Shorting the Dollar When Global Stock Markets Roar: The Equity Hedging Channel of Exchange Rate Determination*

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Abstract

This paper investigates the influence of global equity market value shocks on institutional investors' (IIs') hedging behavior and the resultant effects on exchange rates. Employing unique granular daily data on Israeli IIs' foreign exchange (FX) forward flows and prices and a granular instrumental variable estimation approach, we find that foreign equity market value shocks generate significant selling of U.S. dollar forwards by IIs, as a hedge against heightened FX exposure, along with significant exchange rate appreciation. A value-shock-induced one-standard-deviation increase in IIs' supply of forward flows appreciates IIs' forward rate by 0.53%. (JEL E44,F3,F31,G15,G23)

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We highlight a channel through which global equity market value shocks influence exchange rate variation: the collective hedging of foreign exchange (FX) risk by institutional investors (IIs), such as pension and insurance funds. This equity hedging channel of exchange rate determination is driven by the need for investors with foreign equity positions to hedge against increased FX exposure resulting from a rise in the value of their foreign equity positions. They do this by selling foreign currency on the forward market. However, the purpose of their selling is not to rebalance their portfolios by changing their allocation of foreign and local equities, but rather to secure their foreign equity gains without selling the underlying foreign stocks. This in turn puts downward pressure on the forward rate, and consequently, leads to a decline in the spot rate.[1]

To causally identify the equity hedging channel of exchange rate determination, we apply a granular instrumental variable (GIV) estimation approach using novel daily data on FX forward flows and rates (prices) of Israeli IIs. Our data set covers a recent (roughly) 10-year sample period that saw slight variation in local and foreign monetary policy rates. Our GIV value shock is defined as the difference between the size-weighted and inverse-variance-weighted averages of individual shocks to the returns of the 774 S&P 500 constituents covered by our sample period. This shock represents exogenous variation in global equity market valuation, termed a ”global value shock” (interchangeably used with ”value shock” throughout the paper). Importantly, this variation arises not from endogenous macroeconomic forces but from idiosyncratic value shocks to the stock returns of large companies. This value shock causes a rightward shift in IIs' supply of forward foreign currency along a downward-sloping demand curve. The semi-elasticity of this curve, which our methodology can identify, determines the extent of the appreciation in the forward rate (expressed in percentage terms). To ensure the latter individual shocks are unrelated to various common shocks to the forward market, our GIV estimation procedure controls for interest rates, risk premium shocks, an aggregate U.S. bond index return, and the broad dollar exchange rate.

Our main findings can be summarized as follows. First, a one-standard-deviation GIV value shock leads to significant selling of foreign currency forwards by IIs equal to 0.13-standard-deviation units of forward flows, or US$17.4 million. This meaningful collective sale of dollars in the forward market serves as a hedge against increased foreign exchange exposure. Second, both the

[1] Even if the covered interest parity (CIP) condition fails to hold, it is very reasonable to expect a positive relation between forward and spot rates. See the model from Section 2 for more details.

forward and spot rates experience a significant decline of 0.07% following the GIV value shock. Our 2SLS estimation implies that a value-shock-induced one-standard-deviation increase in IIs' supply of forward flows appreciates IIs' forward rate by 0.53%. While, to our knowledge, we are the first to estimate a *forward* demand semi-elasticity, it is noteworthy that our 0.53 semi-elasticity is comparable to the spot demand semi-elasticities estimates of Evans and Lyons (2002) (0.5) and Hau, Massa, and Peress (2009) (0.38).[2]

Although our granular econometric approach in combination with our observing IIs' daily forward flows and price data provides us with confidence that we are identifying causal evidence, we exercise caution throughout the paper in ruling out other potential mechanisms that could explain the relationship we observe between the GIV value shock and the forward rate. We do this in a twofold manner. First, as mentioned above, we control for exogenous controls in our micro constituent-level regressions to rule out mechanisms based on interest rate changes, risk premium shocks, debt hedging motives, and the broad dollar exchange rate. Second, we consider the responses of IIs' spot flows and cross-currency basis—both of which are insignificant—to rule out competing mechanisms rooted in portfolio rebalancing and FX swap market frictions.

We argue that the channel we document is not specific to the Israeli economy. In fact, the recent OECD (2021) report "Pensions at a Glance 2021" shows that in 2020, pension funds in OECD countries had an average of 100% of assets in terms of gross domestic product (GDP), up from 63% in 2010 (in Israel, Pension funds had assets equivalent to 68% of their GDP according to the same report). As these assets grow, pension funds often seek to invest abroad as they become quite large relative to their local financial markets. As evidence, the report states that out of a sample of 50 countries, these pension funds invested abroad 35% of their assets in 2020, with some countries as high as 90% of their assets. Appendix E of the Internet Appendix reinforces our external validity argument by providing meaningful FX hedging of IIs in other economies based on survey evidence.

In this paper, we use the terms "dollar" and "foreign currency" interchangeably to refer to the USD/ILS currency pair, where a decline (increase) in the USD/ILS rate represents an appreciation

[2]These two papers computed their elasticities with respect to a US$1 billion order flow against the DM and euro, respectively. Hau, Massa, and Peress (2009) also present the standard deviation of daily USD/EUR order flows, which stands slightly above US$1 billion at US$1.127 billion, implying a semi-elasticity of 0.43 with respect to one-standard-deviation currency flows increase. Given the dominant role of the DM in the euro region, one should expect the 0.5 estimate from Evans and Lyons (2002) to translate to a similar magnitude for a corresponding such normalization for the USD/DM case.

(depreciation) of the ILS against the USD, as 80% of the average daily volume of IIs' FX forward trades is conducted in dollars. (The remaining 20%—over 14% of which is in euro—of IIs' trade volume is nevertheless included in our data and converted to dollar terms.) Additionally, since the local economy underlying the equity hedging channel is relatively small, we use the terms ”foreign” and ”global” interchangeably throughout the paper.[3]

1 Related Literature

To the best of our knowledge, this paper constitutes the first empirical investigation of the equity hedging channel of exchange rate determination that uses granular daily FX forward flow and price data to quantify this channel. The daily frequency and granular nature of this data allows us to quite cleanly identify this channel. We now turn to discuss the literatures that motivate our work.

1.1 Exchange Rate Determinants

The determinants of exchange rate behavior have long eluded researchers (Meese and Rogoff (1983)), with the data offering only a weak connection between exchange rates and macroeconomic aggregates, thus leading to the coinage of the term ”exchange rate disconnect puzzle” by Obstfeld and Rogoff (2000). Understanding which forces drive exchange rates is crucial given their central role in global capital allocation (Maggiori, Neiman, and Schreger (2020)) and open economies' macroeconomic fluctuations (Schmitt-Grohé and Uribe (2016)).

Recently, meaningful advancement has been made in resolving the ”exchange rate disconnect puzzle” by two relevant literatures to our work. First, by turning to order flow data, a growing body of work has demonstrated that currency order flow can provide insight into explaining ex-

[3]Finally, it is worth clarifying that FX forward flows can arise from two types of contracts: ”standard” (single-leg) forward contracts and swap contracts. (FX Swap contracts consist of two legs, with the first being a spot transaction and the second being an opposite forward transaction of equal value.) While IIs use FX forwards to hedge *existing* FX exposure, thus making FX forwards the quantity object underlying the equity hedging channel, they use FX swaps to obtain FX-risk-free funding for foreign investment. That is, they use FX swaps to hedge *new* FX exposure (see, e.g., Ben Zeev and Nathan (2023)). Moreover, as elaborated on in Appendix A.5 of the Internet Appendix, FX swaps can have a potential biasing role in our estimation of the equity hedging channel only through cross-currency basis variation conditional on a global value shock; importantly, we eliminate the possibility of such role in our empirical analysis. Be that as it may, for the purpose of simplicity and clarity, we use the term ”standard (non-swap-linked) forward flows” to be equivalent to ”forward flows” throughout this paper.

change rate excess returns. For example, Evans and Lyons (2002), Froot and Ramadorai (2005), and Menkhoff et al. (2016) find that changes in currency order flow can help explain a significant amount of the fluctuations in the exchange rate.

Second, another body of literature has turned to investigating the relation between equity and credit markets and FX markets. Lustig, Roussanov, and Verdelhan (2011) were the first to produce evidence supporting a global-risk-based view of exchange rate determination. Offering a post-GFC resolution to the exchange rate disconnect puzzle, Lilley et al. (2019) show that proxies for global risk appetite explain a significant share of currency returns after the GFC; the particular post-GFC element of the Lilley et al. (2019) findings is possibly related to the findings from Avdjiev et al. (2019), who show that post-GFC CIP deviations are representative of risk-taking capacity in global capital markets and are accordingly systematically related to the dollar exchange rate. And Hau and Rey (2004) (using a VAR) and Camanho, Hau, and Rey (2022) (exploiting fund-level international equity allocations) provide significant empirical evidence for an equity portfolio rebalancing channel (whose theoretical underpinning is from Hau and Rey (2006)), with a US$7.1 billion equity U.S. outflow (induced by foreign equity returns) resulting in a 1% dollar depreciation.

