrews (1991). *, **, and *** represent significance levels at the 10%, 5%, and 1% levels.

Table 11: **Narrative Analysis.**

Date	GIV Shock Size (SD Units)	Idiosyncratic Shock Size (Million USD Units)	II Size	Event	Explanation
01/06/22	0.2	198.4	19.2%	75 million dollar foreign investment providing 22.5% ownership rate in global renewable energy company.	Foreign investment funding from swaps.
03/22/16	0.7	154.3	19.2%	Selling of stake in local commercial real estate company for 329 million ILS.	Additional ILS cash collateral for foreign-investment-funding swaps.
04/01/19	2.6	175.6	19.2%	Receipt of 250 million ILS from equity private placement proceeds.	Additional ILS cash collateral for foreign-investment-funding swaps.
06/30/08	0.4	76	19.2%	70 million dollar acquisition of U.S.-based investment bank subsidiary.	Foreign investment funding from swaps.
06/01/21	0.5	249.2	11%	288 million ILS proceeds from selling part of mutual fund and brokerage activity.	Additional ILS cash collateral for foreign-investment-funding swaps.
07/22/20	0.2	72.7	20.9%	Investment committee decision on investing up to 25% and 75% of IPO proceeds of 200 million ILS in debt and equity assets, respectively.	Foreign investment funding from swaps: No comment/restriction is made on how much is to be allocated to foreign assets and so we reason that some of the investment is to be directed to foreign assets.
02/19/13	1.4	182.9	20.9%	Selling of mutual fund and portfolio management activity for 210 million ILS.	Additional ILS cash collateral for foreign-investment-funding swaps in the II's long-term fund activity.

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 company for 221 million dollars.	Additional ILS cash collateral for foreign-investment-funding swaps which is a result not only of the cash injection but also the alleviation of creditors' pressure on the parent company (and, as a result, on the II as well). This pressure alleviation in turn frees up the II's balance sheet for uses that are unrelated to the parent company's difficulties.
10/23/14	-0.7	-166.6	20.9%	Announcing deleveraging policy to pay off bank debt of 388 million ILS.	Drawing down of swap positions can be used as a deleveraging tool as the II receives ILS in return for dollars.
08/25/14	-0.5	-75.1	20.9%	Final approval received from Israel Securities Authority for bond debt prepayment of 233 million ILS.	Drawing down of swap positions can be used for local debt payment as the II receives ILS in return for dollars.
05/09/16	1.8	265	10.8%	Merging with a competing II managing 7 billion ILS worth of assets.	While the II being merged is small relative to the II in question, as the latter holds nearly 6 times as much assets as the former, the added assets from the merger nevertheless constitute an addition of more than 17% to the II's assets. Such meaningful addition provides supplementary ILS cash collateral for obtaining foreign-investment-funding swaps.

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.
09/30/21	2.4	96.6	12.1%	Acquisition of long-term investment funds managing 26 billion ILS worth of assets for 185 million ILS.	This is a regulation-driven sale that provides additional ILS cash collateral for foreign-investment-funding swaps.
11/08/12	0.1	62.3	12.1%	Acquisition of real estate assets in the U.S. worth 79 million dollars.	Foreign investment funding from swaps.

Notes: This table provide a narrative account for our identified idiosyncratic demand shocks. The source is the MAYA website which gathers all TASE public company disclosures of out-of-the-ordinary events (available at https://maya.tase.co.il/reports/company). The first column gives the event's date; the second column provides the GIV shock (in standard deviation units) computed from the idiosyncratic demand shocks; the third column reports the idiosyncratic demand shock (in millions of dollars) corresponding to the event; the fourth column reports the size of the II to which the idiosyncratic shock corresponds (computed as the share of the II's average swap volume in total IIs' average swap volume); the fifth column states the event; and the sixth column gives an explanation (narrative) that links the event to the idiosyncratic demand shock. Positive (negative) values of the GIV and idiosyncratic shocks correspond to more (less) demand for swap-linked spot dollars.

