



# 1 Introduction

We highlight a channel through which global equity market 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 ex-

the duration of this reversal by nearly half. The decrease in the spot and forward rates is very similar and coincides with a minimal response in U.S. and Israeli interest rates, as indicated by the insignificant estimated change in the USD/ILS cross-currency basis for all benchmark forward contract horizons.

**Ruling Out Other Potential Mechanisms.** Although our daily 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 shocks to the MSCI and the exchange rate.

**I. Causality Between Forward Flows and the Exchange Rate.** In order to ensure that our analysis is valid and to address potential concerns that hedging activities by IIs may not directly cause changes in forward rates but rather just occur concurrently with them, we investigate whether forward flows have an impact on the exchange rate in a general setting. That is, forward shocks that are not related to the MSCI shock (e.g., the need for some IIs to increase their hedging ratio.)

To do this, we exploit the granularity of our data and use a granular instrumental variable (GIV) estimation approach (Gabaix and KoijGabteMSCe [228()TJ0.6 0 .0 rg 0.6 0 .0 RG [(G2020te)-te ve f idiosyrhocks o Isorward hupples 050GIV-3936(ho





dimension estimates the model for two alternative lag specifications in the AR process underlying the MSCI return series equation. The results from these four robustness checks are similar to the baseline ones, reinforcing confidence in the message of a meaningful equity hedging channel. It is noteworthy that for the pre-COVID sample, the MSCI innovation continues to produce significant selling of dollar forwards, while accounting for as much as 36% of the variation in the spot rate, but it no longer generates significant selling of spot dollars as in the baseline case.

**External Validity.** We argue that the channel we document is not specific to the Israeli economy (For more information on the external validity of our analysis in other economies, see Section 7.). In fact, the recent OECD 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 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 35% of their assets in 2020, with some countries as high as 90% of their assets.

USD/ILS forward and spot flows of IIs as well as USD/ILS forward and spot rates corresponding to benchmark FX forward contracts.

To achieve our stated goal, this paper unfolds in two parts. The first section presents a clear conceptual framework that helps to clarify our ideas, motivates the use of the litmus test mentioned above, and provides a suitable foundation for the paper. The second part of the paper then carries out the litmus test itself. Before discussing these two sections, we will first briefly clarify some terminology to facilitate the exposition of the paper.

**Terminology.** In this paper, we use the terms "dollar" and "foreign currency" interchangeably to refer to the USD/ILS currency pair, as 84% and 81% of IIs' FX forward and spot trades, re-

there is a perfectly inelastic supply curve of foreign currency forwards which shifts rightward along the importer's downward-sloping demand curve when the II's foreign equity position's value rises. This downward pressure on the forward rate translates into a decline in the spot rate owing to a global arbitrageur's activity which produces a positive equilibrium relation between forward and spot rates (albeit in tandem with an unconditional violation of the CIP condition).

The second part of the paper, to which we turn our attention next, tests the model's prediction that an increase in global stock prices leads to increased forward flows and lower forward and spot



two-step approach is preferable over a one-step estimation approach.) Our Bayesian approach is in the spirit of a long tradition in the literature on impulse response estimation (see, e.g., [Del Negro](#)

Outline.



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 PM 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



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).

## 4 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.

**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 779 million dollars, half the size of the spot market's daily average turnover of 1,491 million dollars. This places Israel in the third quartile of the 51 countries for this relative measure, alongside other major FX markets like the U.S., the U.K., and Switzerland, indicating the forward market is a liquid market

ance policies.<sup>4</sup> IIs are important players in the Israeli financial market, managing 607.7 billion

FX swaps (see Section 6.4).

**Basis for Abstraction from FX Swaps.** The previous section's theoretical framework centers the equity hedging channel around forward contracts between IIs and importers, where the latter





**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

ticipants 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.<sup>8</sup> The centrality of the real sector as buyer of dollar 34(noteworthy)-6 TcsWaonsist27933(



