How do Global Portfolio Investors Hedge Currency Risk?*

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Abstract

We use monthly portfolio data from one of the world's largest custodian banks, with over $40 trillion assets under custody, to study how global portfolio investors hedge foreign exchange risk in their equity and fixed income portfolios over the past 25 years. The data allow us to match asset positions with their corresponding foreign exchange forward positions. We present five findings: 1) We confirm the oft-conjectured hypothesis that fixed income investors hedge more than equity investors; Fixed income managers are more likely to hedge at all, and when they do hedge, their hedge ratios are more likely to be approximately one; 2) Across fixed income and equity managers, non-US dollar domiciled investors hedge more than US-domiciled investors, but the difference is shrinking over time 3) Hedging activity has increased steadily especially after 2008, both for USD-domiciled and non-USD-domiciled investors; 4) A significant fraction of currency hedgers manage towards a target hedge ratio and rebalance their currency positions accordingly. 5) We investigate the determinants of USD and EUR domiciled investors' hedge ratios across currencies and over time, including carry, volatility, and FX momentum. For equity investors, we find higher carry and lower volatility are associated with stronger hedging. USD equity investors hedge low momentum currencies more strongly, EUR equity investors less strongly. For fixed income investors, we find higher carry, lower currency momentum, lower FX volatility, higher bond volatility, and, for USD investors, higher FX-FI correlations are associated with stronger hedging. Even after controlling for these correlations, we observe an increase in hedging after the 2008 global financial crisis across domiciles and asset classes.

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A large literature in finance has suggested that investors who own foreign assets would do well to hedge, or partially hedge, their currency risk. Beginning with Solnik (1974) and Black (1990) many authors have sought to characterize optimal currency positions in a mean-variance framework.[1] More recently, Glen and Jorion (1993) and Campbell, Serfaty-de Medeiros, and Viceira (2010) and Campbell, Viceira, and White (2003) measure empirically the benefit of foreign currency hedging based on historical patterns of returns and risk. Campbell, Serfaty-de Medeiros, and Viceira (2010) show that for a global bond investor, the risk-minimizing strategy is near 100% currency hedge; for equity investors, the risk minimizing strategy tends to be long the US dollar, the Swiss franc, and the Euro, but short other currencies. Statman (2005) and Michenaud and Solnik (2008) extend this literature to derive optimal currency hedging choices when investors are motivated by the avoidance of regret.

Despite much theory, until recently there has been little evidence on what institutional investors actually do. Exceptions to this are recent papers by Sialm and Zhu (2024), Du and Huber (2024), and Opie and Riddiough (2024). Sialm and Zhu (2024) document widespread use currency forward contracts by US mutual funds. They also show that mutual funds that hedge currency risk do not generate differential abnormal returns. Du and Huber (2024) analyze industry- and company filings of global institutional investors, with a focus on their hedging of US dollar exposures. They show that foreign mutual funds and other investors have raised their US-dollar hedge ratio over the past two decades, notwithstanding higher hedging costs. Opie and Riddiough (2024) also study US mutual funds, additionally finding that funds trade in currencies not in the underlying equity portfolio. Despite this growing evidence, most data on institutional investors are sparse, indirect, and cover only a handful of years or currencies. This leaves open several important empirical questions. Are USD-domiciled investors different? How has currency hedging evolved over time? How does hedging activity vary according to asset type? Do investors appear to have target hedge ratios? If the cost of hedging goes up, do funds stick to their target hedge ratios or do they cut back? To answer these questions, substantially better data is needed.

In this paper, we bring granular new data to analyze the hedging behavior of USD- and foreign currency domiciled equity and fixed income investors around the world over a 25-year period. Our objective is to document the main patterns in how investors across domiciles and asset classes hedge their currency exposure, and how this has evolved over time. We observe historical monthly positions from a large group of institutional

[1] See also Boudoukh, Richardson, Thapar, and Wang (1995) and Tien (2002).

investors around the globe represented by anonymized custodial data provided by State Street Corporation. State Street is among the world's largest global custodians, with assets under custody or administration amounting to over US$40 trillion as of 2023, comprising investors over many different domiciles. These data, anonymized for confidentiality, comprise complete fiduciary accounts of all transactions and positions for the portfolios in which these assets are held, including foreign-exchange and underlying securities. The key advantage of our data, compared with previous work, is the ability to match investors' asset positions (equity and fixed income) with forward foreign exchange positions, which we can do for a large universe of investors in different domiciles from 1998 to 2023.

We present five main findings. First, we construct hedge ratios for US-dollar and foreign-domiciled investors. We define the hedge ratio as the ratio of the foreign exchange short position to the value of the underlying assets (say, Australian equities or German bonds). We show that USD-based fixed income investors hedge far more often than USD-based equity investors. Fixed income managers are more likely to hedge, and when they do hedge, their hedge ratios are larger. On average, only 21% of USD-based equity investors hedge their currency exposure, compared to 41% of US fixed income managers. Even these estimates may be biased upwards because of data considerations. Of the managers that hedge, the average hedge ratio for equity investors is 35%, and 66% for fixed income investors. Beyond these average patterns, there is considerable heterogeneity. For example, while 77% of US-domiciled fixed income managers hedge their exposure to Euros, the remaining 23% do not, including investors who take FX positions without owning any underlying Euro-denominated assets. Many fixed income investors have hedge ratios close to one suggesting complete hedging, but many exhibit a range of different hedge ratios that vary by currency and over time. USD-based investors in our data hedge more frequently and at higher ratios than documented for mutual funds by Sialm and Zhu (2024).

Our second set of findings compares USD-domiciled investors with their counterparts who are domiciled in other currencies. Across fixed income and equity managers, non-US dollar domiciled investors hedge with greater frequency and higher intensity than US-domiciled investors. For example, on average, 36% of Euro-based equity investors hedge currency risk compared with 23% of USD-based investors. 82% of Euro-based fixed-income investors hedge currency risk compared with 75% of USD-based investors. These patterns are repeated on the intensive margin: of the fixed income investors that hedge, USD-domiciled investors have an average hedge

ratio of 66%, compared with 95% for Euro-based investors. Conditional on hedging, most non-US domiciled fixed income investors hedge their dollar exposure with a ratio of about one, significantly more than USD-based investors hedge their non-dollar exposure. These findings are surprising from the perspective of theory, and have obvious implications for demand for the US dollar: because non-USD investors hedge currency more than US investors, foreign asset purchases by USD investors have greater implications for USD demand than do USD asset purchases by non-USD investors.[2]

Third, currency hedging activity has increased steadily over time, both for USD-domiciled and non-USD-domiciled investors, and on both the intensive and extensive margins. For example, on average between 1998 and 2023, 77% of USD-based fixed income investors hedged their Euro exposure, a number that rose to 85% by November 2023. Hedge ratios have risen too: the average hedge ratio for USD-based fixed income investors hedging Euro risk rose from a sample average of 81% to 106% in November 2023. These findings are consistent with Du and Huber (2024) who document increases in USD hedge ratios by an average of 15 percentage points post GFC, as well as Lilley et.al. (2022), who see a weaker relation between US investors' foreign bond purchases and the USD in recent years. Greater hedging by USD investors would dampen net currency demand coming from their foreign bond purchases.

Fourth, we measure how currency hedges change in response to fluctuations in the underlying assets, by measuring what we term "dynamic hedge ratios". For example, consider a Euro-domiciled equity investor who appears to have hedged their dollar assets with a ratio of 0.5, meaning they have a negative forward position in US dollars equivalent to half of their dollar-denominated assets. What happens when the dollar assets go up in value by 10 percent? If the investor adheres to a hedge ratio of 0.5, she would sell forward the USD by an amount equal to half of the dollar increase in asset value. We show that a significant fraction of currency hedgers act in this way, meaning they rebalance their foreign exchange exposures when the underlying value of their equity and fixed income positions move. In addition, we show that investors adjust their hedges relatively quickly: most of the adjustment occurs at a horizon of one month.

[2] Lilley et. al. (2022) find a relationship between US investor purchases of foreign bonds and the USD: a lower degree of hedging by US based investors implies greater net demand for currency from their bond purchases than an equivalent purchase of US Treasuries by a foreign investor.

In the last section we investigate what drives how hedge ratios move around across currencies and over time. We have already noted the increase in hedging post-GFC. As additional potential predictors of currency hedging, we include carry, volatility, FX momentum, and measures of the volatility of the underlying asset and its correlation with currency returns. For equity investors, we find higher carry and lower FX volatility are associated with stronger hedging. USD equity investors hedge low momentum currencies more strongly, EUR equity investors less strongly. For fixed income investors, we find higher carry, lower currency momentum, lower FX volatility, higher bond volatility, and, for USD investors, higher FX-FI correlations are associated with stronger hedging. We also find an increase in hedging after the 2008 global financial crisis across domiciles and asset classes, after controlling for other variables. The regressions reflect increases at the intensive margin, but we also show an increase at the extensive margin. In other words, we find more funds hedging and those that do, do so at higher hedge ratios. These results expand upon Du and Huber (2024), who study cross-sectional patterns in USD hedging.