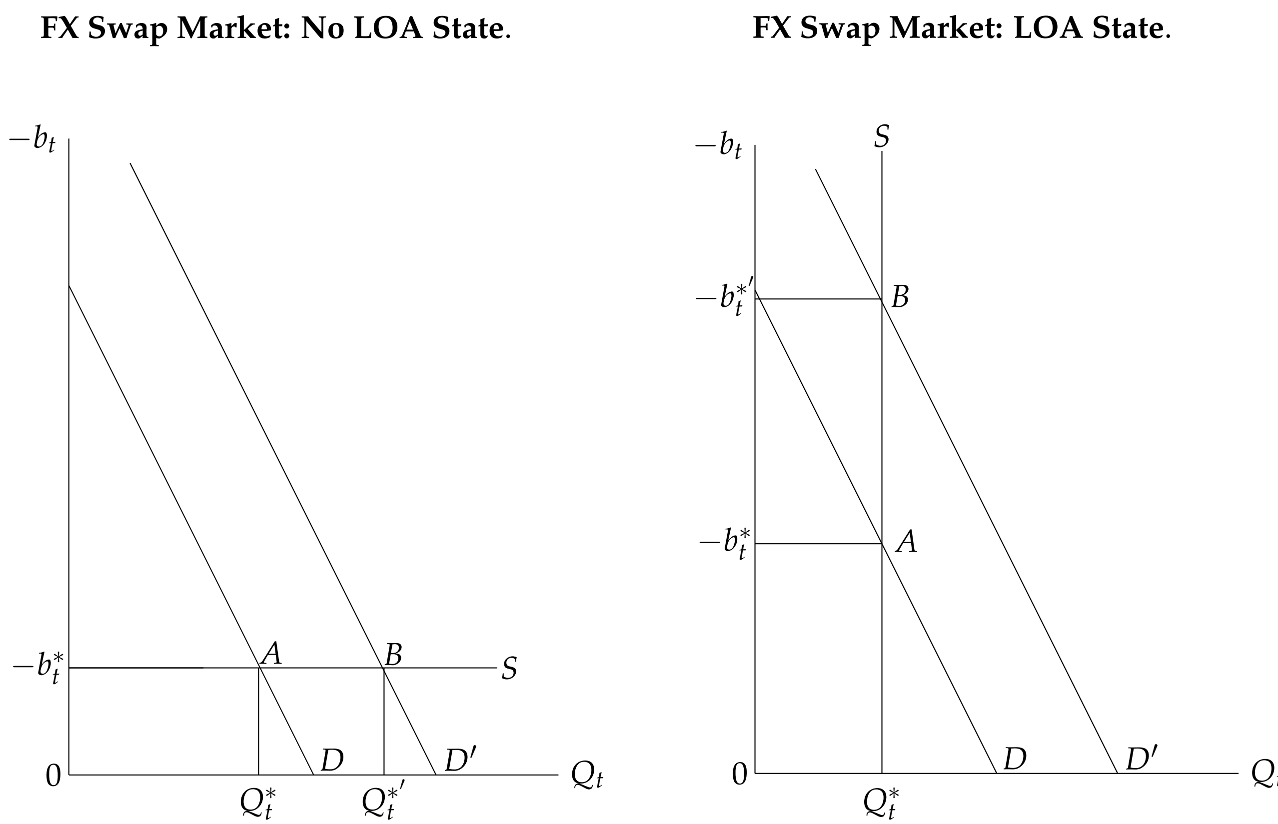
Table 12: **Seasonal Demand Shifter Results: LOA-Dependent Effects.**

	IIs' Aggregate Basis (in Basis Points)	
Response	Seasonal-Without-Controls	Seasonal-With-Controls
LOA State	21.7**	22.1**
	(9.2)	(8.8)
No LOA State	-7.9*	-7.1
	(4.4)	(5.2)
Difference	29.5**	29.2**
	(12.5)	(12.5)
R^2	0.2%	37.9%
Obs	2,650	2,650