1.2 Portfolio Rebalancing

While the equity portfolio rebalancing channel studied by Hau and Rey (2004, 2006) and Camanho, Hau, and Rey (2022) focuses on the relation between foreign equity markets and FX *spot* markets, our paper studies the equity hedging channel of exchange rate determination and therefore focuses on the relation between foreign equity markets and FX *forward* markets. A critical distinction between the equity hedging channel we examine and the portfolio rebalancing channel lies in the underlying impulse driving each channel. In the equity hedging channel, the primary impulse is a foreign equity innovation, whereas in the portfolio rebalancing channel, the impulse stems from an innovation in the equity return *differential* between foreign and local equity markets.

To illustrate this difference, consider a scenario in which both U.S. and European stocks generate 10% returns in a given year, but the USD/EUR spot rate remains relatively unchanged. According to the portfolio rebalancing channel, no FX flows would be expected in this situation. However, in the equity hedging channel we emphasize, European investors would still experience increased FX exposure to the dollar and might want to hedge against this exposure, thereby leading to fluctuations in the FX market.

1.3 Hedging and Exchange Rates

Two additional papers are relevant to ours in studying the role of hedging in exchange rate determination, and we will turn to discussing them next. The first is Melvin and Prins (2015), who assume that IIs' hedges are most typically adjusted once per month at the end of the month (around the 4 p.m. fix). Therefore, they use equity returns up until the second to last day of the month as a proxy for equity-price-induced hedging to test the relation between equity hedging and exchange rates for the 2004–2013 period for the eight most liquid currencies; they find a statistically significant negative relation, leading them to conclude that hedging demand plays a role in exchange rate determination. The second paper is Liao and Zhang (2020), who study a debt hedging channel of exchange rate determination. They insightfully connect country-level measures of net external financial imbalances to exchange rates, while interpreting this channel as debt- rather than equity-based.

Our paper differs from Melvin and Prins (2015) in several crucial aspects. First, they assume that IIs hedge only in response to the relative outperformance of returns, an assumption we find unnecessary and do not adopt. Second, the granularity and high-frequency nature of our data enables us to identify the equity hedging channel more clearly. (Our data indicates that IIs execute hedging trades not on one specific day, as Melvin and Prins (2015) assume, but rather sporadically throughout the month.) This aspect also distinguishes our analysis from that of the Liao and Zhang (2020) analysis. However, we also diverge from their study in three additional ways, which we will now discuss.

First, their paper does not set out to study the equity hedging channel, focusing instead on a debt hedging channel while using data that excludes FX forward flows. As Sialm and Zhu (2022) document, while 90% of U.S. international fixed income funds use FX forwards, they hedge, on average, only 18% of their FX exposure. Considering that regulatory FX hedging constraints on many local IIs do not differentiate between debt and equity instruments, and considering the available survey evidence on local IIs' significant foreign equity hedging practices (see Appendix E of the Internet Appendix for more details on both points), the debt and equity hedging channels seem to stand on fairly equal grounds in terms of their underlying motivating evidence on local IIs' hedging practices. Moreover, as documented in Du and Huber (2023), pension funds have a nonnegligible amount they invest in U.S.-denominated equities and also a nonnegligible hedging ratio.

Second, we do not view our channel as hinging on the direction of an economy's net external balances. Rather, as explained in Appendix E of the Internet Appendix, it hinges on meaningful foreign equity positions of local IIs that are in turn meaningfully hedged, with these IIs belonging to a sufficiently small economy so that a counteracting hedging mechanism from the world economy does not prevail and eliminate the local one. And, third, at the core of their debt hedging channel is a CIP-deviation-based mechanism stemming from global arbitrageurs' concave return from investment in non-swap-related activity, an element which is omitted from our framework due to the insignificant IIs' cross-currency basis response to our GIV value shock (also see related discussion in Appendix A.5 of the Internet Appendix).

1.4 Intermediaries and Asset Pricing

Last, we also contribute to the extant literature investigating the many ways in which intermediaries affect financial markets (Greenwood and Vayanos (2010), Ellul, Jotikasthira, and Lundblad (2011), He and Krishnamurthy (2013), He, Kelly, and Manela (2017), O' Hara, Wang, and (Alex) Zhou (2018), He and Krishnamurthy (2018), Klingler and Sundaresan (2019), Hendershott et al. (2020), Jiang, Krishnamurthy, and Lustig (2021), Koijen and Yogo (2022), Greenwood et al. (2023), and Pinter (2023) among others). We add to this literature by showing how hedging demand by IIs (an important form of intermediaries) through FX forwards affects exchange rates.

2 Theoretical Motivation

In Appendix A of the Internet Appendix we lay out a simple structural framework that is meant to fix ideas and form a suitable conceptual base for this paper's empirical analysis. The framework is a partial equilibrium of the FX forward market consisting of two time periods (t and $t+1$) and three agents. The first is a local II who sells foreign currency forwards to hedge its position in foreign equity markets. The second is a local importer (IM) who demands foreign currency forwards for its import activity. And the third is a global arbitrageur (GA) whose activity produces violations from CIP that are unaffected by foreign equity prices, in line with our evidence.

The central prediction of the model is that an increase in the value of the II's foreign equity position causes an increase (decline) in the equilibrium quantity (price) of foreign currency forwards; this appreciation of the forward rate leads to an identical (in percentage change terms) appreciation of the spot rate. The intuition for this prediction is simple. The rise in the II's foreign equity position prompts it to increase its hedging of this now enlarged position. Hence, the II's supply of foreign currency forwards shift rightward along the unchanged IM's downward-sloping forward demand curve, thus generating an increase in the equilibrium quantity of forwards along with a decrease in their price. Through the GA's arbitrage activity, this forward rate appreciation translates into an equivalent spot rate appreciation (in percentage change terms).

3 Institutional Background

This section lays out information about the IIs in Israel and the environment in which they operate. We first start with a description of the liquidity in the Israeli FX market.

3.1 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 forward market was US$779 million, half the size of the spot market's daily average turnover of US$1,491 million. This places Israel in the third quartile of the 51 countries for this relative measure, alongside other major FX markets like the United States, the United Kingdom, and Switzerland, indicating the forward market is a liquid market relative to the spot market for the ILS. Compared to other countries, Israel's daily average turnover in the forward market is similar to Belgium's (US$807 million) and Norway's (US$708 million). The interquartile range and median daily forward market turnover for the 51 countries are US$373 and US$1,407 million, respectively. Israel's total daily average turnover in the FX market, including spot, forwards, FX swaps, and options, is US$8.07 billion. These data suggest that Israel's forward FX market is vibrant and liquid.

3.2 Definition of IIs

IIs 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 daily 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,[4] and life insurance policies.[5] IIs are important players in the Israeli financial market, managing US$607.7 billion on behalf of the public as of December 2020, which is 44% of the public's entire financial asset portfolio and 141% of GDP.

3.3 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.[6]

It was only by the end of 2009 that Israeli IIs reached a double-digit level of foreign asset holdings as a share of their total assets. In tandem with this landmark, they began to hedge their foreign investments more aggressively, recording an FX hedge ratio (share of foreign assets' value that is hedged using forwards, swaps, and options) of 29% at the end of 2009.

3.4 Hedging FX Exposure

IIs have several methods to hedge their FX risk that arises from making profits through international investments. One approach is to sell appreciated foreign equities and immediately convert the earnings into local currency (e.g., portfolio rebalancing). Another method—central to our

[4]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 for long-term investment.

[5]Mutual 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) composing our sample, the universe of investment banks and insurance companies is 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 excluded from the list of entities that composes our sample.

[6]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.

paper—involves purchasing the local currency in the FX forward market in the desired amount as to hedge the profit. This selling strategy ensures that IIs will not incur losses on the amount of profits they hedged due to future fluctuations in the dollar's value. Moreover, it offers benefits compared to merely selling an asset. When the forward contract reaches maturity, IIs can fund it without necessarily having to sell the asset, which in practice they often do using FX swaps (see Appendix D of the Internet Appendix).