Our findings are related to a large normative literature in asset pricing on how global investors should hedge their exposure to currency risk, including Solnik (1974), Black (1972), Glen and Jorion (1993), Campbell, Serfaty-de Medeiros, and Viceira (2010) and Campbell, Viceira, and White (2003).[3] Liao and Zhang (2021) suggest a model where investors increase their currency hedging during periods of financial distress, driving changes in exchange rate. Greenwood, Hanson, Stein and Sunderam (2024) consider the role of FX hedging for covered interest parity (CIP) deviations. Our paper also relates naturally to the even larger literature documenting how international investors adjust their portfolios, including Froot, O'Connell, and Seasholes (2001), Froot and Ramadorai (2005) and Portes and Rey (2005), among others.

The paper proceeds as follows. Section I describes the data and steps required to reach a sample that is suitable for analysis. Section II describes how we measure currency hedging at the currency and portfolio level, and presents a number of statistics regarding how USD-domiciled and other investors hedge their currency risk. Section III outlines the evidence that investors tend to dynamically adjust their portfolios towards a target hedge ratio. Section IV investigates what drives hedge ratios in the time series and cross-section. Section V concludes.

[3] See also Froot (1993), Walker (2008).

I. Data: Measuring Asset and Currency Positions

Overview

We observe monthly historical stock, fixed income, and currency positions from a large group of institutional investors represented by anonymized custodial data provided by State Street Corporation[4]. State Street is among the world's largest global custodians, with assets under custody or administration amounting to over $40 trillion as of September 30th 2023[5]. These anonymized data comprise complete fiduciary accounts of all transactions and positions for the portfolios in which these assets are held (including foreign-exchange and underlying securities). Previous studies using parts of this data include Froot, O'Connell, and Seasholes (2001), Froot and Donohue (2002), Froot and Teo, and Cheema-Fox et al (2021). We use two State Street datasets: one on holdings of underlying assets (equity, fixed-income, and money-market / cash holdings) and another with foreign exchange forward positions. This dataset extends from February 1998 to November 2023, a quarter century of history. We focus on assets denominated in "G10" currencies, comprising the Australian Dollar (AUD), the Canadian Dollar (CAD), the British Pound (GBP), the Euro (EUR), the Swiss Franc (CHF), the Japanese Yen (JPY), the Norwegian Krone (NOK), the Swedish Krona (SEK), the New Zealand Dollar (NZD), and the US Dollar (USD).

Utilizing State Street's custodial records, we construct portfolio level holdings consisting of public equities, fixed-income instruments, and money-market instruments. Cash equities primarily consist of holdings of common stocks. We utilize positions taken in securities within the MSCI ACWI IMI, which covers more than 99% of public equity by market value. We also include positions in depository receipts connected to MSCI securities. ETFs are included but constitute a very small proportion of sample assets.[6] We utilize MSCI pricing to value positions. We map State Street positions to MSCI market data using a combination of SEDOL, ISIN, and CUSIP identifiers. Similarly, we connect State Street data to fixed-income market data from Refinitiv Datascope

[4] All analysis was performed within State Street's secure environment and was subject to anonymization to protect client confidentiality.

[5] State Street 10Q Filing, October 2023 https://d18rn0p25nwr6d.cloudfront.net/CIK-0000093751/ffbca906-845f-44f7-88cf-fc966d3f8cb2.pdf

[6] ETF positions, where present, are factored into underlying security constituents at index weights (for instance, if we observe a holding of an SP500 tracking ETF, we would break this down into a certain proportion of implied shares of APPL, AMZN, etc.); these ETF positions comprise a very small portion of our sample, under 1%.

and utilize pricing from Refinitiv Datascope to value positions for corporate bonds, sovereign bonds, mortgage-backed securities, and where available commercial paper.[7] We define the portfolio as the set of positions for which we have complete prices and holdings. Below we describe an additional set of screens that we impose to ensure that the portfolios we measure are representative of the actual portfolios.

Our analysis requires us to match the foreign exchange trading of a fund with its underlying positions. We take the conservative approach and consider a fund for analysis only if we observe it trading FX over the past 12 months. While this approach may seem overly conservative and biased in favor of finding more hedging behavior, it allows us to avoid misclassifying funds as non-hedgers simply because we do not ever observe them doing FX transactions, which they may execute in another account (such as an overlay account, a common practice). We use the term "matched funds" to describe the sample where we have both position data, securities prices, matched FX transactions, and for which we can identify the funds as being either equity or fixed income oriented, on which we elaborate below.

Last, when we have this sample of matched funds, we implement a series of data screens, such as requiring funds that have more than ten positions. These data screens are detailed in Appendix A. Appendix Figure 1 provides a diagram to describe the complete set of steps taken to arrive at our final sample. After passing these screens, we refer to the dataset used in the bulk of the paper as "our sample." In section X, where we study dynamic hedge ratios estimated via regression for each fund, we impose a further set of screens to ensure that hedge ratios are being estimated on sufficient data. Data confidentiality does not allow us to list estimates of AUM and limits our discussion of observation counts.

Foreign Exchange Market Data

[7] Following Cheema-Fox et al., our universe and pricing of equity securities is taken from Morgan Stanley Capital International (MSCI) All Country World Investible Market Indices, which are designed to encompass over 99% of investible market capitalization of global equities according to MSCI. For fixed-income investments, our pricing data are derived from Refinitiv Datascope. These encompass global sovereign bonds (local-currency only), corporate bonds, and US Agency Mortgage-Backed security (MBS) assets. We focus primarily on cash instruments (excluding fixed-income futures, derivatives and swap positions), with the exception of MBS TBA (to be announced) forward positions, which are included. Money-market instrument pricing is taken from the State Street accounting systems (using point-in-time information), except where commercial paper instruments are mappable to the Refinitiv Datascope asset universe, in which case we use Datascope pricing.

We obtain spot exchange rates valued each day as of 11 a.m. EST from WMR/Reuters where available, and Refinitiv Datastream where WMR/Reuters lack data. To compute present values of FX forward positions, we obtain interest rate data from Refinitiv Datastream. We use daily interbank rates where available for tenors up to one year; where these are absent, we use deposit rates or country treasury rates. While most forward contracts have tenors expiring within a year, we discount longer-term contracts using swap or sovereign bond rates for maturities from 1 to 30 years.

FX Forward Contracts

Foreign exchange forward positions are from State Street's custodial records. We define a forward transaction as a paired-buy-sell currency trade having a tenor exceeding 7 days. We separately decompose each forward into the two currency legs-- currency bought and currency sold-- and compute the discounted value of these two legs in USD using the current spot exchange rate. To permit aggregation across forward contracts of different tenors, we take the present value of each leg of the forward and convert to USD.

For forward contracts of maturity one-year or less, for a given currency *c*, a contract with notional value *X* measured in local currency bought or sold and maturity *t*, the present value of the forward *PV* is

$$PV = \frac{X_c}{\left(1 + R * \frac{m}{360}\right)} \quad (1)$$

where *R* denotes the annualized interest rate and *m* is the remaining maturity, defined as the value date minus the trade date. *m* is the remaining maturity in days, which we divide by 360 except for GBP where we use a 365-day count convention. Equation (1) needs to be adjusted for contracts of maturities greater than one year.[8] For a given forward, if the percent difference of the discounted USD value of the bought and sold legs exceeds 30%, we discard the transaction as erroneous. Where the remaining term of the forward does not match available interest rates, we linearly interpolate between the nearest available rates.

[8] Specifically, $PV = \frac{X_c}{(1+R)^{\lfloor t \rfloor} * (1+R*frac(t))}$, where $\lfloor t \rfloor$ refers to the floor function. *t* is the remaining contract term, measured in days, divided by a day count. *frac(t)* refers to the fractional part of *t*. E.g. for a 500 day non-GBP contract, these components would result in $\lfloor t \rfloor$ = 1 and *frac(t)* = 140/360 respectively

As an example of (1), suppose we observe a transaction to buy 100 JPY and sell 1 USD 180-days forward. Suppose the US 6-month interest rate is 5% (annualized), the Japanese rate is 1%, and the current spot rate (JPY per USD) is 101. Then we have:

$$PV_{JPY} = \frac{100}{1+.01*.5} = 99.5025 \text{ JPY}$$

$$PV_{USD} = \frac{1}{1 + .05 * .5} = .9756 \text{ USD}$$

We then convert each leg to USD

$$PV_{USD} = .9756 \text{ USD}$$

$$PV_{JPY} = 99.5025 \text{ JPY}*(1 \text{ USD}/ 101 \text{ JPY}) = .9852 \text{ USD}.$$

These calculations are performed for each forward transaction in each currency by each fund. We sum over forwards for each currency in each fund to compute fund-currency level forward positions (for instance, a fund may have multiple forwards in a given currency pair with varying maturities). We use these fund-currency level FX forward holdings to compute hedge ratios at a later stage.

$$FX_{f,c,t} = \sum_{contracts\ j\ held\ by\ fund\ f} FX_{f,c,j,t} \quad (2)$$

Prior to 1999, we aggregate EUR constituent countries into a proxy EUR aggregate.