	IIs' Aggregate Swap Flows (in Millions of Dollars)	
Response	Seasonal-Without-Controls	Seasonal-With-Controls
LOA State	-94.3	-241.2
	(136.9)	(190.4)
No LOA State	-861.7***	-757.0***
	(177.7)	(172.3)
Difference	767.3***	515.8**
	(268.4)	(263.2)
R^2	1.7%	37.8%
Obs	2,650	2,650

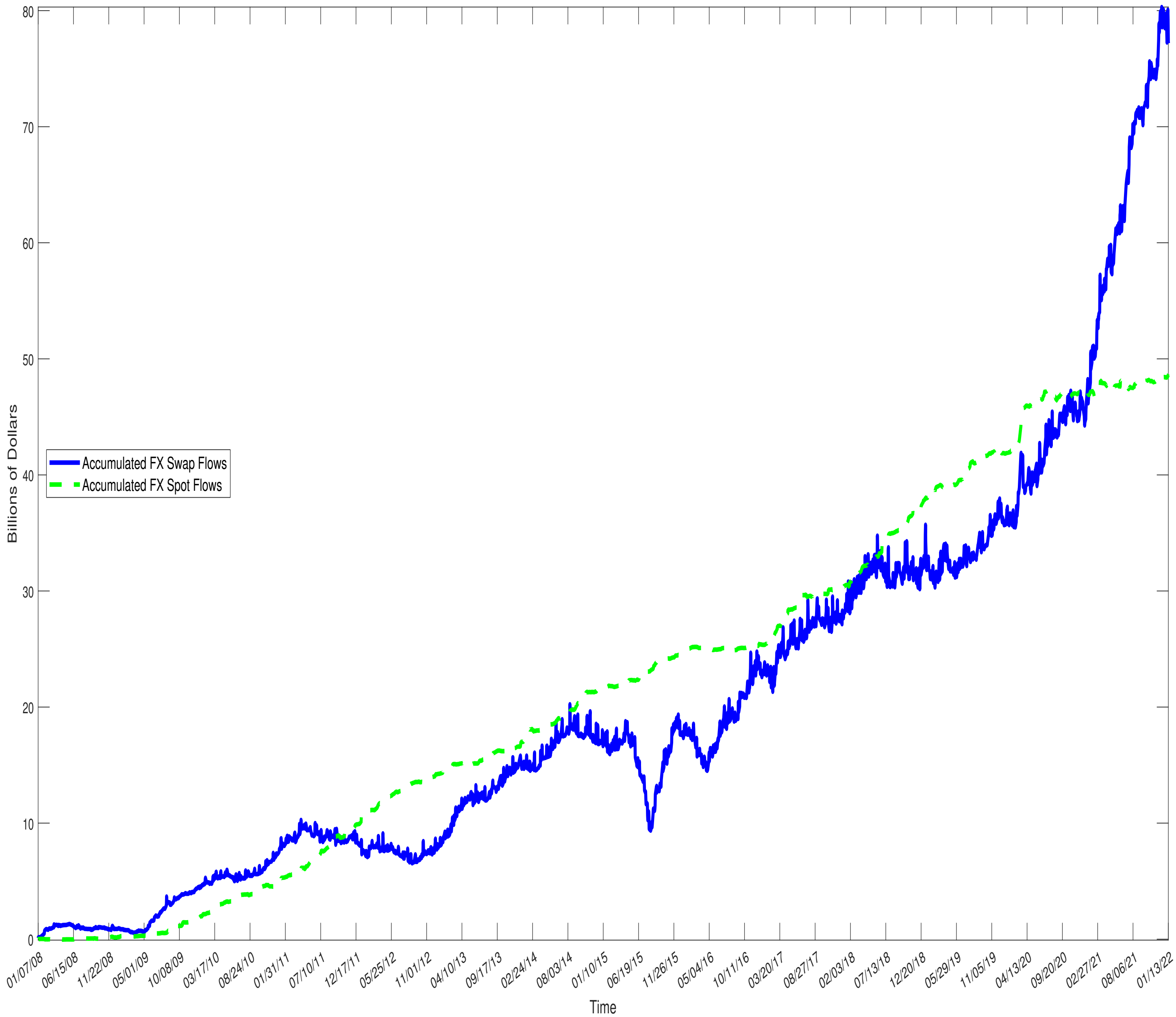
Notes: The first panel of this table presents the LOA-dependent effects of the middle- and end-of-month seasonal demand shifter on IIs' aggregate (volume-weighted average) basis from estimation of Equations (9) and (10), respectively. The second panel of the table shows the corresponding responses of IIs' aggregate swap flows obtained by replacing the basis variable in Equations (9) and (10) with the swap flow one and adding a time trend to the RHS of these equations. The LOA (no LOA) state corresponds to the LOA variable being 2 (1.4) standard deviations above (below) its mean. Numbers in parentheses represent standard errors computed from the heteroskedasticity- and autocorrelation-consistent procedure of Newey and West (1987) with the truncation lag selected from the data-driven procedure from Andrews (1991). *, **, and *** represent significance levels at the 10%, 5%, and 1% levels.