3.5 IIs' Exposure to FX Risk

To gain an understanding of the unconditional behavior of IIs' foreign assets as a share of total assets, foreign equities as a share of foreign assets, the FX hedge ratio, and the USD/ILS exchange rate, Figure 1 plots these variables in monthly frequency for the monthly sample of 2011:M4-2021:M8, which corresponds to the daily sample of our forward flows data. A salient feature of this figure lies in the broadly steady rise in the share of total assets being allocated to foreign assets (solid line), which peaks in June 2021 at 31.7%. By contrast, and not surprisingly given foreign equities values' relatively large fluctuations, foreign equities as share of foreign assets (round dotted line) exhibit much less stability; especially notable are the periods 2015:M7-2016:M4 and 2020:M3, for which the foreign equites share in foreign assets declined considerably owing to significant U.S. stock market sell-offs. Nevertheless, the latter share is considerable for the whole sample period recording a mean of 47% and even surpassing the 50% mark toward the end of the sample.

This high reliance of IIs on foreign assets in general and foreign equities in particular necessitates some hedging of these positions' FX risk. Accordingly, the average FX hedge ratio (square dotted line) is 36.8% for the sample; that is, IIs on average hedge 37% of their FX-sensitive positions, which represents meaningful hedging on the part of IIs. One might expect the USD/ILS spot rate (dashed line) to move in the opposite direction to the FX hedge ratio. This would appear as IIs being more prone to hedging in an appreciating USD/ILS spot rate environment. However, Figure 1 does not show this conclusively. For example, while from 2011 to 2014 these two variables do seem to move in opposite directions, from 2015 onwards the general appreciation trend of the USD/ILS spot rate coexists with a trending downward FX hedge ratio.

3.6 IIs' FX Trading

As noted above, IIs hedge a considerable portion of their foreign asset position. Such hedging can be done with either non-swap-linked and swap-linked FX forwards or FX options. In accordance with our earlier discussion, the forward flow data we present below abstracts from swap-linked forward flows and simply refers to "non-swap-linked forward flows" as "forward flows", in line with the terminology used in the rest of this paper. Moreover, since FX options are a negligible hedging trading tool in Israel, we abstract from them in both the descriptive analysis shown here and the empirical analysis that follows this section.[7]

Alongside their hedging related trading activity, Israeli IIs also trade on the FX spot market. Figure 2 shows the evolution of accumulated daily forward (solid line) and spot (dashed line) flows for April 26, 2011, to August 18, 2021. Negative accumulated flows' values represent the accumulated selling of foreign currency; positive values represent the accumulated buying of foreign currency.

Two noteworthy facts are borne out by Figure 2. First, Israeli IIs conduct meaningful hedging through selling dollar forwards, as reflected by the significant accumulation of IIs' dollar forwards sold, which reaches a peak of US$77.8 billion at the end of the sample. Second, IIs also appear to be quite active on the spot market, as such spot activity enables them to fund their foreign asset investments (the other such funding device being FX swaps (Ben Zeev and Nathan (2023))), purchasing an accumulated amount of US$54.2 billion over the sample. But this buying of spot dollars is smaller than the selling of dollar forwards which points to the centrality of the latter in the way IIs trade in FX.

Figure 3 shows the evolution of accumulated daily forward flows for April 26, 2011, to August 18, 2021 for four additional sectors on top of the II sector (which, for completeness, is also included in the figure): real sector, which represents the net FX flows from forward transactions involving Israeli exporters and importers; banking sector, which includes the Israeli commercial banks; financial sector, which includes Israeli mutual funds, exchange traded funds, hedge funds, and proprietary trading firms; and foreign sector, which includes all types of foreign economic units.

[7] Not even a single option trade was done by IIs in 78.6% of the sample's trading days. And even when IIs do trade in options, the role that these trades plays in hedging appears null with a daily average notional flow value of only US$-0.1 million.

This figure demonstrates that the sole effective sellers of dollar forwards among market participants are IIs, against which the two main buyers of dollar forwards are the real and banking sectors. It is noteworthy that the more central buyer of dollar forwards throughout the bulk of the sample is the real sector. These buying and selling activities are intermediated by FX dealers (local banks) who provide liquidity to the market and are central in the determination in exchange rates (see, e.g., Gabaix and Maggiori (2015) and Itskhoki and Mukhin (2021)); only at the end of the sample do local banks accumulate dollar forward purchases that are quantitatively comparable to those of the real sector.[8] The centrality of the real sector as buyer of dollar forwards is consistent with the modeling approach taken in the previous section which assumes that importers are IIs' counterparties in their forward selling trades. In the empirical analysis we will demonstrate the role of the real and banking sectors as counterparties to IIs' forward selling *conditional* on a global value shock.

4 Methodology

This section elucidates the methodology used in the empirical analysis undertaken in this paper. We first describe the data used in the estimation after which we turn to present the general lines of the estimation.

4.1 Data

Our data are daily and cover the period April 26, 2011, to August 18, 2021. The specific starting and ending points of this approximate 10-year period are dictated by the availability of the Bank of Israel (BOI) proprietary data we have on FX flows and prices of Israeli IIs. We begin our data description by providing details on IIs' data after which we turn to discuss the other variables we utilize in our empirical analysis.

4.1.1 IIs' FX Flows and Prices Data

We have proprietary granular daily data for Israeli IIs on FX flows and prices by type (spot, forward, swap, and option). We have a total of 13 IIs fund families, which correspond to the universe

[8]Notice that local banks only started buying in the beginning of the COVID-19 crisis when global prices of equities collapsed. This collapse created a surge in the selling of forwards by IIs which banks had to absorb on their balance sheet.

of investment banks and insurance companies than manage the public's long-term savings.[9] Our obvious focus is on forward flows and prices given their focal role in the equity hedging channel of exchange rate determination but we also look at spot flows to rule out the competing portfolio rebablancing channel; spot prices to confirm that our forward rate response also translates to a similar spot rate response; and cross-currency basis constructed from IIs' swap trades to rule out a mechanism rooted in swap market frictions.

As mentioned on Page 2 when explaining this paper's terminology, since 80% of IIs' average daily volume of FX forward trades is done in dollars, throughout this paper's terminology we treat USD/ILS as the sole currency pair underlying IIs trades with the term 'dollar' and 'foreign currency' being equivalent in our terminology. The remaining 20% share of IIs' forward transactions are nevertheless included in our FX flows data with their corresponding flows and prices being translated into dollar quantity and USD/ILS rate terms, respectively.

The flows variable measures (in dollars) the daily net transaction flow from IIs' buying and selling of U.S. dollars on the FX forward market. There is a negative (positive) value for this variable for a given observation when an II was a net seller (buyer) of dollar forwards on the corresponding day. The aggregate IIs' daily forward flows variable is simply the sum of the individual 13 IIs' daily forward flows. We construct aggregate daily IIs' forward rates as the volume-weighted average of forward rates computed from all daily IIs' FX forward transactions. Descriptive statistics (mean and standard deviation) for IIs' forward flows and rates are shown in Table 1; for completeness, this table also shows the corresponding statistics for spot flows and rates (whose construction is detailed below).

The flows variable measures (in dollars) the daily net transaction flow from IIs' buying and selling dollars on the FX spot market. This variable has a negative value for this variable for a given observation when an II was a net seller (buyer) of spot dollars on the corresponding day. As in the case of the forward flows variable, we sum this variable across all 13 IIs in our sample to obtain the aggregate IIs' spot flows variable; and we construct the aggregate daily IIs' spot rates

[9]Formally, the II sector as defined by the BOI contains 14 IIs. However, for empirical analysis, we omit one very small II from this list—whose average forward flow volume accounts for less than 0.3% of the average total volume of IIs' forward flows transactions—for the estimation of the equity hedging channel because, unlike the other IIs who systematically sell forward dollars and hence accord with the view underlying our analysis that IIs represent the supply side of the forward market, this omitted II does not systematically sell forward dollars but rather tends to buy such dollars (albeit to a negligible extent - it accumulated a net buying of less than 74 million forward dollars over our sample period).

as the volume-weighted average of spot rates computed from all daily IIs' FX spot transactions.

4.1.2 Other Sectors' Forward Flows Data

To understand who stands on the other side of IIs' forward flows' behavior, i.e., which sectors act as the demand side on the USD/ILS forward market conditional on the aggregate value shock, we also consider forward flow data for four additional sectors: real sector, which represents the net FX flows from forward transactions involving Israeli exporters and importers; banking sector, which includes the Israeli commercial banks; financial sector, which includes forward flow activity of Israeli mutual funds, exchange traded funds, hedge funds, and proprietary trading firms; and foreign sector, which includes all types of foreign economic units.