**Spot Flows.** This variable measures (in dollars) the daily net transaction flow from buying and

**Interest Rates.** In accordance with the time horizons for the forward rate data, we also look at the responses of the 1-, 3-, 6-, and 12-month London Interbank Offered Rate (Libor) as our measure

outcome variable at horizon  $h_{,10,11}$  and e

the standard errors within our Bayesian estimation procedure. In doing so we accord with the reasoning from [Miranda-Agrippino and Ricco \(2021\)](#), who estimate a hybrid VAR-local-projections model and follow the suggestion from [Müller \(2013\)](#) to increase estimation precision in the presence of a misspecified likelihood function (as in our and their setting) by replacing the original posterior's covariance matrix with an appropriately modified one. Moreover, given the high-frequency nature of our data and the general tendency of impulse responses from local projections to exhibit jaggedness, we apply the smoothing procedure from [Plagborg-Møller \(2016\)](#) to our estimated raw impulse responses. (Details on this smoothing procedure are provided in Appendix





USD/ILS Spot and Forward Rates.

quantitative terms, the selling of dollar forwards is much larger than that of spot dollars with the latter accumulating to a peak value of 72.4 million dollars after 256 trading days and the former's corresponding value standing at 4.7 times larger than that at 338.8 million dollars after 277 days.





4 sub-figures of Figure 11 present the differences between responses of the Libor and Telbor rates, where each difference corresponds to one of the four considered interest rate time horizons.

These results clearly indicate a negligible role for interest rate spreads across the U.S. and Israeli economies as a propagation mechanism for the foreign stock price innovation. Both U.S. and Israeli interest rates' responses are economically negligible, resulting in their associated spreads being also immaterial with the largest response difference standing at only 2.7 basis points for the 3-month spread after 2 years. All in all, the main takeaway from these results is that the fact that most of the sample period considered in our analysis saw constant interest rates glued to their effective zero lower bounds facilitates our analysis by ruling out a meaningful interest rate spread based mechanism being present after an MSCI index innovation.

### **ILS/USD Cross-Currency Basis.**

### 6.3 Inspecting the Mechanism Through the Lens of Forward Supply Shocks

**GIV- and Bartik-Based Estimation.** One concern that may still arise from our empirical evidence is that MSCI innovations' effect on the exchange rate is not intrinsically rooted in a causal

now discuss the construction of each shock.

The GIV shock is constructed as the difference between the size-weighted- and inverse-variance-weighted-average of the 14 idiosyncratic micro-level forward supply shocks from the first estimation step, where the size weights are calculated from the share of forward flows average volume of each II in total IIs' average volume. As shown in [Gabaix and Koijen \(2020\)](#), this GIV construction is optimal in the sense that the resulting estimation possesses the highest precision. Moreover, it provides an aggregate shock to IIs' forward supply in line with [Gabaix and Koijen \(2020\)](#).



where  $i$  and  $t$  index IIs and time at daily frequency;  $a_{i,0,L}$  is the fixed effect;  $FF_{i,t}$  is II  $i$ 's forward flows;  $p_i$  denotes the number of lags for II  $i$ 's equation;

that guide these traders. And any potentially remaining common variation in our 14 idiosyncratic shocks is likely removed owing to our GIV approach which subtracts the inverse-variance-

and -0.054% for the GIV and Bartik cases - which are 25.4% and 23.6% of the corresponding baseline magnitude of the response to the MSCI innovation - and significance only lasts for 8 and 9 days, respectively. To understand this stark difference with respect to the baseline exchange rate response to the MSCI innovation, we now turn to the response of the forward flow variable.

## 6.4 Are Forward Flows Distinct from Rebalancing-Induced Spot Flows?

**FX Swaps as a Central Funding Tool for Forward Contracts' Settlement.** Investing abroad presents risks for IIs. They face FX risk because of the currency mismatch due to their liabilities being in the local currency while holding a portion of their assets in foreign currency. International investors such as IIs can mitigate potential losses by hedging against the FX risk. For instance, let's consider a foreign investor who invested in the S&P 500 in 2020, which saw a 16% increase. However, the US broad dollar index weakened by 3% during the same period. Without hedging the FX risk, the investor would have experienced approximately a 20% loss when converting their investment into their local currency.

IIs employ various strategies to hedge their FX risk. One approach - the focus of our paper - involves selling their dollar profits and purchasing the local currency through the FX forward market. By selling the profits in the forward market, investors safeguard themselves against potential

while using their quantification to learn about the relevance of the third option.