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



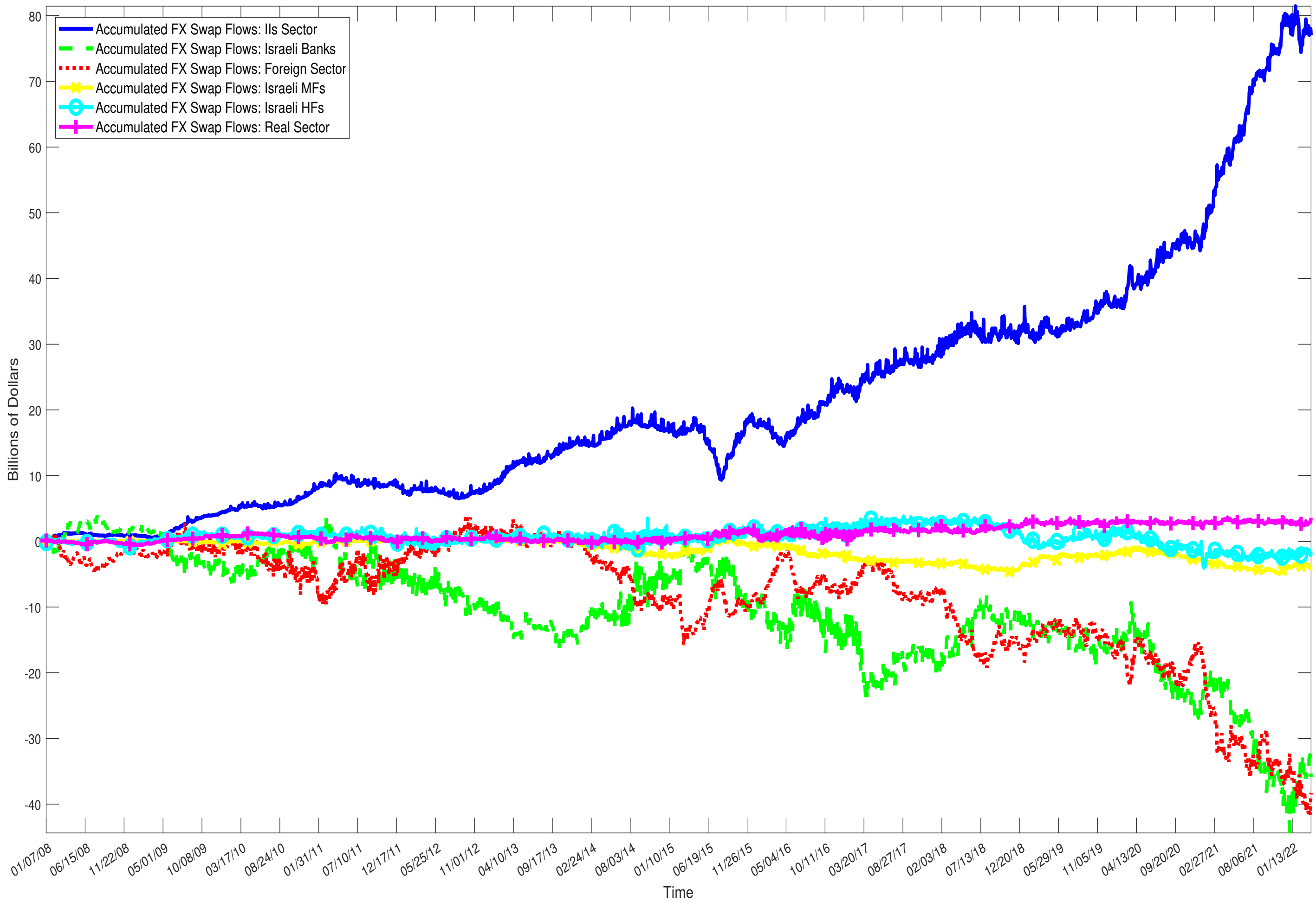
Notes: This figure provides a qualitative depiction of the LOA-dependent FX swap demand channel underlying the structural model from Section 3 whose details are presented in Appendix A of the online appendix to this paper. The no LOA (LOA) state represents the state in which the arbitrageur's arbitrage capital is abundant (scarce). b_t is cross-currency basis defined in the usual way as the difference between the cash dollar interest rate and the CIP-implied dollar interest rate. These states are assumed to correspond to the extreme cases of perfectly *elastic* FX swap supply (leftward panel of the figure, i.e., no LOA state) and perfectly *inelastic* FX swap supply (rightward panel of the figure, i.e., LOA state). The core of this demand channel lies in how the responsiveness of the basis varies across the two states in the presence of a rightward shift in FX swap demand. $-b_t$ (which is on the y-axis) represents the marginal profit that arbitrageurs make from CIP arbitrage, which can in turn be interpreted as the price of FX swaps. The quantity of FX swaps, in dollar terms, is on the x-axis.