4.1.3 S&P 500 Constituent Data

To operationalize this paper's granular identification approach, we use return and valuation data on historical S&P 500 constituents from CRSP. For our sample period, there are a total of 774 constituents which in turn represent all companies with a sufficiently long sample period as S&P 500 stayers for estimation purposes. (The shortest sample across the 774 constituents covers 116 daily observations.) These constituents' returns are used as dependent variables in constituent-level regressions to extract the individual stock price return shocks while their valuations are used to construct companies' size weights. Both the individual return shocks and the valuation size weights are the inputs used to for our GIV and Bartik shock construction.

4.1.4 Macro-Financial Data

We use several aggregate daily frequency macro-financial variables in our analysis, all of which cover the IIs' FX flows' sample (April 26, 2011, to August 18, 2021). All of these variables are taken from Bloomberg and their values are end-of-day quotes.

The MSCI All Countries World Index Investable Market Index (MSCI ACWI IMI; henceforth MSCI) is a measure of global stock prices that we use to support the validity of our GIV shock by considering the MSCI's response to the latter shock. This widely quoted index covers 23 developed markets and 25 emerging markets (roughly 85% of the investable global equity market). The leading regions in terms of market weight in this index are the U.S. (51.6%), Europe (22.2%), Asia (13.3%), BRIC (5.1%), and Canada (3.1%) (these are average annual weights over 2011-2021, reflecting the time-varying nature of this index's regional weights).

To control for foreign risk-free interest rates in our constituent-level regressions, we use the current and lagged values of changes in the 3- and 12-month London Interbank Offered Rate (Libor) variables where the former captures well the initial part of the U.S. yield curve's front end while the latter captures well its front end's later segment.[10]

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 constituent-level regressions to control for both global flight-to-quality shocks as well as the back end of the U.S. yield curve.

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 constituent-level regressions to control for both global risk appetite shocks (Avdjiev et al. (2019)) as well as any non-USD/ILS exchange rate variation coming from the global FX markets.

To control for global credit supply shocks, we include in our constituent-level regressions first-differences of current and lagged values of the *daily* excess bond premium (EBP) shock variable from Gilchrist et al. (2021) who construct a high-frequency EBP version of their original series from Gilchrist and Zakrajšek (2012) by using micro-level data to construct a U.S. corporate credit spread index which they decompose into a component that captures firm-specific information on expected defaults and a residual component that they term as EBP.[11]

4.2 Estimation

We estimate a daily frequency econometric model that consists of two estimation steps. The first estimates constituent-level regressions. The second step constructs GIV and Bartik shock instruments from the latter regressions' residuals and estimates the 2SLS-estimated effect of a

[10] In a later part of our empirical analysis, which is meant to further inspect the mechanism underlying our equity hedging channel results, we use a granular identification approach to identify local forward supply shocks and hence for that analysis we also control for local risk-free interest rates, measured by the 3- and 12-month Tel Aviv Inter-Bank Offered Rate (Telbor), which are based on interest rate quotes by a number of commercial banks in the Israeli inter-bank market.

[11] The permanent link for this daily excess bond premium series is https://www.atlantafed.org/research/publications/policy-hub/2021/09/24/12–term-structure-of-excess-bond-premium. It is in daily frequency and covers our baseline sample period. We are grateful to Bin Wei for sending us an updated series.

GIV/Bartik-value-shock-induced increase in IIs' aggregate forward flows on IIs' aggregate forward rate. As explained below, we focus on the GIV value shock for the additional empirical analysis beyond the basic one due its inherent advantage over the Bartik shock in being able to remove potential estimation bias from unobserved common shocks. Our granular econometric approach to studying the equity hedging channel is premised on the notion that the associated granular constituent-level residuals and resultant GIV construction would generate global equity market value variation that is not coming from macro forces but rather from idiosyncratic large companies' value shocks.

4.2.1 Econometric Model

We estimate (via OLS) 774 constituent-level regressions given by

$$\Delta SP_{i,t} = \mathbb{C}_t' \gamma_i + v_{i,t}, \tag{1}$$

where $\Delta SP_{i,t}$ is the log-first-difference of constituent i's stock price; $\mathbb{C}_t$ 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 the following exogenous controls:[12] first-difference of 3- and 12-month Libor included to control for changes to short-term U.S. interest rates, first-difference of EBP and log-first-difference of broad dollar index included to control for risk appetite shocks with the broad dollar variable inclusion also ensuring our results are not coming from global FX market related forces, and log-first-difference of the FTSE US Government Bond Index included to control for global flight-to-quality shocks as well as changes to long-term U.S. interest rates; and $v_{i,t}$ is the regression's residual where $v_{i,t} = \eta_t + \epsilon_{i,t}$ with η_t and $\epsilon_{i,t}$ representing an unobserved common shock and the constituent i's idiosyncratic value shock, respectively. Regression (1) does a fairly good job of explaining the variation in constituent-level returns, with mean and standard deviation of R^2s across the 774 regressions of 19.9% and 12.8%, respectively, and an interquartile range of 24.5%-11.9%=12.6%.

Our sought-after shocks are the $\epsilon_{i,t}$s as we wish to use these exogenous, idiosyncratic shocks to construct our GIV. The GIV construction is our preferred way of constructing an IV from the estimated $\hat{v}_{i,t}$ as such construction is able to remove the variation coming from the unobserved

[12] The number of lags for returns and exogenous controls in $\mathbb{C}$ 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 constituent-level regression. The mean and standard deviation of lags across the 774 regressions are 4.4 and 4.2, respectively.

common component η_t. Nevertheless, for completeness, we also consider the complementary Bartik instrument (also known as shift-share estimators) which has been popularized by Blanchard and Katz (1992) and extensively used in many fields in economics (Goldsmith-Pinkham, Sorkin, and Swift (2020)). We now turn to a description of our second estimation step which deals with the construction of the GIV and Bartik shocks and estimation of their effects.

Following Gabaix and Koijen (2023), we define the GIV shock (denoted by $\varrho_{GIV,t}$) as the difference between the size-weighted- and inverse-variance-weighted-average of the estimated idiosyncratic shocks, i.e., $\varrho_{GIV,t} = \sum_{i=1}^{774} \hat{v}_{i,t} w_{i,t-1} - \sum_{i=1}^{774} \hat{v}_{i,t} u_i$ (normalized to have unit standard deviation), where the weights $w_{i,t-1}$ are calculated from the share of constituents' market capitalization share in total market capitalization at period $t-1$ and u_i is the share of $\hat{v}_{i,t}$'s inverse variance in the sum of estimated residuals' inverse variances. As shown in Gabaix and Koijen (2023), this inverse-variance-weights-based GIV construction is optimal in the sense that the resulting estimation possesses the highest precision. Gabaix and Koijen (2023) also define and compare the Bartik instrument in relation to their GIV instrument, and we follow them in defining the Bartik shock (denoted by $\varrho_{Bartik,t}$) as the equal-weighted-average of the estimated idiosyncratic shocks, i.e., $\varrho_{Bartik,t} = \sum_{i=1}^{774} \hat{v}_{i,t} \frac{1}{774}$ (normalized to have unit standard deviation).

So long that $\hat{v}_{i,t}$ captures well $\epsilon_{i,t}$ for all is, i.e., that the common shock η_t is not meaningful relative to the $\epsilon_{i,t}$'s, the Bartik shock represents exogenous idiosyncratic variation from the $\hat{v}_{i,t}$s that can be utilized to properly estimate the equity hedging channel. As opposed to the Bartik shock, even if there still remains an unobserved common component in the $\hat{v}_{i,t}$s, the GIV shock construction removes this common component and ensures that the GIV shock is still valid in that it represents exogenous idiosyncratic variation coming from the $\epsilon_{i,t}$s since the common shock gets cancelled out in the subtraction of the inverse-variance-weighted-average from size-weighted-average. While the bulk of the variation in the $\hat{v}_{i,t}$s is idiosyncratic rather than common, with the $\hat{v}_{i,t}$s possessing an average absolute pairwise correlation of 25.4% and a corresponding standard deviation of 11%, there is still a non-negligible enough unobserved common component in the $\hat{v}_{i,t}$s which warrants the favoring of the GIV approach over the Bartik. Therefore, after showing the initial baseline results for both approaches in the empirical analysis, the subsequent additional analysis focuses solely on the GIV approach.