Identifying Fund Types

Funds in the data are anonymized, meaning that we cannot discern their objectives from their name or description. We use their asset holdings to discern their base currencies as well as whether they have equity or fixed income mandates. We omit funds whose allocations appear to be multi-asset or money market in focus. A fund is classified as an equity portfolio if at least 60% of its total assets are in cash equities and cash equities combined with cash instruments constitute at least 90% of its total assets. A fund is classified as a fixed-income portfolio if at least 60% of its assets are in fixed-income instruments of tenor over one year and these plus cash instruments (which include T-bills as well as money market assets and commercial paper) constitute at least 90% of total fund assets. Typically, less than 5% of assets in the universe we study are invested in multi-asset portfolios.[9]

[9] This is similar to the proportion of hybrid US mutual fund assets tracked by the Investment Company Institute https://www.ici.org/research/stats/trends_12_22

Additional Screens

As noted above, once we have a sample of funds for which we can identify objectives and match FX and underlying asset data, we apply a final set of screens, including removing funds that have fewer than $1 million USD in foreign assets or less than 10 underlying asset positions. The complete details of these screens are listed in Appendix Figure 1.

Other notation

Of the G10 currencies we analyze, so-called "major" currencies include EUR, GBP, USD, CHF, and JPY. The others AUD, CAD, NOK, NZD, SEK are "non-majors".

Summary Statistics of Final Sample

Table I summarizes our data by fund type (equity, fixed income) and currency domicile.[10] Panel A shows that over half of the funds in the sample are USD domiciled (63% by number and 66% by value). The next most frequent domicile by number is Euro, followed by British pounds. Panel A also shows that we have greater representation of equity funds in USD, CAD, and AUD, but more fixed income funds in other currencies. These summary statistics refer to averages first computed for each month and then averaged over time.

Panel B of Table I summarizes the asset composition for USD and Euro domiciled investors in our sample. USD-based investors' largest foreign holdings are denominated in Euros (38% on a value-weighted basis), with British Pounds (22%) and Yen (21%) coming in second and third. Not surprisingly given the size of US equity markets, Panel B also shows that Euro-based investors hold far more dollar-denominated assets than US investors own Euro-denominated assets.

[10] The sample summarized in Table I is used for the bulk of our analysis. Appendix Figure A1 shows a schematic guide to data requirements and screens required for each of the tables and figures. Specifically, for some of the later analysis, we require a set of further screens that further narrow the sample.

Table I: Portfolio Statistics by Currency

Panel A depicts the relative proportions of observations (at the fund-currency level) and the value of underlying assets (in USD terms) across different base currencies and groups of portfolios (equity and fixed-income as well as hedged versus all observations). Each month we compute the proportion of observations by the respective splits, then we average these proportions across time. Panel B depicts the relative proportions of observations (at the fund-currency level) and the value of underlying assets (in USD terms) across different base currencies and groups of portfolios (equity and fixed-income as well as hedged versus all observations) for funds with a non-zero hedge ratio. For both panels, VW refers to the proportion of value in USD terms; EW refers to the proportion of fund-currency observations. Proportions are computed monthly and averaged over time. In Panel B, proportions are computed within a given asset class and base currency, relative to all positions within that asset class and base currency.

Panel A: Base Currency Composition

Base Currency	Weighting	EQ	FI	Fraction of Sample
AUD	VW	64%	36%	5%
	EW	58%	42%	6%
CAD	VW	78%	22%	5%
	EW	75%	25%	7%
EUR	VW	38%	62%	9%
	EW	34%	66%	13%
GBP	VW	52%	48%	14%
	EW	45%	55%	10%
USD	VW	81%	19%	66%
	EW	58%	42%	63%

Panel B: Foreign Asset Composition for USD and Euro domiciled investors

	USD-domiciled Funds				Euro-domiciled Funds			
	Equity		Fixed-Income		Equity		Fixed-Income	
Assets:	**EW**	**VW**	**EW**	**VW**	**EW**	**VW**	**EW**	**VW**
AUD	9.9%	3.6%	7.0%	1.8%	5.5%	1.0%	4.7%	0.5%
CAD	8.5%	2.6%	12.4%	5.2%	5.7%	1.1%	8.3%	2.1%
CHF	13.0%	9.6%	1.8%	0.3%	15.4%	6.8%	1.7%	0.1%
EUR	19.8%	38.2%	31.5%	58.6%				
GBP	17.3%	23.3%	22.4%	15.3%	17.1%	15.3%	26.1%	14.0%
JPY	17.9%	20.7%	10.6%	15.8%	17.6%	17.1%	7.6%	9.9%
NOK	4.9%	0.7%	2.6%	0.5%	7.5%	1.1%	1.9%	0.2%
NZD	1.6%	0.1%	4.6%	1.1%	2.3%	0.1%	2.0%	0.3%
SEK	7.0%	1.1%	7.2%	1.5%	9.4%	2.1%	7.1%	1.5%
USD					19.7%	55.3%	40.2%	70.9%

II. Measuring Hedge Ratios

In this section, we document the first three of our findings, namely, how investors hedge currency risk on average, how this varies over time, and how it varies over currency domiciles.

We define the instantaneous hedge ratio *HR* for fund *f* in period *t* and foreign currency *c* as the level of FX forward positioning relative to underlying foreign assets.

$$HR_{f,c,t} = \frac{-\ FX_{f,c,t}}{FA_{f,c,t}} \tag{3}$$

Note the minus sign in Equation (3), there because currency hedging involves taking a short position in the currency associated with the asset; the unhedged investor is naturally long the currency. Suppose we have a USD base investor with foreign asset positions in GBP(100 units), EUR (100 units) and JPY (10,000 units). This investor holds a short FX forward position in 40 euros vs the dollar, a short JPY position versus USD of 5,000 yen, and no FX position in GBP. This implies hedge ratios respectively of 40% for EUR, 50% for JPY, and 0% for GBP.

We also compute a portfolio-level weighted hedge ratio from the perspective of the base currency over all foreign assets held by the fund. To compute the portfolio hedge ratio, we divide the *long* positions in the fund's base currency in the numerator by sum the value of all foreign asset holdings across currencies in the denominator, i.e., total foreign assets *TFA*:

$$TFA_{f,t} = \sum_{c} FA_{f,c,t} \tag{4}$$

We define the portfolio hedge ratio for fund *f* at time *t* as the sum of all long positions in the fund's base currency divided by foreign asset holdings across currencies in the denominator:

$$HR_{f,t}^{portfolio} = \frac{FX_{f,t}^{BaseCurrency}}{TFA_{f,t}}. \tag{5}$$

Returning to our previous example, suppose the Japanese exchange rate is 100 yen per dollar, and the Euro and British Pound exchange rates are 1 per dollar. Then the portfolio weights of our EUR, GBP, and JPY assets are all equal at 1/3 each. The portfolio hedge ratio $HR_{f,t}^{portfolio}$ is the weighted average of these three: 1/3 * (40% + 50% + 0%) = 30%. The portfolio hedge ratio mirrors, for each base currency, the various foreign currency

positions taken against that base currency. Relative to Eq. (3), the portfolio hedge ratio drops a minus sign because it is computed from the perspective of the base currency.[11]

Note that for portfolio hedge ratios, exchange rates fluctuations impact the weighting across currencies. In our earlier example, if the GBP spot rate had appreciated versus USD while the others did not, then the final portfolio hedge ratio would be lower, since the GBP hedge ratio was zero. This contrasts with currency-by-currency foreign hedge ratios, which are unaffected by exchange rate moves because currency effects cancel out in the numerator and denominator of Equation (3).

How US investors hedge currency risk

Table II summarizes hedging levels for USD-based investors by currency, at both the intensive and extensive margins. Panel A and B compare equity versus fixed-income investors. We also show both full sample (March 1998-November 2023 average) behavior compared to a more recent snapshot (November 2023), which can be seen by comparing the left- and right-sides of each panel. In each month, we average hedge ratios across funds, then we report cross-time statistics based upon these monthly cross-fund averages. Average hedge ratios are only computed based upon hedgers.

Consider the first row of Table II Panel A. On average, US equity funds have hedged their AUD equity exposure 21% of the time, though in November 2023 they are hedging 33% of the time; 73% of the time they held unhedged equity, 6% of the time they hold AUD FX forward with no AUD equity versus 48% and 19% in 2023 respectively. Of the 33% who hedge, the average hedge ratio was a mere 4% historically; more recently this has risen to 19%. The fraction hedged is on average higher than AUD but has evolved similarly, averaging 21% overall, 36% in 2023, while hedge ratios averaged 35% historically but rose to 47% by 2023.