Figure 2: **Time Series of IIs' Accumulated FX Swap and Spot Flows.**



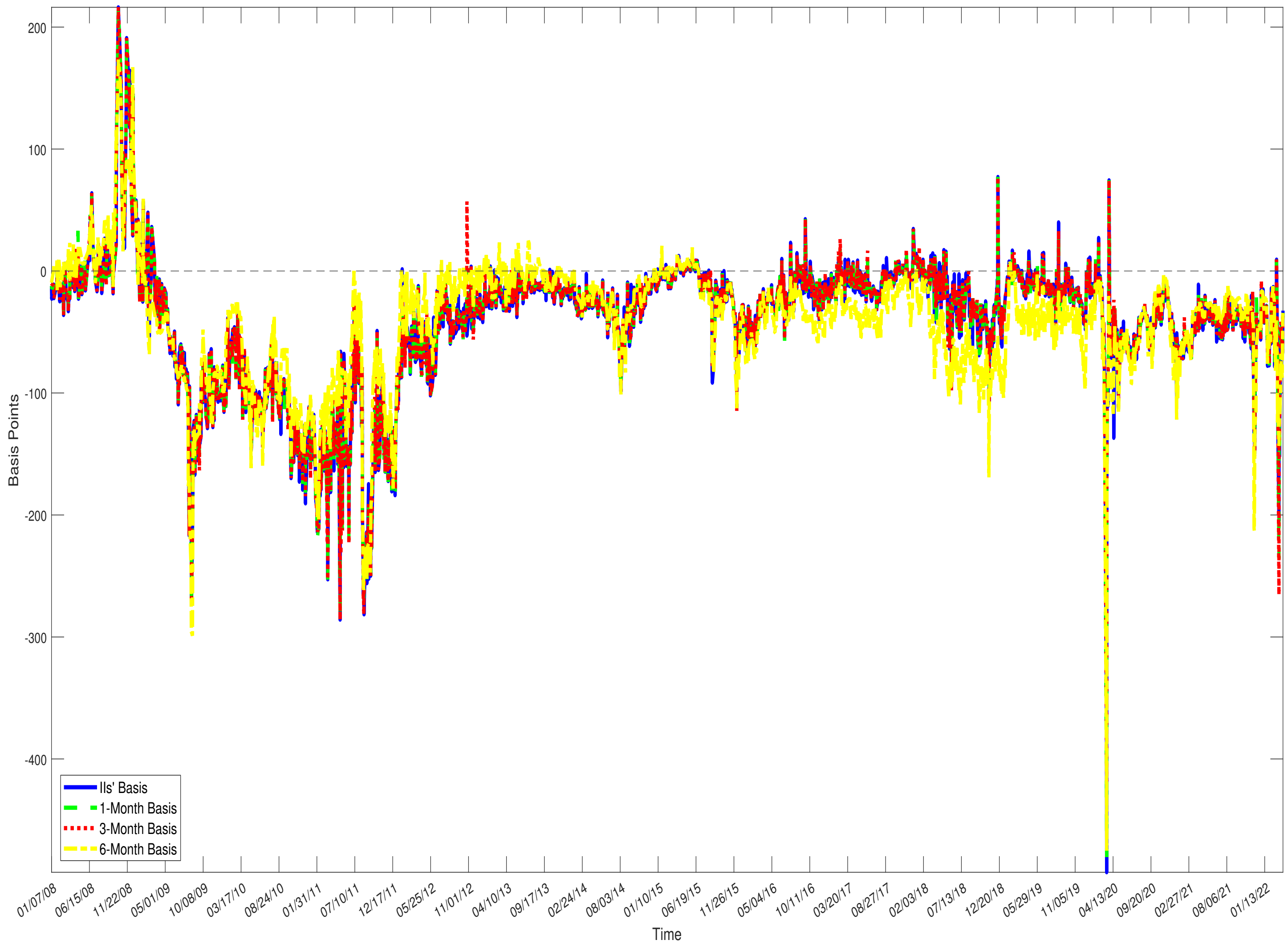
Notes: This figure presents the time series of the accumulated daily flows of IIs' FX swap (solid line) and spot (dashed line) trades in the USD/ILS currency pair. Since FX swap flows are changes in IIs' open FX swap position, their shown accumulated series can be viewed as IIs' open FX swap position. A positive (negative) value for the latter series represents the accumulated selling (buying) of swap-linked dollar forwards. Positive values for the accumulated spot flow series represent the accumulated buying of spot dollars. Data are from the BOI and cover 01/07/2008-3/31/2022. Time (in daily frequency) is on the x-axis. Values are in billions of dollars.