Specifically, our second estimation step deals with estimating the regressions given by

$$ff_t = \alpha_0 + \alpha_1 \mathbb{T}_t + \Omega IV_t + u_t, \tag{2}$$

$$\Delta fr_t = \beta_0 + \beta_1 \mathbb{T}_t + \Xi IV_t + z_t, \tag{3}$$

where ff_t is the IIs' aggregate forward flows (quantity) variable and Δfr_t is the log-first-difference of IIs' aggregate (volume-weighted average) forward rate (price); $\mathbb{T}_t$ is a time trend; and IV_t is either $\varrho_{Bartik,t}$ or $\varrho_{GIV,t}$. Note that Equations (2) and (3) can be viewed as the first stage regression and reduced form regression, respectively, corresponding to the structural supply curve equation of the USD/ILS forward market, given by

$$\Delta fr_t = \delta_0 + \delta_1 \mathbb{T}_t + \theta ff_t + e_t. \tag{4}$$

In our empirical analysis we will show OLS estimation results for Equations (2) and (3) as well 2SLS estimation results for structural supply Equation (4) using either $\varrho_{GIV,t}$ or $\varrho_{Bartik,t}$ as the IV. (The estimated $\hat{\theta}$ from Regression (4) can be interpreted as the semi-elasticity of forward demand curve conditional on the GIV/Bartik shock.)

5 Empirical Evidence

This section presents the main results of the paper. We begin with basic results for the GIV and Bartik value shocks after which we focus solely on the GIV value shock for the additional analysis that concerns the responses of the S&P 500 and MSCI indices, IIs' spot flows and cross-currency basis, and sectoral forward flows as well as for the additional analyses concerning an array of robustness checks (the robustness analysis' results are only discussed in the text and fully shown in Appendix C of the Internet Appendix). We end the section with an inspection of the mechanism underlying our results through the lens of forward supply shocks.

5.1 GIV and Bartik Value Shocks

The first (second) panel of Table 2 shows 2SLS-estimated first stage effect of the GIV (Bartik) value shock on IIs' aggregate forward flows (second column) from Equation (2); the reduced form effect on IIs' aggregate (volume-weighted average) forward rate (fourth column) from Equation (3); and the 2SLS-estimated second stage estimate of the forward demand semi-elasticity (third column) conditional on the GIV (Bartik) value shock from Equation (4). For completeness, we also report in the first column the OLS-estimated effect from structural Equation (4). The Forward flows variable is divided by its standard deviation prior to entering the regressions for comparability purposes and hence its response is in terms of standard deviation units. Standard errors for this table, 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).

For both shocks, the significance of the first stage estimate (second column) is very strong with corresponding F-statistics of 19 and 25.6 for the GIV and Bartik shocks, respectively, reflecting 0.13 and 0.14 standard-deviation-units of forward selling. Hence, it is clear that both shock instruments are sufficiently strong. The GIV and Bartik shocks produce significant forward rate appreciation of 0.07% and 0.06%, respectively, with the 2SLS estimation producing significant estimates of 0.53 and 0.46. That is, the 2SLS-estimated forward demand semi-elasticities conditional on the GIV and Bartik shocks are 0.53 and 0.46, respectively: a GIV/Bartik-value-shock-induced one-standard-deviation increase in IIs' forward flows brings upon a 0.53%/0.46% IIs' forward rate appreciation. Note that the corresponding OLS-estimated semi-elasticity is only 0.09, demonstrating the importance of using an appropriate IV to correctly identify the forward demand semi-elasticity *conditional* on an aggregate value shock.

As discussed in the previous section, the ability of the GIV shock construction to remove the biasing effect of any remaining unobserved common shocks driving the variation of the constituent-level residuals renders this shock instrument superior to the Bartik shock in our setting. We therefore focus solely on results from the GIV shock in all of our subsequent analysis.[13]

5.2 GIV Value Shock: Additional Analysis

Table 3 shows the responses of the S&P 500 and MSCI returns to the GIV value shock. To obtain these responses we simply replace the log-first-difference of IIs' forward rate from Equation (3) with the S&P 500 and MSCI returns. For internal consistency we construct the S&P 500 return as the market-capitalization-weighted average of the log-first-differences of our sample's 774 S&P 500 constituents' stock prices. The MSCI return is the log-first-difference of the MSCI index.

[13] It is nevertheless noteworthy that the similarity between the GIV and Bartik shock results from Table 2, as well as that for the GIV and (unreported) Bartik shock results in the subsequent analysis, indicates that the aforementioned biasing effect from the unobserved common shock appears to be modest.

Table 3's results confirm that our GIV value shock acts precisely as expected from an aggregate value shock, producing significant 0.99% and 0.71% increases in the S&P 500 and MSCI indices, respectively. That the MSCI index, a standard measure of global equity markets' value, also significantly rises in responses to the GIV value shock validates the notion that this shock acts as an aggregate *global* value shock which is not limited to the U.S. stock market. Note that over our sample period the average weight of U.S. stocks in the MSCI index is 51.6%, indicating that the 0.71% increase in the MSCI is not merely a mechanical artifact of the inclusion of S&P 500 stocks in the MSCI but also a reflection of a meaningful cross-regional spillover effect induced by our GIV value shock.

Table 4 shows the responses of IIs' aggregate (volume-weighted average) spot rate, aggregate spot flows, and aggregate (volume-weighted average) cross-currency basis to the GIV value shock.[14] To obtain these responses we simply replace the log-first-difference of IIs' forward rate from Equation (3) with the log-first-difference of IIs' spot rate, spot flows, and first-difference of IIs' basis. We divide the spot flows variable by its standard deviation before entering it into the regression and so the spot flows response is in terms of standard deviation units of spot flows.

IIs' spot rate significantly appreciates by 0.07%, the same magnitude (up to 2-digit rounding) as the corresponding forward rate appreciation from the first panel of Table 2. In other words, the forward premium is essentially unchanged conditional on the GIV value shock which in turn accords with the both economically and statistically insignificant basis response of 0.66 basis points from Table 4's third column. This negligible basis response rules out the possibility that the GIV value shock affects the forward rate through a swap-market-frictions-based mechanism.

Notably, we can also rule out the possibility that the GIV value shock affects the forward rate through a portfolio-rebalancing-based mechanism given that the spot flows response is also both economically and statistically insignificant, standing at a mere -0.02-standard-deviations units of spot flows. In Appendix D of the Internet Appendix, we further reinforce the notion that our re-

[14] We construct the basis variable by computing a daily volume-weighted average of IIs' transaction-level bases. (The basis variable is *dollar* basis, i.e., computed from USD/ILS swap transactions, as is common in the basis literature.) This is made possible for us by the availability of the spot and forward rates underlying each transaction in our FX swap dataset accompanying our forward and spot datasets. 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 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.

sults are not driven by a portfolio-rebalancing-based mechanism by providing granular evidence that our IIs - when faced with the imminent need to obtain dollars to fund their maturing forward contracts - tend to roll over their foreign equity positions rather than realize the capital gains which are normally accrued to these positions.

Table 5 shows the responses of forwards flows of the real sector, banking sector, foreign sector, and financial sector to the GIV value shock. (For completeness, this table also shows the response of IIs' forward flows.) To obtain these responses we simply replace the log-first-difference of IIs' forward rate from Equation (3) with each of the sectoral forward flow variables. All sectoral forward flow variables are divided by the standard deviation of IIs' forward flows and so the sectoral forward flow responses are in terms of standard deviation units of IIs' forward flows.

The results from Table 5 highlight that the real sector buys up the bulk of the forward dollars supplied by IIs, having a significant response of 0.08-standard-deviations units of IIs' forward flows. Local banks also play a meaningful counterparty role against IIs' forward dollar selling with a significant response of 0.06-standard-deviation units. The foreign sector plays no role whatsoever while the financial sector has a statistically significant albeit economically unimportant response of -0.02-standard-deviation units of IIs' forward flows.[15]

5.3 Further Inspecting the Mechanism Through the Lens of Forward Supply Shocks

Until now we have concentrated on the equity hedging channel of exchange rate determination. It is also insightful to look at the effect that forward flows have outside of that. It could also be viewed as complementary to our previous analysis to strengthen the causal link between forward flows and exchange rates. Toward this end, this section provides a further inspection into the mechanism underlying the GIV value shock results by considering the effects of forward supply shocks that are unrelated to global equity market value changes. To conserve space, we only outline the general lines of the forward supply shocks' estimation procedure and defer the associated detailed presentation to Appendix B of the Internet Appendix. The procedure involves two esti-

[15]Recall from the unconditional data from Figure 3 that the financial sector has actually bought, rather than sold, forward dollars in net terms over our sample period. Considering that the financial sector includes local mutual funds, exchange traded funds, hedge funds, and proprietary trading firms, it is not insensible that these funds would potentially do some hedging *conditional* on a favorable GIV value shock to the extent that a part of their assets is invested abroad. However, Table 4 shows that this hedging is economically negligible.

mation steps. The first regresses our 13 IIs' forward flow series on a fixed effect, day-dummies, time trend, lags of IIs' aggregate (volume-weighted average) forward rate, own lags, and current and lagged values of the exogenous controls used in the constituent-level regressions. (The only exception is that we also include the 3- and 12-month Telbor rates to control for local interest rate changes.) The second step constructs GIV and Bartik forward supply shocks from the 13 residual series from the II-level regressions and then conducts the analogous estimation from Table 2 that was applied to the GIV and Bartik value shocks. We now present the results from this estimation.