[11] A more subtle point is that for portfolio hedge ratios, exchange rate fluctuations affect weights and thus affect hedge ratios, in a way that they do not at the individual currency-pair. In the preceding example, if the GBP spot rate had appreciated versus USD while the others did not, then the final hedge ratio would be lower, since the GBP hedge ratio was zero. This contrasts with currency-by-currency foreign hedge ratios, which are unaffected by exchange rate moves because currency effects cancel out in the numerator and denominator of Equation (3).

Table II: Hedging Snapshots: USD Investors

This table presents, for US-dollar domiciled investors, in each month for each foreign currency the proportion of funds hedging, unhedged, and FX only (holding only FX forwards, without owning any underlying asset in that currency). We then calculate the average hedge ratio for the entities that hedge. We require at least 3 fund-currency observations in a given month to include a monthly observation before computing the averages across time, from March 1998 to November 2023. Portfolio refers to portfolio hedge ratios, defined in the text.

Panel A: USD Equity Funds

	Avg 1998-2023				November 2023			
	%Hedged	**%Unhedged**	**%FX Only**	**Avg HR**	**%Hedged**	**%Unhedged**	**%FX Only**	**Avg HR**
AUD	21%	73%	6%	4%	33%	48%	19%	19%
CAD	20%	72%	8%	39%	45%	46%	9%	52%
CHF	24%	73%	3%	26%	43%	45%	11%	27%
EUR	29%	69%	1%	38%	58%	38%	4%	71%
GBP	26%	72%	2%	37%	50%	42%	8%	56%
JPY	30%	68%	2%	28%	41%	53%	6%	26%
NOK	15%	75%	10%	55%	28%	49%	24%	29%
NZD	12%	66%	22%	72%	9%	48%	43%	92%
SEK	16%	77%	7%	16%	21%	52%	27%	53%
Average	21%	72%	7%	35%	36%	47%	17%	47%
Portfolio	32%	68%	0%	34%	60%	40%	0%	53%

Panel B: USD Fixed-Income Funds

	Avg 1998-2023				November 2023			
	%Hedged	**%Unhedged**	**%FX Only**	**Avg HR**	**%Hedged**	**%Unhedged**	**%FX Only**	**Avg HR**
AUD	32%	10%	58%	68%	34%	9%	56%	75%
CAD	46%	16%	38%	59%	40%	8%	52%	76%
CHF	15%	4%	81%	73%	25%	7%	67%	75%
EUR	77%	12%	11%	81%	85%	7%	8%	106%
GBP	65%	14%	22%	76%	73%	7%	20%	93%
JPY	44%	8%	48%	30%	41%	6%	53%	56%
NOK	22%	14%	64%	55%	28%	9%	63%	103%
NZD	30%	12%	58%	94%	42%	9%	49%	74%
SEK	38%	14%	47%	56%	30%	10%	61%	91%
Average	41%	12%	47%	66%	44%	8%	48%	83%
Portfolio	86%	14%	0%	71%	92%	8%	0%	89%

The results on portfolio hedging resemble that of individual currency averages, but need not, since it is a weighted average and weights will be larger on larger positions, typically taken in the so-called "majors" (EUR, GBP, USD, CHF, JPY). Average hedge ratios are slightly lower than portfolio hedge ratios because more funds hedge their larger weights than hedge any individual currency. Non-majors (AUD, CAD, NOK, NZD, SEK)

tend to have lower proportions of positions hedged. With the exception of the NZD, proportions hedged have increased, for the most part by reducing the proportion unhedged. NZD is notable for having few equity funds choosing to hedge, but conditional on hedging, hedging with high ratios (92% in 2023).

With the exception of NOK and JPY, hedge ratios for equity investors have increased over time. Portfolio level hedging has increased from a mean of 32% to 60%, with hedge ratios rising from 34% to 53%. JPY and CHF are notable for having low hedge ratios, perhaps because of their well-known equity-foreign exchange correlations.

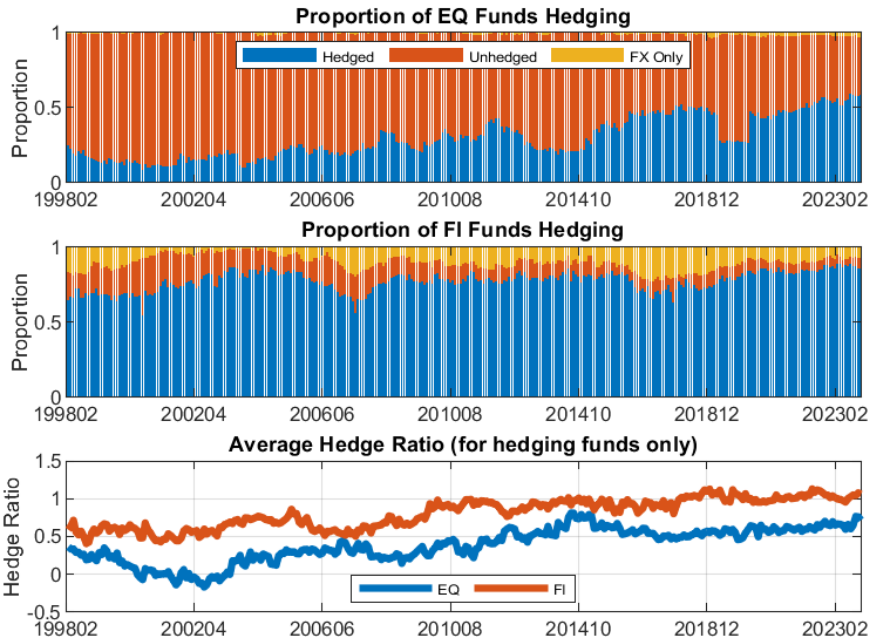
Panel B shows the results for US-domiciled fixed-income funds. Starting again with AUD, 32% of funds hedge their currency, and of those that do, the average hedge ratio was 68%. A large number of funds (58%) trade AUD without owning underlying AUD assets, perhaps because they use it to hedge exposure to correlated assets in the region. 77% of fixed income funds hedge their Euro exposure, with an average hedge ratio of 81%. Overall, USD-based fixed income funds are both more likely to hedge than equity funds, and conditional on hedging, have higher hedge ratios.

Panel B also shows increased hedging activity over time. At the extensive margin, the fraction of funds hedging has not moved very much, for example rising from 32% to 34% for AUD and from 65% to 73% for GBP. But for every currency, conditional on hedging, the average hedge ratio has risen. For example, Panel B reports that the average hedge ratio for EUR is 106% at the end of the sample, compared with 81% sample mean.

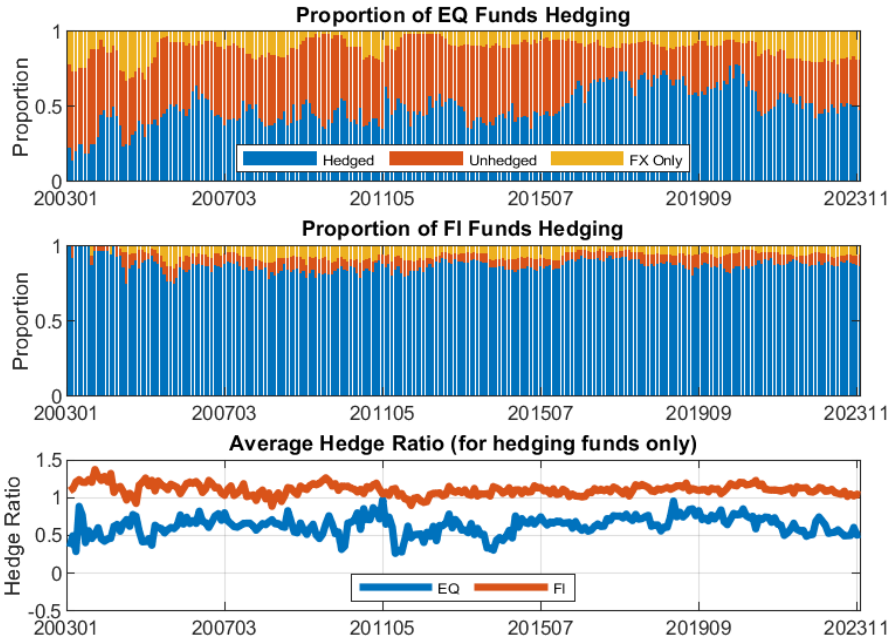
Another observation gleaned from Table II concerns the portion of portfolios that have FX positions without owning the underlying. For fixed-income investors, “FX-only” proportions are higher than in equities, and cluster in currencies with smaller bond markets such as NZD and CHF. This is consistent with market folklore that fixed-income managers express macroeconomic views via the more liquid vehicle of currency forwards, rather than buying bonds or equities.

Figure 1: Foreign Currency Hedging Through Time. This figure shows how foreign hedging of EUR and USD assets by USD and EUR funds respectively has evolved through time: In each panel, the top time series show the proportion of equity portfolios hedging a currency, holding a currency unhedged, or holding only FX forwards in a currency; the middle shows the corresponding numbers for fixed-income portfolios; the bottom shows average hedge ratios of equity and fixed-income funds with nontrivial hedge ratios.