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



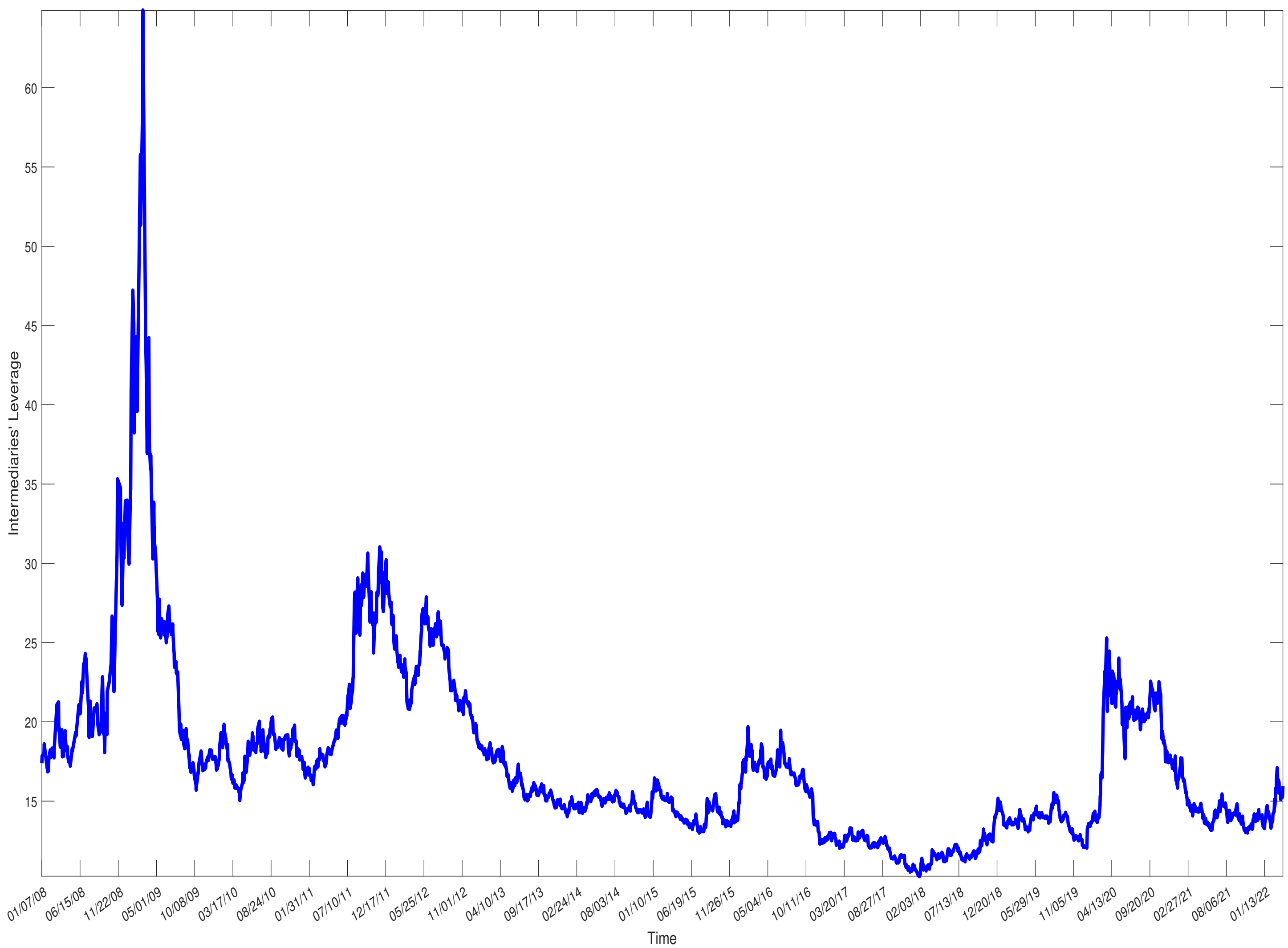
Notes: This figure presents the time series of accumulated daily FX swap flows by sector. Since FX swap flows are changes in the corresponding sector's open FX swap position, their shown accumulated series can be viewed as the corresponding sector's open FX swap position with positive (negative) values representing the accumulated selling (buying) of swap-linked dollar forwards. On top of the IIs sector (which, for completeness, is also included in the figure and is represented by the solid line), this figure includes five additional sectors: local commercial banks (dashed line); foreign sector (dotted line), which includes all foreign firms engaged in financial activity (i.e., foreign commercial and investment banks, pension and insurance funds, mutual funds, exchange traded funds, hedge funds, and proprietary trading firms); local mutual funds and exchange traded funds (cross-marked-line) - abbreviated by MFs in the figure; local hedge funds and proprietary trading firms (circle-marked-line) - abbreviated by HFs in the figure; and local real sector (plus-marked-line), which represents Israeli exporters and importers. Data are from the BOI and cover 1/7/2008-3/31/2022. Time (daily dates) is on the x-axis. Values are in billions of dollars.