The first (second) panel of Table 6 shows the OLS- and 2SLS-estimated effects of the GIV (Bartik) forward supply shock where the exposition is identical to that of Table 2.[16] For both shocks, the significance of the first stage estimate (second column) is very strong with corresponding F-statistics of 319.3 and 343.1 for the GIV and Bartik shocks, respectively, reflecting 0.74- and 0.84-standard-deviation units of forward selling. Hence, it is clear that both shock instruments are very strong. The GIV and Bartik shocks produce significant forward rate appreciation of 0.04% and 0.05%, respectively, with the 2SLS estimation producing a significant estimate of 0.05. That is, a GIV/Bartik-forward-supply-shock-induced one-standard-deviation increase in IIs' forward flows' supply causes a 0.05% appreciation of IIs' forward rate. This demand semi-elasticity is considerably smaller than the 0.53 and 0.46 GIV- and Bartik-value-shock-induced semi-elasticities from Table 2. We now turn to reconcile this difference and focus our analysis for this reconciliation on the GIV forward supply shock in line with our GIV-focused approach for the value shock.

Why are the value- and forward-supply-shock-induced demand semi-elasticities different? The first panel of Table 7 shows the responses of forwards flows of the real sector, banking sector, foreign sector, and financial sector to the GIV forward supply shock. For completeness, this table also shows the response of IIs' forward flows and the second panel of the table shows the corresponding GIV value shock results from Table 4.

The results from Table 7 show that the real sector buys up the same amount of forward dollars for both shocks, indicating that this sector likely appears to possess a downward-sloping demand curve that becomes effectively fully inelastic beyond a supply increase of 0.08 standard deviation units of IIs' forward flows. Since the GIV forward supply shock produces a supply increase that

[16]The first column shows the OLS-estimated semi-elasticity which should in principle be identical to that from Table 2 but due to slightly different sample size it is slightly smaller (they are nearly the same without the rounding). The sample size difference (2,109 observations compared to 2,042 for the equity hedging channel analysis sample) stems from some missing observations for the constituent-level data.

is nearly 6 times larger than the corresponding value-shock-induced increase, the GIV shock's associated supply increase takes place only moderately so along the real sector's demand curve but predominantly so along local banks' demand curve (local banks buy up the vast majority (over 81%, or 0.6-standard-deviation units of IIs' forward flows) of the forward dollars sold by IIs).[17]

In other words, the results indicate that local banks' demand curve is considerably flatter than that of the real sector, resulting in a vastly smaller estimated semi-elasticity for the much larger (in terms of supply increase) forward supply shock relative to the value shock whose associated supply increase is mostly answered by forward purchases from the real sector. An interesting avenue of future research, which is beyond the scope of this paper, would be to explore these apparent demand slope differences across the real and banking sectors. (One reasonable explanation is that the real sector's forward dollar demand hinges on real, lower frequency factors and thus behaves more rigidly than the market-making ILS-liquid local banks.)

5.4 Robustness Checks

Appendix C of the Internet Appendix examines and confirms the robustness of the baseline results from the first panel of Table 2 along five dimensions. The first considers alternative lag specifications for the constituent-level regressions. The second truncates the baseline sample at February 28, 2020, so as to confirm that the baseline results are robust to omission of the COVID period. The third replaces the constituent-level, granular approach with an aggregate one by defining the instrumented value shock as an MSCI residual purged of variation from the same exogenous controls used in the constituent-level regressions. The fourth re-runs separate estimations by the currency (USD and non-USD) underlying IIs' forward transactions. And the last confirms our

[17] The associated 0.04% currency appreciation can be viewed as a volume-weighted average of the counterparty-sector-specific currency appreciations. Note that we can not observe these individual appreciations because the data underlying our regressions can not identify such sub-transaction information. That the 0.04% appreciation is lower than the corresponding value-shock-induced 0.07% appreciation is consistent with forward market segmentation related to variation in forward contract maturities across sectors. In particular, IIs have a volume-weighted average maturity of 52 days, roughly 70% of that of the real sector (72 days) and twice that of the financial sector (26 days). This means that for both shocks when IIs' forward supply increases this creates a maturity mismatch for the market-making local banks which in turn should require a premium (i.e., greater appreciation) for this mismatch between IIs' and the real sector. In the forward supply shock case, since the financial sector also significantly buys forward dollars, this mismatch issue is less severe. Moreover, by definition, the buying of forward dollars by the banks has no effect on maturity mismatch. This, together with the financial sector's buying in response to the forward supply shock, implies an alleviation of the maturity mismatch issue and is therefore consistent with the lesser appreciation in response to this shock.

results are robust to controlling for latent factors in the first stage of our estimation.

6 Conclusion

This paper documents a significant response of IIs' selling of foreign currency forwards in response to a global value shock, along with a significant appreciation of IIs' forward and spot rates and insignificant responses of IIs' cross-currency basis and spot flows. The 2SLS estimation indicates that a GIV-value-shock-induced increase in IIs' supply of forward flows appreciates IIs' forward rate by 0.53%. This set of findings, obtained from a granular econometric approach, can be viewed as representing evidence in favor of a meaningful equity hedging channel distinct from FX-swap-market-frictions- and portfolio-rebalancing-based mechanisms.

This paper's results have potentially meaningful policy implications. A significant equity hedging channel may render it optimal for policymakers looking to combat an exchange rate appreciation to consider outright FX intervention in the forward, rather than spot, market. An additional potentially relevant policy tool can involve limiting the use of IIs' hedging through taxation or quantitative restrictions. Studying the normative aspect of the employment of such policy tools in the presence of a meaningful equity hedging channel would be a potentially fruitful avenue for future research.

Code Availability: The replication code could not be shared because of the proprietary nature of the data. The editor gave permission prior to publication.

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Table 1: **Descriptive Statistics for IIs' Forward and Spot Flows and Rates.**

Response	Forward Rate	Spot Rate	Forward Flows	Spot Flows
Mean	-0.002%	-0.002%	-35.1	25.1
Standard Deviation	0.4%	0.4%	135.4	84.2
Obs	2,042	2,042	2,042	2,042

Notes: This table shows our baseline sample period's descriptive statistics (mean and standard deviation) for IIs' forwards flows and rates as well as IIs' spot flows and rates. IIs' forward and spot rates are the daily volume-weighted averages of IIs' corresponding rates from their transactions; the rates' statistics are in terms of growth rates. The flows' statistics are in millions of dollars; negative (positive) values represent selling (buying) of forward/spot dollars.

Table 2: **GIV and Bartik Value Shocks Estimation Results.**

		GIV Shock		
Response	OLS	2SLS 1^{st} Stage	2SLS 2^{nd} Stage	Reduced Form
IIs' Forward Rate	0.09***		0.53***	-0.07***
	(0.02)		(0.10)	(0.01)
IIs' Forward Flows		-0.13***		
		(0.03)		
F-Stat		18.98		
R^2	2.91%	8.92%		1.81%
Obs	2,042	2,042	2,042	2,042
		Bartik Shock		
IIs' Forward Rate	0.09***		0.46***	-0.06***
	(0.02)		(0.10)	(0.01)
IIs' Forward Flows		-0.14***		
		(0.03)		
F-Stat		25.60		
R^2	2.91%	9.09%		1.55%
Obs	2,042	2,042	2,042	2,042

Notes: The first (second) panel of this table shows 2SLS-estimated first stage effect of the GIV (Bartik) value shock on IIs' aggregate forward flows (second column) from Equation (2); the reduced form effect on IIs' aggregate (volume-weighted average) forward rate (fourth column) from Equation (3); and the 2SLS-estimated second stage estimate of the forward demand semi-elasticity (third column) conditional on the GIV (Bartik) value shock from Equation (4). For completeness, we also report in the first column the OLS-estimated effect from structural Equation (4). The Forward flows variable is divided by its standard deviation prior to entering the regressions for comparability purposes and hence its response is in terms of standard deviation units. 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 3: **S&P 500 and MSCI Responses to GIV Value Shock.**

	S&P 500	MSCI
Response	0.99***	0.71***
	(0.05)	(0.04)
R^2	66.64%	44.89%
Obs	2,042	2,042

Notes: Table 3 shows the responses of the S&P 500 and MSCI returns to the GIV value shock estimated from Equation (3) after replacing the log-first-difference of IIs' forward rate from this equation with the S&P 500 and MSCI returns. For internal consistency we construct the S&P 500 return as the market-capitalization-weighted average of the log-first-differences of our sample's 774 S&P 500 constituents' stock prices. The MSCI return is the log-first-difference of the MSCI index. 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 4: **Spot Rate, Spot Flows, and Basis Responses to GIV Value Shock.**