**Econometric Specification.** To rigorously examine the relationship between FX swaps and forward contracts, we employ a panel regression analysis at the fund level, utilizing our granular (transaction-level) dataset comprising of 175 funds. The dependent variable in our regression is the daily amount of dollars bought or sold in the FX swap market by fund  $i$  at time  $t$  (FX

the dependent variable (Figure 6), we do not observe any discernible pattern. This suggests that

specific information on expected defaults and a residual component that they term as EBP. In particular, they use the structural "distance to default" model based on the seminal work of [Merton \(1973\)](#) to purge micro-level credit spread data of their endogenous default risk component and interpret the residual component (EBP) as a credit supply shock that represents exogenous move-



of the estimated coefficient on the MSCI innovation and that on the interaction between this in-

shares of the aggregate IIs' foreign equity position.<sup>22</sup> We then estimate our model using the latter aggregate return series instead of the MSCI return series. (We also report in the context of this robustness check that the correlation between these two return series is 98.3%, indicating that our baseline MSCI return series is an excellent measure of the actual aggregate return of IIs' foreign equity portfolio.)

The second robustness check replaces the MSCI return series with the S&P 500 index return series. The purpose of this exercise is to further confirm the insensitivity of the baseline results to the specific return series being used. (The correlation between the S&P 500 index return series and the micro-based return of IIs' foreign equity portfolio is 98.2%. And the correlation between the former series and the baseline MSCI return series is 90%.) The third robustness check truncates the baseline sample to 1990-1999 (see Table 1).

Table 1: Baseline Results

Table 1: Baseline Results (continued)

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observe in our analysis are not aimed at hedging against changes in international bond prices. The driving impulse of our channel is a shock to global equity markets and our empirical shock captures exactly this driving impulse rather than a shock to global debt markets. Since bonds and



able expectation, documenting a 18.5% average share of foreign equities in total pension funds' assets across several small economies (Australia, Canada, Chile, Colombia, Denmark, Mexico, New Zealand, Norway, Peru, South Korea, Sweden, and Switzerland) along with a moderate standard deviation of 8%.

derivatives, having the largest net short FX derivatives position and, at times, being the only net suppliers of U.S. dollars in the forward market. By the end of 2018, they held 41.3 billions of U.S dollars in FX derivatives, which is equivalent to 30% of the commercial banking credit and 15% of GDP.

## **7.2 Suggestive Evidence for External Validity**

Economies that meet the three conditions laid out in the previous section should see their exchange rates appreciate in the presence of a rise in global stock prices. This prediction is a litmus test for the validity of these three conditions as requisites for a meaningful equity hedging channel.



## 8 Conclusion

This paper documents a significant response of IIs' selling of dollar forwards in response to an MSCI index innovation, along with a significant decline in USD/ILS forward and spot rates that embodies an inconsequential response of USD/ILS currency basis and interest rate differentials.



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**Figure 2: 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





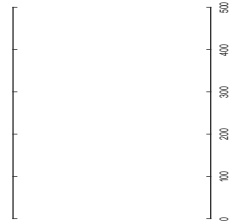


Figure 5:



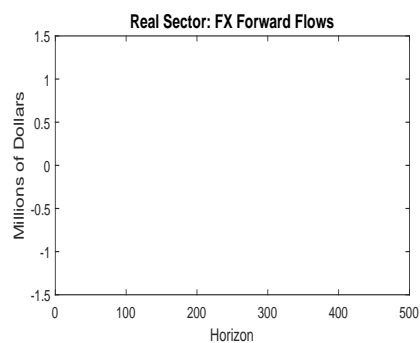
Figure 7:

Figure 8: FX Market Prices and Quantities: (a) Impulse Responses; (b) FEVs.



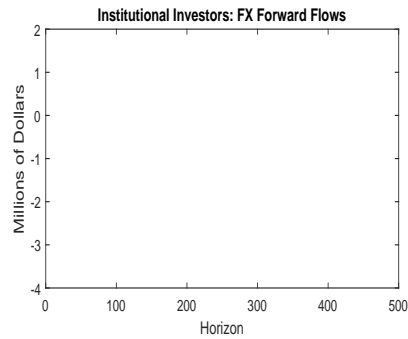
(a) Impulse Responses of FX Market Prices and Quantities to a One

**Figure 9: Impulse Responses to a One Standard Deviation MSCI Index Innovation: Non-II Sectors' Spot and Forward Flows.**



*Notes:* This figure presents the impulse responses of spot and forward flows of the real, banking, foreign, and financial sectors to a one standard deviation MSCI index innovation

Figure 10: **Impulse Responses to a One Standard Deviation MSCI Index Innovation: Banking and Real Sectors' Forward Flows Versus IIs' Forward Flows.**



*Notes:* This figure presents the difference between raw and accumulated (in absolute terms) response of IIs' forward flows and banking and real sectors' raw and accumulated forward flows, respectively, to a one standard deviation MSCI index innovation from the model described by Equations (1) and (2). (For completeness, responses themselves (both raw and accumulated) for all three sectors are also shown in the figure.) Responses are in terms of deviations from pre-shock values (in million of dollar terms). Horizon (on x-axis) is in days.