Figure 4: **Time Series of USD/ILS Cross-Currency Basis.**



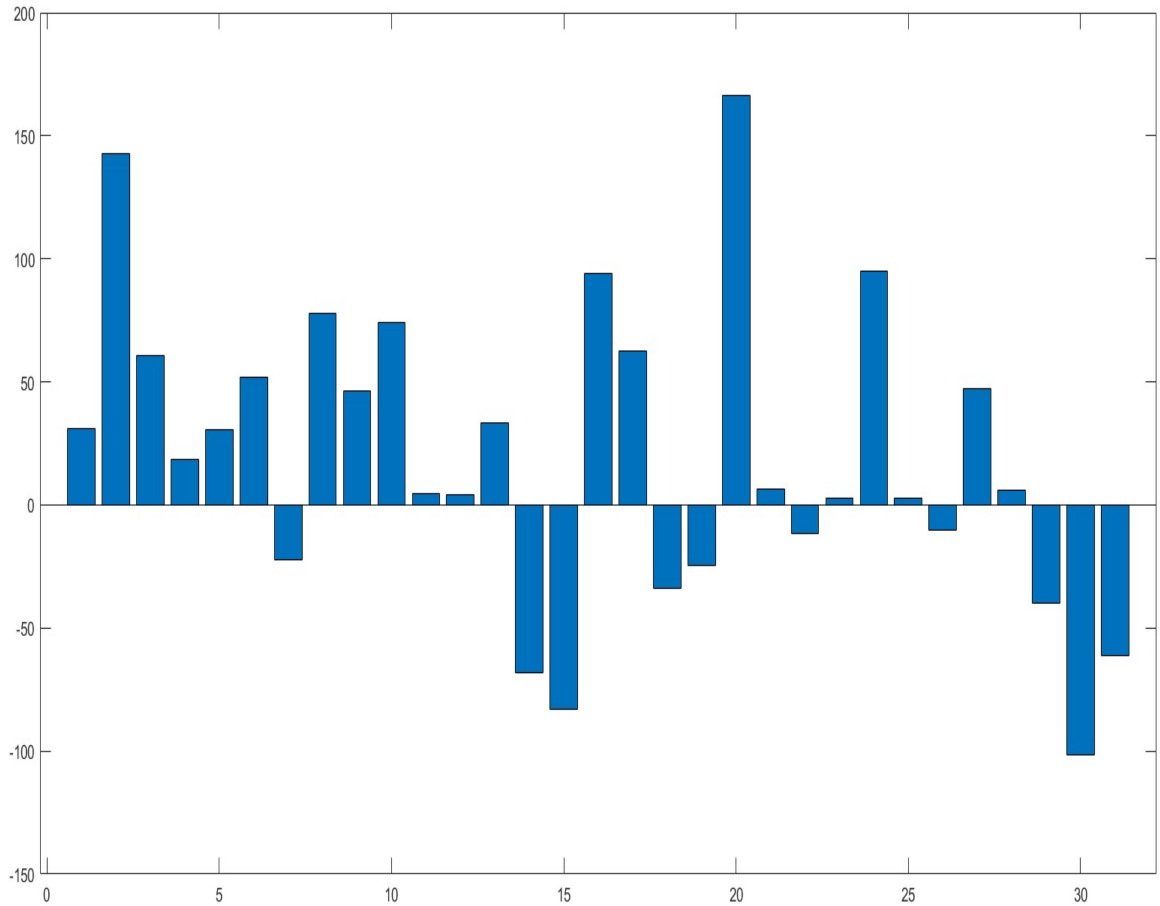
Notes: This figure presents the time series of daily USD/ILS cross-currency basis for IIs (constructed from our transaction-level FX swap dataset as the volume-weighted average of the transaction-level bases) (solid line) and the 1- (dashed line), 3- (dotted line), and 6-month (dash-dotted line) bases constructed from Thomson Reuters spot and forward rate data. The bases are computed as the difference between Libor dollar rates and CIP-implied dollar rates. The data cover 1/7/2008-31/3/2022. Time (daily dates) is on the x-axis. Values are in basis point terms.

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



Notes: This figure presents the time series of intermediaries aggregate leverage ratio. To construct this series, we used our transaction-level USD/ILS FX swap data to uncover the 12 largest global intermediaries operating in this market, whose volume covers over 95% of foreigners' activity in the market, and then used Bloomberg book debt and market equity to compute an aggregate (value-weighted) leverage series. The data cover 1/7/2008-31/3/2022. Time (daily dates) is on the x-axis. Values are in leverage (asset value over market equity) terms.

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



Notes: This figure presents the sum of IIs' swap flows across daily calendar dates for our baseline sample. Daily dates are on the x-axis (i.e., 1 represents the 1st of each month, 2 represents the 2nd of each month, etc.). Values on the y-axis are in millions of dollars, with positive (negative) values representing IIs' buying (selling) of swap-linked spot dollars.