Panel A. USD Funds' Hedging of EUR Assets



Panel B. EUR Funds' Hedging of USD Assets



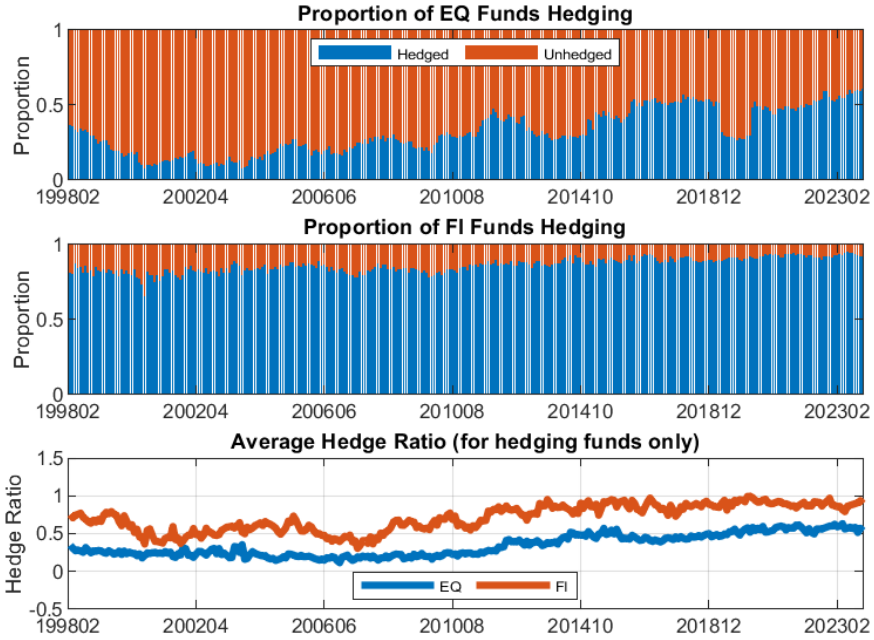
While Table II shows averages over the full period as well as a recent snapshot, in Figure 1 Panel A we illustrate how hedging patterns for USD investors have evolved over time. The figure shows three graphs. The first displays the fraction of equity funds that hedge, don't hedge, or take FX positions without owning the underlying. The second displays the corresponding fraction for fixed income funds. The third graph shows the average hedge ratio, for the subset of funds we identify as hedging their currency risk. A greater proportion of US equity investors have hedged over time, with similar but less dramatic trends for fixed income investors. The average hedge ratio evolved in a similar fashion, with hedge ratios rising more for equity investors.

Figure 1 Panel B illustrates how hedging patterns have evolved for Euro-based investors hedging their USD assets. Here we see less evidence of a trend – there is a slight increase in the proportions of funds hedging in the second half of the sample period, but the hedge ratios themselves are relatively similar across time, even decreasing somewhat in recent years for equity investors. What is more differentiated is the behavior or USD vs EUR based investors. US funds are much less likely to hedge, particularly equity investors, and hedge less intensively, although in recent years US funds' behavior has come to resemble European funds' behavior.

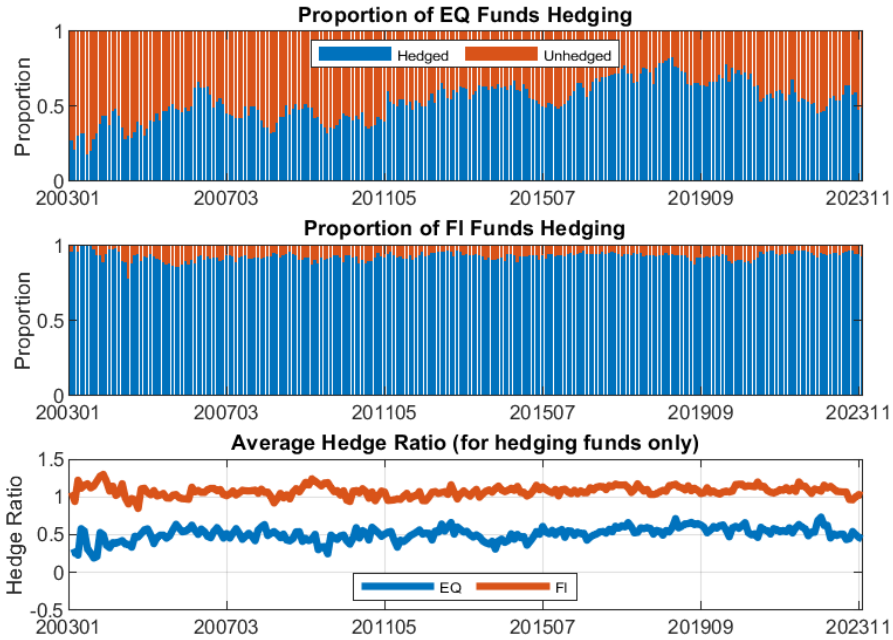
Figure 2 presents statistics on portfolio-level hedging for USD and Euro-based investors, following a similar format to Figure 1. Recall that the portfolio hedge ratio is the weighted average of individual currency hedge ratios. Panel A shows USD funds' portfolio hedging; Panel B shows Euro-based funds' portfolio hedging. As can be seen, USD-based funds have steadily increased their hedging since the early 2000s. Both USD- and Euro-based fixed income funds have a much higher incidence of portfolio hedging, and for the funds that hedge, hedge ratios tend to be higher.

Figure 2: Portfolio Hedging Through Time. This figure shows portfolio level by USD (Panel A) and EUR funds (Panel B) has evolved through time: In each panel, the top time series show the proportion of equity portfolios hedging a currency, holding a currency unhedged, or holding only FX forwards in a currency; the middle shows the corresponding numbers for fixed-income portfolios; the bottom shows average hedge ratios of equity and fixed-income funds with nontrivial hedge ratios. Portfolio hedging is defined as base currency FX holdings divided by total foreign assets.

Panel A. USD Funds' Portfolio Hedging



Panel B. EUR Funds' Portfolio Hedging



How non-US investors hedge currency risk

Table III and Table IV expand our analysis to funds with different base currencies, showing full sample averages (1998-2023). Table III reports the extensive margin (the proportion of funds that hedge) and Table IV reports the intensive margin (the mean hedge ratio, conditional on hedging).

For each currency pair (for example, an AUD-based investor holding JPY assets), Table III reports the fraction of hedgers. The bottom lines of each Panel report means across all G10 currency assets. For example, AUD-based equity investors with CAD assets tend to hedge this exposure about 47% of the time, while USD-based equity investors with CAD assets tend to hedge this exposure only 22% of the time. The bottom lines of each panel report averages across currencies (taking a mean across rows) as well as the mean portfolio-level hedge. The main takeaway from Panel A is that US-domiciled equity investors hedge far less than their counterparts in other domiciles.

Turning to Table III, Panel B, we see the same conclusion holds for fixed income funds, although here the differences between US- and non-US investors are less dramatic. On average, USD-based investors are 75% likely to hedge their foreign fixed income risk, compared with 91%, 83%, 82%, 81% for AUD-, CAD-, EUR- and GBP-based investors.

Table IV turns to the intensive margin. Using a corresponding structure to Table III, for each currency pair we report the average hedge ratio for investors we have identified as hedging. We also report averages for each domicile. USD-based equity investors who hedge, for example, hedge their Euro exposure with an average ratio of 0.38. Euro investors, on the other hand, hedge their dollar equity exposures with an average ratio of 0.61. These patterns are equally dramatic when we look at fixed income funds, in Panel B. As can be seen, AUD-, CAD- and Euro based investors tend to have hedge ratios near 1. GBP-based investors have average hedge ratio of 0.82; USD-based investors are even lower with 0.66.

Table III: Extensive Margin, Average Proportion of Funds Hedging

This table presents, for each base currency and each foreign currency, the average, over time, of the monthly cross-fund average proportion of funds hedging, in addition to the same evaluated at the portfolio level for each base currency. See appendix for details on the set of funds used. We further require that each currency-month has at least 3 observations, and that each currency has 12 months of observations after imposing the previous restrictions. The column average reflects an average across base currencies for each foreign currency; the row average reflects the average across foreign currencies for each base currency.