	Spot Rate	Spot Flows	Basis
Response	-0.07***	-0.02	0.66
	(0.02)	(0.03)	(0.72)
R^2	2.04%	8.27%	0.13%
Obs	2,042	2,042	2,042

Notes: This table shows the responses of IIs' aggregate (volume-weighted average) spot rate, aggregate spot flows, and aggregate (volume-weighted average) cross-currency basis to the GIV value shock estimated from Equation (3) after replacing the log-first-difference of IIs' forward rate from this equation with the log-first-difference of IIs' spot rate, spot flows, and first-difference of IIs' basis. We divide the spot flows variable by its standard deviation before entering it into the regression and so the spot flows response is in terms of standard deviation units of spot flows. 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 5: **Sectoral Forward Flows Responses to the GIV Value Shock.**

	IIs	Real	Banks	Foreign	Financial
Response	-0.13***	0.08***	0.06**	0.00	-0.02**
	(0.03)	(0.02)	(0.03)	(0.01)	(0.01)
R^2	8.92%	4.31%	2.98%	0.06%	0.77%
Obs	2,042	2,042	2,042	2,042	2,042

Notes: This table shows the responses of forwards flows of the real sector, banking sector, foreign sector, and financial sector to the GIV value shock. (For completeness, this table also shows the response of IIs' forward flows.) These responses are estimated from Equation (3) after replacing the log-first-difference of IIs' forward rate from this equation with each of the sectoral forward flow variables. All sectoral forward flow variables are divided by the standard deviation of IIs' forward flows and so the sectoral forward flow responses are in terms of standard deviation units of IIs' forward flows. 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 6: **GIV and Bartik Forward Supply Shocks Estimation Results.**

		GIV Forward Supply Shock		
Response	OLS	2SLS 1^{st} Stage	2SLS 2^{nd} Stage	Reduced Form
IIs' Forward Rate	-0.08***		0.05**	-0.04**
	(0.02)		(0.02)	(0.01)
IIs' Forward Flows		-0.74***		
		(0.04)		
F-Stat		319.27		
R^2	2.76%	58.12%		0.54%
Obs	2,109	2,109	2,109	2,109
		Bartik Forward Supply Shock		
IIs' Forward Rate	-0.08***		0.05***	-0.05***
	(0.02)		(0.02)	(0.02)
IIs' Forward Flows		-0.84***		
		(0.05)		
F-Stat		343.15		
R^2	2.76%	74.00%		0.88%
Obs	2,109	2,109	2,109	2,109

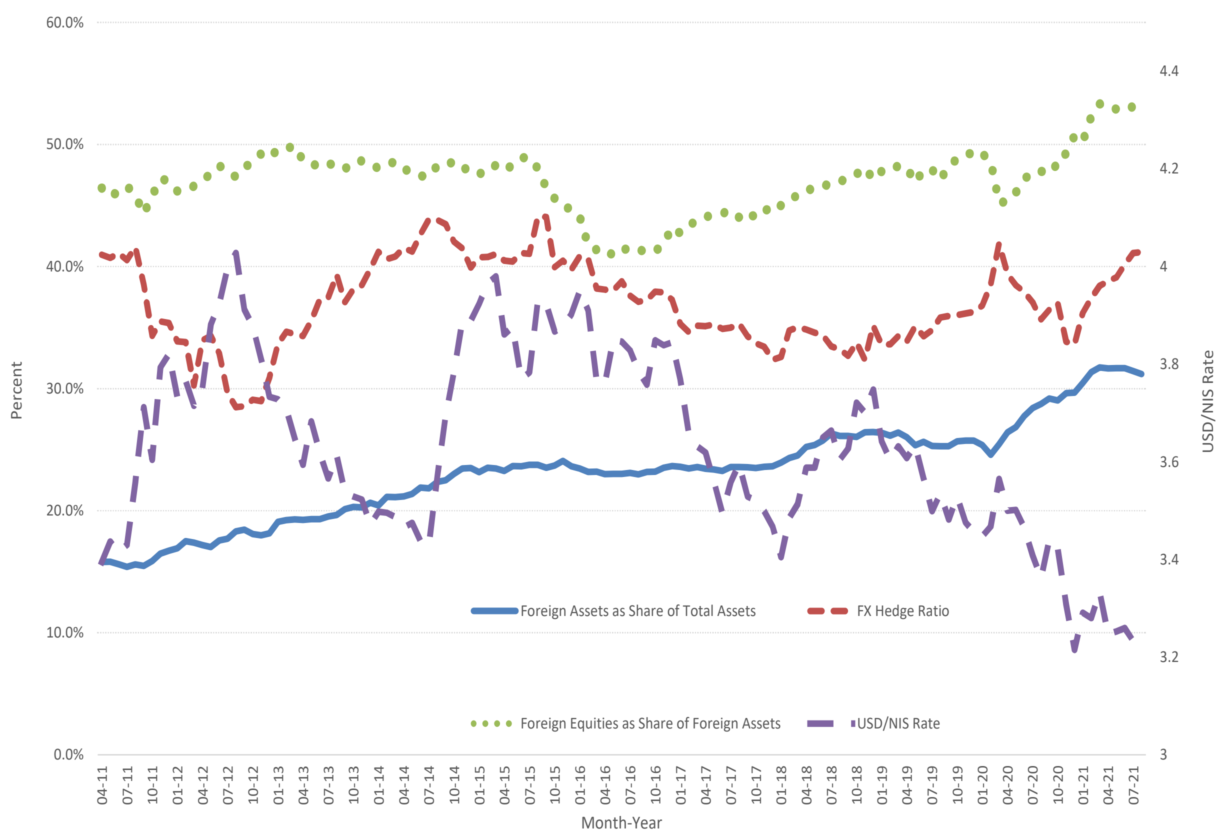
Notes: The first (second) panel of this table shows the OLS-estimated effects of the GIV (Bartik) forward supply shock on IIs' aggregate forward flows (second column) and aggregate (volume-weighted average) forward rate (fourth column) as well as the 2SLS-estimated forward demand semi-elasticity (third column) conditional on the GIV (Bartik) forward supply shock. The estimation is analogous to that of the GIV and Bartik value shocks; details of the estimation (specifically, the II-level regressions estimated for the construction of the forward supply shocks) are shown in Appendix B of the online appendix of this paper. For completeness, we also report in the first column the OLS-estimated semi-elasticity. The Forward flows variable is divided by its standard deviation prior to entering the regressions for comparability purposes and hence its response is in terms of standard deviation units. 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: **Sectoral Forward Flows Responses to the GIV Forward Supply and Value Shocks.**

	GIV Forward Supply Shock				
	IIs	Real	Banks	Foreign	Financial
Response	-0.74***	0.08***	0.60***	0.00	0.05***
	(0.04)	(0.02)	(0.03)	(0.01)	(0.02)
R^2	58.12%	4.16%	34.93%	0.08%	1.76%
Obs	2,109	2,109	2,109	2,109	2,109
	GIV Value Shock				
	IIs	Real	Banks	Foreign	Financial
Response	-0.13***	0.08***	0.06**	0.00	-0.02**
	(0.03)	(0.02)	(0.03)	(0.01)	(0.01)
R^2	8.92%	4.31%	2.98%	0.06%	0.77%
Obs	2,042	2,042	2,042	2,042	2,042