**Figure 12: Impulse Responses to a One Standard Deviation GIV-Based Forward Flow Shock: FX Market Prices and Quantities.**

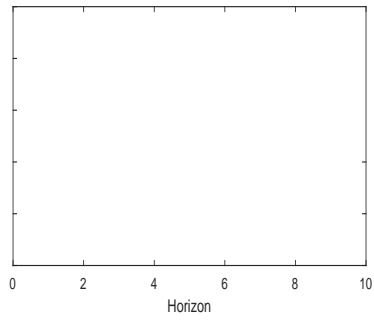


Figure 13:

Figure 14: Impulse Responses to a One Standard Deviation MSCI Index Innovation Orthogonalized with Respect to Risk Appetite Shocks: FX Market Prices and Quantities.

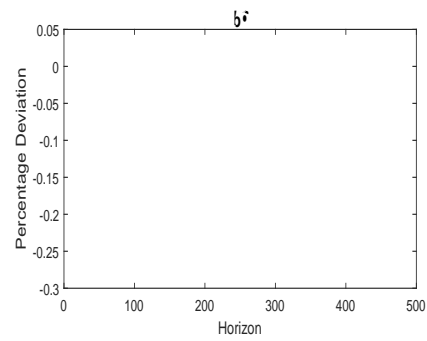
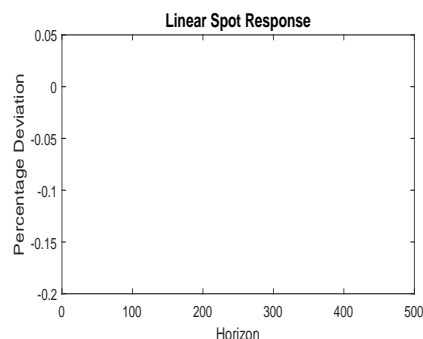


Figure 15: LOA-Dependent Impulse Responses to a One Standard Deviation MSCI Index Innovation: FX Market Prices and Quantities.



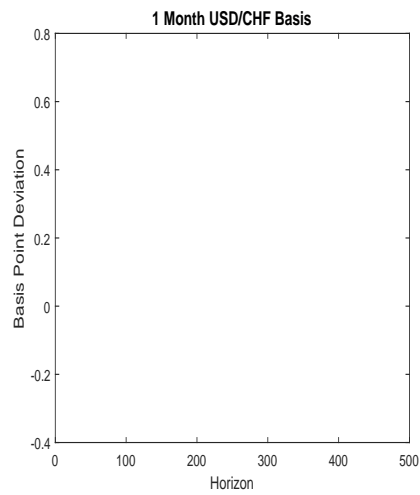
*Notes:* This figure presents the LOA-dependent impulse responses of the spot rate and raw and accumulated forward flows to a one standard deviation MSCI innovation from an augmented version of the model described by Equations (1) and (2) where we add to the RHS of Equation (2) the global financial institutions' equity capital measure from He et al. (2017) (normalized to have a zero mean and unit variance) and the interaction between the latter variable and our MSCI innovation. The figure shows the linear (first column) and no-LOA state (second column) effects of the MSCI innovation. The no-LOA state effect effectively shows the effect of the MSCI innovation when the He et al. (2017) equity capital variable is one standard deviation above its mean. In the third column we also show the difference between the no-LOA state effect and the linear effect (i.e., the third column shows the interaction effect). Responses are in terms of deviations from pre-shock values (percentage deviation for the spot rate and Millions of dollars for forward flows' raw and accumulated responses). Horizon (on x-axis) is in days.

Figure 16: Spot Exchange Rates for Other Economies: (a) Impulse Responses; (b) FEVs.



(a) Impulse Responses of Spot Exchange Rates for Other Economies to a One Standard Deviation MSCI Index Innovation.

Figure 17: Cross-Currency Basis for Other Economies.



*Notes*