Panel A: Equity Funds

	Base Currency					
Hedged Currency:	**AUD**	**CAD**	**EUR**	**GBP**	**USD**	**Average**
AUD		32%	38%	20%	23%	28%
CAD	47%		35%	17%	22%	30%
CHF	42%	29%	31%	26%	25%	31%
EUR	49%	37%		35%	30%	38%
GBP	44%	32%	38%		27%	35%
JPY	54%	42%	50%	37%	30%	43%
NOK	38%	25%	24%	17%	17%	24%
NZD	61%	35%	37%	17%	16%	33%
SEK	38%	24%	25%	19%	18%	25%
USD	52%	48%	51%	36%		47%
Average	47%	34%	36%	25%	23%	33%
Portfolio	49%	42%	50%	33%	32%	41%

Panel B: Fixed-Income Funds

	Base Currency					
Hedged Currency:	**AUD**	**CAD**	**EUR**	**GBP**	**USD**	**Average**
AUD		81%	80%	80%	76%	80%
CAD	91%		84%	73%	76%	81%
CHF	96%	99%	80%	91%	68%	87%
EUR	93%	82%		89%	86%	88%
GBP	93%	79%	88%		83%	86%
JPY	92%	87%	90%	79%	84%	86%
NOK	83%	81%	66%	69%	60%	72%
NZD	93%	83%	78%	87%	71%	82%
SEK	86%	73%	80%	70%	74%	76%
USD	93%	86%	90%	87%		89%
Average	91%	83%	82%	81%	75%	82%
Portfolio	89%	83%	88%	87%	86%	87%

Table IV: Intensive Margin: Average Hedge Ratios of Hedgers

This table presents, for each base currency and each foreign currency, the average, over time, of the monthly cross-fund average hedge ratio taken over the set of funds hedging, in addition to the same evaluated at the portfolio level for each base currency. Sample restrictions are described in the text. We further require that each currency-month has at least 3 observations, and that each currency has 12 months of observations. The column average reflects an average across base currencies for each foreign currency; the row average reflects the average across foreign currencies for each base currency.

Panel A: Equity Funds

	Base Currency					
Hedged Currency:	**AUD**	**CAD**	**EUR**	**GBP**	**USD**	**Average**
AUD		23%	65%	35%	4%	32%
CAD	64%		45%	33%	39%	45%
CHF	53%	24%	61%	39%	26%	41%
EUR	56%	32%		44%	38%	43%
GBP	65%	37%	47%		37%	46%
JPY	57%	17%	61%	49%	28%	42%
NOK	48%	44%	65%	50%	55%	53%
NZD	96%	80%	91%		72%	85%
SEK	63%	29%	56%	46%	16%	42%
USD	58%	44%	61%	34%		49%
Average	62%	37%	61%	41%	35%	47%
Portfolio	63%	49%	45%	44%	34%	47%

Panel B: Fixed-Income Funds

	Base Currency					
Hedged Currency:	**AUD**	**CAD**	**EUR**	**GBP**	**USD**	**Average**
AUD		107%	94%	76%	68%	86%
CAD	96%		92%	71%	59%	79%
CHF	103%		105%	97%	73%	94%
EUR	117%	100%		99%	81%	99%
GBP	111%	105%	107%		76%	100%
JPY	92%	62%	82%	44%	30%	62%
NOK	68%	66%	82%	80%	55%	70%
NZD	101%	147%	105%	105%	94%	110%
SEK	91%	79%	84%	65%	56%	75%
USD	108%	91%	108%	102%		102%
Average	99%	95%	95%	82%	66%	87%
Portfolio	110%	96%	105%	104%	71%	97%

In Appendix table A5, we have further drilled down on intensive and extensive margin changes in hedging of the USD. We find large increases in both extensive and intensive margins of hedging across the board post-GFC. The one exception is AUD fixed income investors who hedge with approximately the same frequency

across funds, but with hedge ratios that are lower post-GFC. These results are overall consistent with Huber and Du (2024) who find increases in hedge ratios of 15 percentage points for USD assets post-GFC.

What distributions of fund-level hedge ratios may underlie these averages? Figure 3 and Table V provide color. In Figure 3 we plot the cross-sectional cumulative distribution of US funds' hedge ratios for Euro equity and Euro fixed income assets during November 2023. The second panel shows their portfolio-level hedge ratios. In each case, the equity CDFs are shifted to the left of those for fixed income, implying a larger share of equity funds, compared to fixed income, hedging at lower ratios. Fixed-income investors see a sharp spike in the CDF around 1; many fixed-income funds have hedge ratios close to unity. Equity hedge ratios exhibit an even progression from around zero to 50%, and then an uptick near 100% as well, albeit less clear and pronounced than in fixed income. While the pictures are similar for EUR assets and at the portfolio level, we see for both asset classes a substantial left tail in portfolio hedging – around 20% of portfolios exhibit negative portfolio hedge ratios, meaning they are net *long* foreign currency vis a vis their base (far fewer are long EUR).

Table V shows that for both USD and EUR fixed-income funds, there is considerably more bunching around a hedge ratio of 1, a pattern that is also visible, but slightly less pronounced, for EUR equity funds. That said, for US fixed income funds, the 25th percentile of hedge ratio is always below 0.5, suggesting than even for this class of investors, there are many who use hedge ratios less than 1.0. European equity funds show a much greater likelihood of being fully hedged. We observe a median-to-75th percentile spread of 85% to 101% hedge ratios for major currencies, for example. Appendix Figure A2 further displays these patterns by currency for EUR and USD portfolios. Appendix Figure A3 shows distributions across funds of average hedge ratios and exhibits similar patterns as Figure 3, however when we additionally plot EUR base investors we find all distributions shifted to the right (reflecting higher hedge ratios).

Figure 3: The Cross-section of Hedge Ratios in 2023: Cumulative distribution functions of hedge ratios of US equity and fixed-income funds in November 2023. We restrict to funds with nonzero hedge ratios. Hedging of EUR refers to foreign hedge ratios of EUR denominated assets. Portfolio hedging refers to portfolio hedge ratios of US funds.

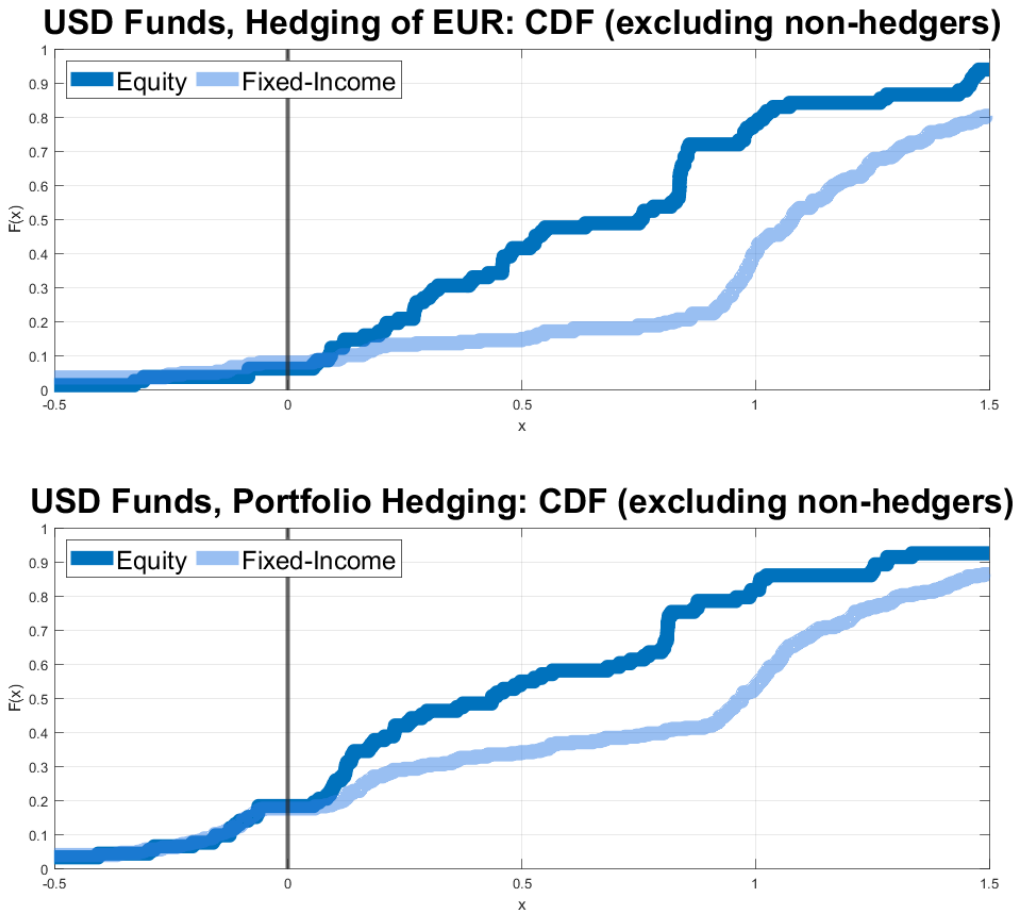


Table V: Hedge Ratios (Intensive Margin) - Fund Distributions

This table presents statistics across portfolios of average hedge ratios for funds over time. These are first computed for each fund, then distributions are calculated across funds. Reported for EUR and USD base investors, equity and fixed-income portfolios. We report: US investors' hedging of EUR assets, EUR investors' hedging of USD assets, and for each base the respective portfolio hedge ratios as well as averages of statistics (first computed currency by currency) across groups of foreign currencies. See appendix for details on the set of funds and observations used ("hedger funds" and "hedger positions"). We further require that each fund-currency is hedged for at least 12 months (not necessarily contiguous) after imposing the previous restrictions.