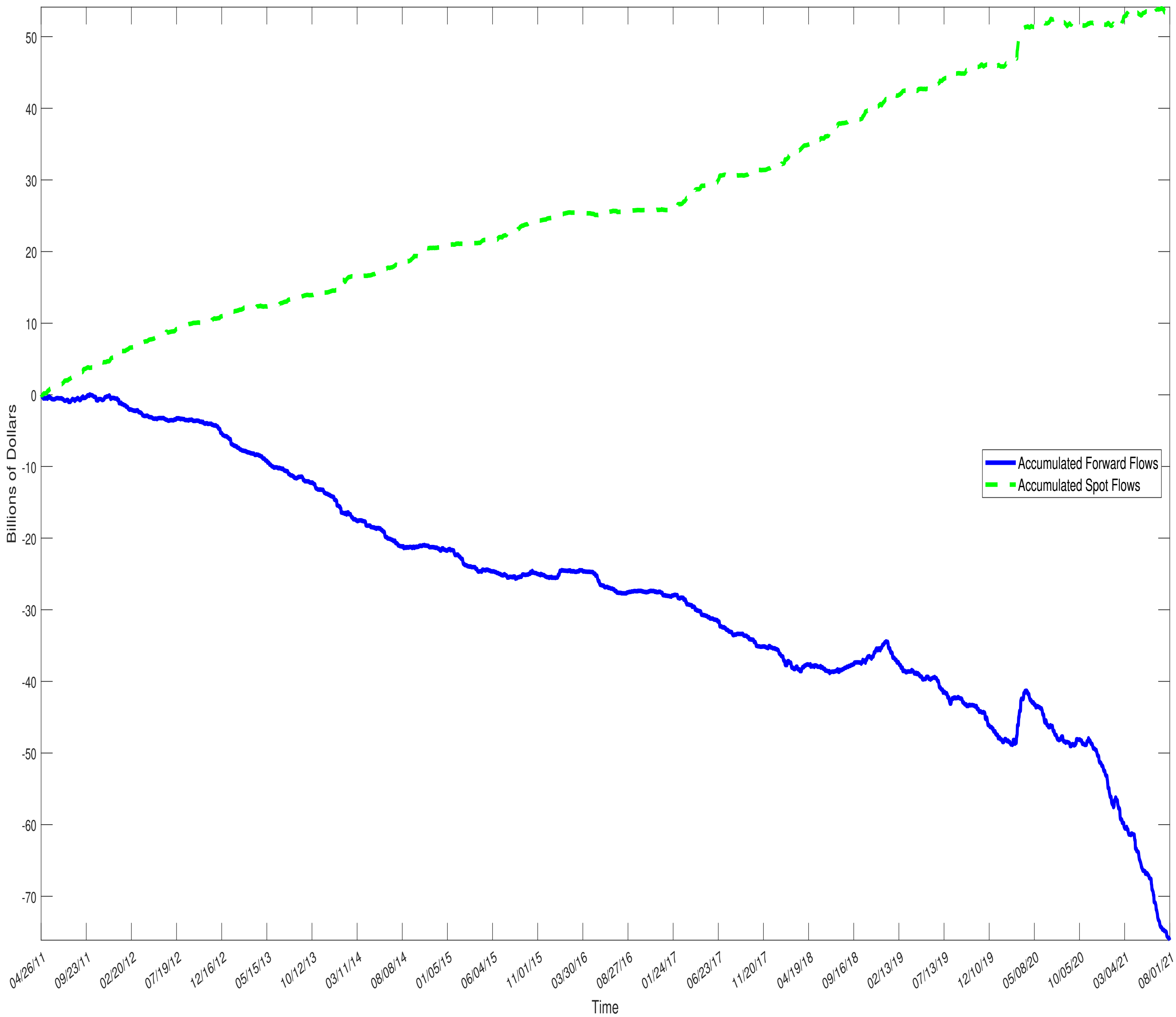
Notes: The first panel of this table shows the responses of forwards flows of the real sector, banking sector, foreign sector, and financial sector to the GIV forward supply shock. For completeness, this table also shows the response of IIs' forward flows and the second panel of the table shows the corresponding GIV value shock results from Table 4. All sectoral forward flow variables are divided by the standard deviation of IIs' forward flows and so the sectoral forward flow responses are in terms of standard deviation units of IIs' forward flows. 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: **Time Series of IIs' Foreign Assets, Foreign Equities, FX Hedge Ratio, and USD/ILS Spot Rate.**



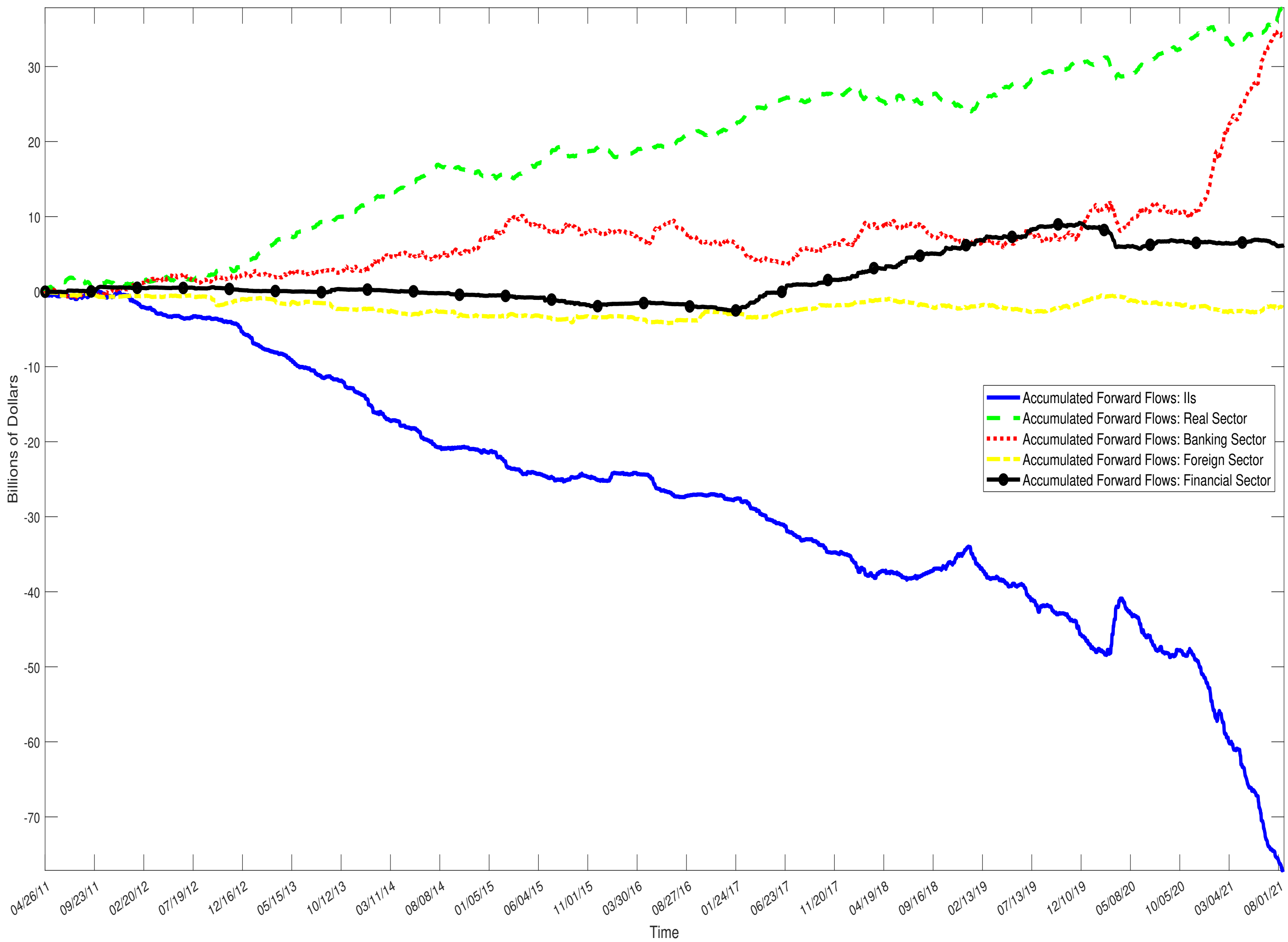
Notes: This figure presents the time series of the monthly shares of IIs' foreign assets in their total assets (solid line) and foreign equities in total foreign assets (round dotted line), IIs' FX hedge ratio (squared dotted line) (the share of foreign assets that is hedged against FX risk using forwards, swaps, and options), and the USD/ILS spot rate (dashed line). Data are from the BOI and cover 2011:M4-2021:M8. Time (monthly dates)is on the x-axis. IIs' variables are on the left y-axis; USD/ILS rate is on the right y-axis.

Figure 2: **Time Series of Accumulated FX Forward and Spot Flows.**



Notes: This figure presents the time series of IIs' accumulated daily FX forward (solid line) and spot (dashed line) flows. Negative accumulated flows values represent the accumulated selling of dollars; positive values represent the accumulated buying of dollars. Data are from the BOI and cover April 26, 2011, to August 18, 2021. Date is on the x-axis. Values are in billions of dollars.

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



Notes: This figure presents the time series of accumulated daily FX forward flows by sector. On top of the II sector (which, for completeness, is also included in the figure and is represented by the solid line), this figure includes four additional sectors: real sector (dashed line), which represents the net FX flows from forward transactions involving Israeli exporters and importers; banking sector (dotted line), which includes the Israeli commercial banks; foreign sector (dash-dotted line), which includes all types of foreign economic units; and financial sector (solid line with circle markers), which includes Israeli mutual funds, exchange traded funds, hedge funds, and proprietary trading firms. Negative accumulated flows' values represent the accumulated selling of dollar forwards; positive values represent the accumulated buying of dollar forwards. Data are from the BOI and cover April 26, 2011, to August 18, 2021. Time is on the x-axis. Values are in billions of dollars.