Panel A: USD Funds

	Equity Funds				Fixed-Income Funds			
	25th	**Median**	**75th**	**Mean**	**25th**	**Median**	**75th**	**Mean**
EUR	6%	31%	69%	36%	47%	99%	121%	83%
Avg. (All)	-3%	33%	73%	31%	34%	85%	106%	68%
Portfolio	9%	22%	58%	32%	26%	86%	113%	70%

Panel B: EUR Funds

	Equity Funds				Fixed-Income Funds			
	25th	**Median**	**75th**	**Mean**	**25th**	**Median**	**75th**	**Mean**
USD	1%	72%	100%	46%	100%	112%	131%	112%
Avg. (All)	30%	85%	101%	62%	86%	101%	116%	97%
Portfolio	9%	48%	100%	50%	96%	110%	132%	109%

Additional observations about fund hedging behavior

The broad patterns we described above raise a number of additional questions that we have tackled in appendix tables A1-A4, but describe briefly here. How consistent are funds in their behavior? Do funds sometimes change between hedging and not hedging a currency? For funds that we observe hedge a particular currency exposure, how much does their hedge ratio move around over time? Relatedly, if a fund hedges their exposure to one currency, is it likely that they hedge all currencies?

Broadly, the data reveal the following patterns. For both EUR and USD fixed income investors, there is evidence of consistency in hedging behavior for currency exposures, in the sense that conditional on seeing a fund hedging at all, we observe it as hedging more than 85% of the time. Time series standard deviations of cross-fund average hedge ratios typically range between 15% and 30% (Table A1)[12]. Equity investors are more eclectic in their approach. For example, conditional on hedging at all, the median USD-based investor hedges her Euro

[12] We observe similar values when we first compute standard deviations of hedge ratios for each fund-currency over time, then examine the distribution these values across funds (Table A4).

exposure only 2/3 of the time, and chooses not to hedge 1/3 of the time (Appendix table A2). There is less consistency in sticking to any given hedge ratio, a topic we return to in Section III.

We have also studied the question of whether investors take uniform approaches to their hedging across the different currencies they are exposed to. For example, if an investor hedges their Euro exposure, does that automatically imply they will also hedge their AUD exposure? We find (Table A3) that for fixed income investors, they are typically holding only a handful of currencies, and are generally hedging all of them or nearly all of them. For equities, global investors typically have exposure to a far larger number of currencies, and they tend to hedge a smaller fraction of them. For both types of investors, there is substantial variation across currencies.

III. Dynamic Hedge Ratios: How Investors Adjust Hedges

Instantaneous hedge ratios give us a snapshot of currency risk positioning at a moment in time. In this section, we define a parallel set of "dynamic hedge ratios" that capture the degree to which investors adjust their currency forward positions to changes in the currency risk of their asset positions. For example, consider a USD-based investor who owns 100 JPY of Japanese equities, currently hedged at a ratio of 50%, meaning that they are short a forward for 50 JPY. Now, consider what happens when Japanese equities right by 10% in local currency terms, from 100 JPY to 110 JPY. Given a fixed forward position, the hedge ratio has shrunk to ~45% (=50/110). To maintain a 50% hedge ratio, the investor would need to add to their FX forward short position by selling JPY forward.. The degree to which they do this is captured by what we call the dynamic hedge ratio, denoted by *DHR*.

In the example above, to maintain a DHR of 50%, the investor would need to sell forward half the amount of the underlying asset move, which in this case means selling 5 JPY forward to incrementally hedge the increase of 10 JPY in underlying equity value. Dynamic hedge ratios, like static hedge ratios, can be computed separately for individual currency foreign hedge ratios and portfolio level hedge ratios. Intuitively, if investors hedge programmatically and stick to target hedge ratios, then the dynamic hedge ratio should correspond to the instantaneous hedge ratios that we computed and described earlier.

Specifically, for fund *f*, currency *c*, and time *t* with lag *k* (in months) we regress changes in FX forward positions from *t-k* to *t* on scaled changes in the underlying asset positions. To limit heteroskedasticity, we scale both sides of the regression by lagged foreign asset holdings.

$$-\frac{\Delta_{t-k,t}FX_{f,c,t}}{FA_{f,c,t-k}} = a + DHR_{f,c} \cdot \frac{\Delta_{t-k,t}FA_{f,c,t}}{FA_{f,c,t-k}} + e_{f,c,t} \quad (6)$$

Equation (6) defines *DHR* as the dynamic hedge ratio. If the intercept is zero, then *DHR* gives us the ratio of the change in FX forward position relative to the change in underlying asset position. For simplicity, we show *DHR* above with a fund-currency subscript, although if estimated on a sample of pooled funds it represents an average dynamic hedge ratio across funds. Like in Eq. (3) the minus sign captures the fact that more hedging requires more *selling* of the foreign currency.

Equation (6) requires us to difference the data, because we are analyzing changes in hedges as they respond to changes in assets. We study changes at horizons of *k*=1 month and *k*=12 months. As it turns out, most adjustment is quick and can be detected already at a horizon of one month.

These analyses focus on variation in intensive margin, namely how a fund that is hedging at *t-k* evolves its hedge to period *t*. We restrict to funds, currencies, and months where we observe non-trivial hedge ratios (over 5% in absolute value). By construction, this means that we do not capture entry into or exit from hedging activity, i.e., the extensive margin. We are implicitly separating the choice to hedge from the degree of hedging, and examining only the latter.

Equation (6) specifies a hedge ratio at the level of a base-currency-foreign-currency pair, e.g., how a USD investor dynamically adjusts their JPY hedge. But analogously to earlier, where we computed a "portfolio" level hedge ratio, we can compute a portfolio-level dynamic hedge ratio. To do so, we convert FX holdings and underlying foreign assets to USD terms to again yield dimensionless quantities, before running the analogous regression to (6):

$$\frac{\Delta_{t-k,t}FX_{f,t}^{BaseCurrency}}{TFA_{f,t-k}} = a + DHR_{f}^{portfolio} \cdot \frac{\Delta_{t-k,t}TFA_{f,t}}{TFA_{f,t-k}} + e_{f,t} \quad (7)$$

Here we are gauging the degree to which a portfolio's aggregate currency exposure from all foreign currency holdings has been matched by net purchases of the base currency versus all foreign crosses. In (7), we can analogously interpret *DHR* as capturing the degree to which aggregate foreign currency exposure movements from changes in the value of foreign assets are met by adjustments to aggregate FX forward positions, typically accomplished by buying the base currency and selling various foreign currencies. Once more, to maintain a given initial portfolio hedge ratio, the investor must sell FX forward proportionate to the amount of change in the

underlying asset value. However, as in the case of static portfolio hedge ratios, exchange rate changes impact the dynamic portfolio hedge ratio (due to the weights applied to different foreign currencies as we aggregate to one portfolio level figure), while they do not affect the dynamic foreign hedge ratio. NOTE that, in comparison with Eq. (6), Eq. (7) drops a minus sign, similar to the sign flip that we explained in comparing Eq. (3) and Eq. (5). This is because incremental hedging at the portfolio level means, over various foreign currencies, buying domestic and selling foreign currency.

As an illustration of Equation (7), consider a USD-based investor who initially holds 100 GBP of UK equities, and 100 Euros of Euro equity, hedged at 50% and 25% respectively, meaning that the investor has forward short positions of 50 GBP and 25 EUR vs. the USD. For simplicity, suppose GBP/USD and EUR/USD exchange rates are both at unity. The portfolio hedge ratio is 0.5*0.5 + 0.5*0.25 = 37.5%.

In the example above, suppose the GBP equity rises in local terms, by 10% to 110 GBP while the EUR equity rises in local terms by 20% to 120 Euro, while exchange rates remain the same at unity. To maintain the portfolio hedge ratio, the investor must either maintain each foreign hedge ratio (sell 0.5*10 = 2.5 GBP and sell 0.25*20 = 5 EUR) for a total purchase of 7.5 USD, or they could maintain the portfolio hedge ratio by permitting the individual foreign hedge ratios to change, for instance by selling 7.5 GBP forward (increasing the GBP foreign hedge ratio) and holding the EUR FX position constant (decreasing the EUR foreign hedge ratio).

Table VI presents estimates from Equation (6). For each regression, we pool funds of a particular type, so that the regression coefficients should be interpreted as an average across funds hedging in that currency or group of currencies. For example, the first column of Panel A shows that for USD equity funds with EUR exposures and for changes estimated at a one-month horizon (k=1 month), *DHR* attracts a coefficient of 0.39, meaning that investors adjust their hedge by an average of $0.39 for every $1.00 change in the value of the underlying assets. This is close to the average hedge ratio of 0.37 that we reported in Table II of USD investors hedging their EUR exposure. Across major currencies, we obtain a regression coefficient of 0.41, which again is similar to our findings that we reported in Table II. Table VI also shows the R-squared, which is below 10% for USD equity funds, and rises to 23% for EUR-based funds. Loosely speaking, the R-squared is a measure of how closely funds adhere to their hedge ratios (an R-squared of 100% would mean immediate adjustment of all funds to a target hedge ratio).

Table VI: Dynamic Hedging: Pooled Regressions, USD and EUR Funds

This table presents pooled (across funds) regression estimates of dynamic hedge ratios from estimating the impact of a change in foreign asset holdings on the corresponding change in FX position. Specifically, we estimate:

$$-\frac{\Delta_{t-k,t}FX_{f,c,t}}{FA_{f,c,t-k}} = a + DHR_{f,c} \cdot \frac{\Delta_{t-k,t}FA_{f,c,t}}{FA_{f,c,t-k}} + e_{f,c,t}$$

where the estimated coefficient *DHR* measures the dynamic hedge ratio. We shows results for USD and EUR based investors across different groups of currencies they hedge. We report two differencing horizons, 1 and 12 months. We require at least 12 observations to estimate *DHR* for a fund. *t*-statistics are based on standard errors clustered by fund and month.

Panel A: Equity Funds

		USD funds			EUR funds		
k:		**EUR**	**Mean all currencies**	**Portfolio**	**USD**	**Mean all currencies**	**Portfolio**
1 Month	*DHR*	0.39	0.42	0.35	0.41	0.59	0.43
	[*t*-stat]	[12.58]	[11.80]	[10.26]	[6.74]	[9.35]	[5.40]
	Adj R2	10%	10%	9%	7%	23%	8%
12 Month	*DHR*	0.48	0.49	0.39	0.64	0.69	0.49
	[*t*-stat]	[16.55]	[12.47]	[13.90]	[9.66]	[10.28]	[7.32]
	Adj R2	28%	25%	28%	34%	43%	27%

Panel B: Fixed Income Funds

		USD funds			EUR funds		
k:		**EUR**	**Mean all currencies**	**Portfolio**	**USD**	**Mean all currencies**	**Portfolio**
1 Month	*DHR*	0.56	0.57	0.46	0.55	0.62	0.56
	[*t*-stat]	[26.89]	[19.11]	[23.91]	[17.42]	[14.97]	[19.83]
	Adj R2	15%	13%	10%	12%	17%	12%
12 Month	*DHR*	0.73	0.70	0.63	0.91	0.86	0.90
	[*t*-stat]	[41.44]	[25.73]	[34.47]	[43.79]	[26.93]	[44.70]
	Adj R2	40%	32%	29%	54%	52%	53%

The next lines of Panel A report the same analysis for k=12 months. As can be seen, our estimated regression coefficient *DHR* is 0.48, a bit larger in magnitude than our results for k=1 months. In other words, we see funds adjusting their hedge ratios quite quickly in response to movements in their asset holdings, but some of this becomes stronger at longer horizons, consistent with some funds taking time to return to a target hedge ratio.

Panel B repeats this analysis for USD-based fixed income funds. Turning first to column 1, where we show the dynamic hedging coefficient associated with hedging of Euro, 0.56. This is a bit lower than the average hedge ratio of hedging fixed income funds of 66% reported in Table II. However, when we study DHR estimated

using 12-month changes, it rises in magnitude to 0.73. Similar magnitudes appear across currency groups across the table.

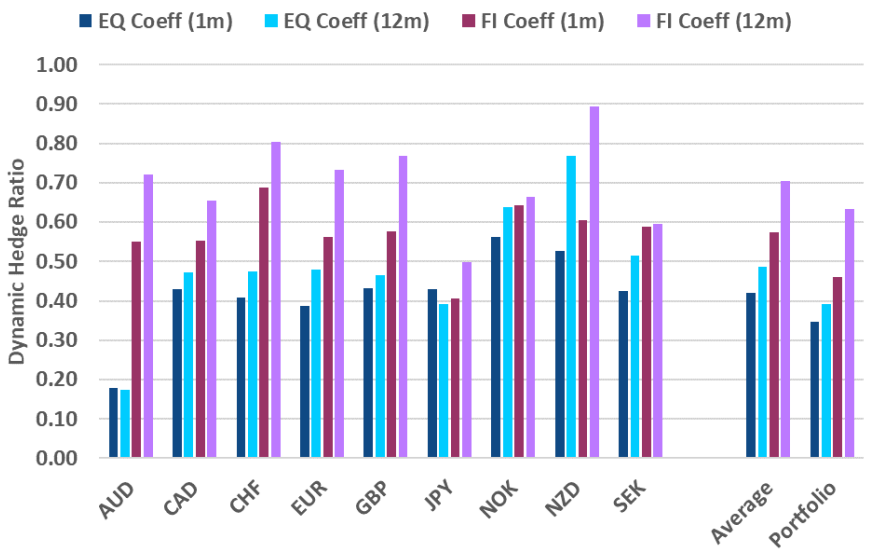
Figure 4 shows estimates of *DHR* for a larger group of currencies. Panel A shows results for USD funds; Panel B shows estimates for EUR funds. For each currency, we show *DHR* for equity investors and fixed income investors. In each case, we show DHR estimated using one-month and twelve-month changes. The figure reveals the following broad patterns, many of which are consistent with our earlier observations. First, comparing across Panel A and Panel B, EUR-based investors hedge more. Second, fixed income investors hedge more. Third, especially for fixed income investors, there are differences in hedging adjustment depending on the horizon. Specifically, when we measure changes over a 12-month period, we find greater responsiveness to changes in the underlying assets.

Figure 4: Dynamic Hedging by Currency: This figure shows dynamic hedge ratio coefficients from pooled regressions across funds.

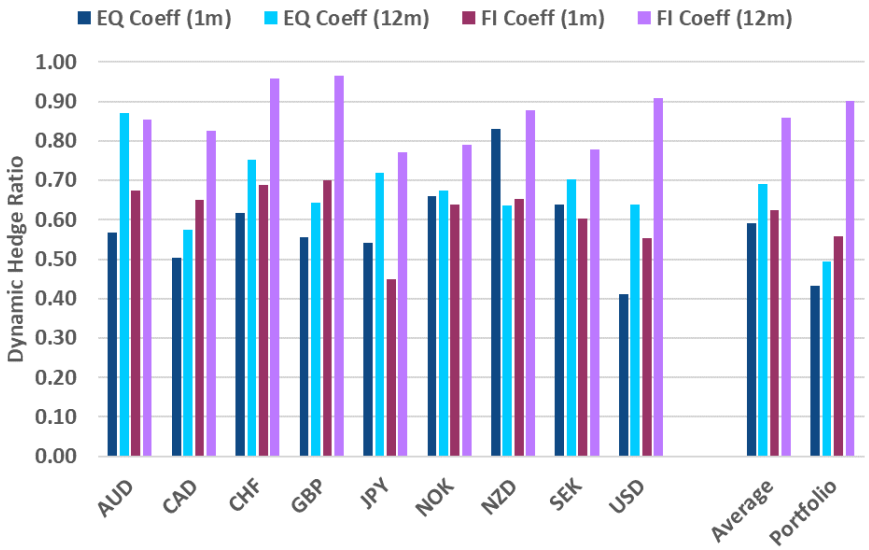
$$-\frac{\Delta_{t-k,t}FX_{f,c,t}}{FA_{f,c,t-k}} = a + DHR_{f,c} \cdot \frac{\Delta_{t-k,t}FA_{f,c,t}}{FA_{f,c,t-k}} + e_{f,c,t},$$

where *FX* refers to forward *FX* position, *FA* refers to foreign assets, and *DHR* is the estimated hedge ratio. The figures show estimates of DHR for EUR and USD base investors for equity and fixed-income portfolios for different currencies. "Average" refers to the average across foreign currency coefficients. See appendix for details on the set of funds and observations used ("hedger funds" and "hedger positions"); we further require at least 12 observations to estimate a given regression.

Panel A: USD funds



Panel B: EUR funds



In addition, we examine dynamic hedging across portfolios. In Table VII, we conduct the same regressions for each fund-currency and summarize their distributions. Mean and median values across funds resemble our pooled estimates from Table VI.

Table VII: Dynamic Hedging: Fund-level Regression Distributions, USD and EUR Base

We estimate:

$$-\frac{\Delta_{t-k,t}FX_{f,c,t}}{FA_{f,c,t-k}} = a + DHR_{f,c} \cdot \frac{\Delta_{t-k,t}FA_{f,c,t}}{FA_{f,c,t-k}} + e_{f,c,t}$$

for each fund, then report below distributions of *DHR* coefficients across funds. The differencing horizon *k* is one month. Reported for USD and EUR base investors, equity and fixed-income portfolios. For each group we report: US investors' dynamic hedging of EUR assets and EUR investors' dynamic hedging of USD assets, mean hedge ratios across all currencies, and portfolio hedge ratios. Each fund-currency regression requires 12 observations.

Panel A: USD funds

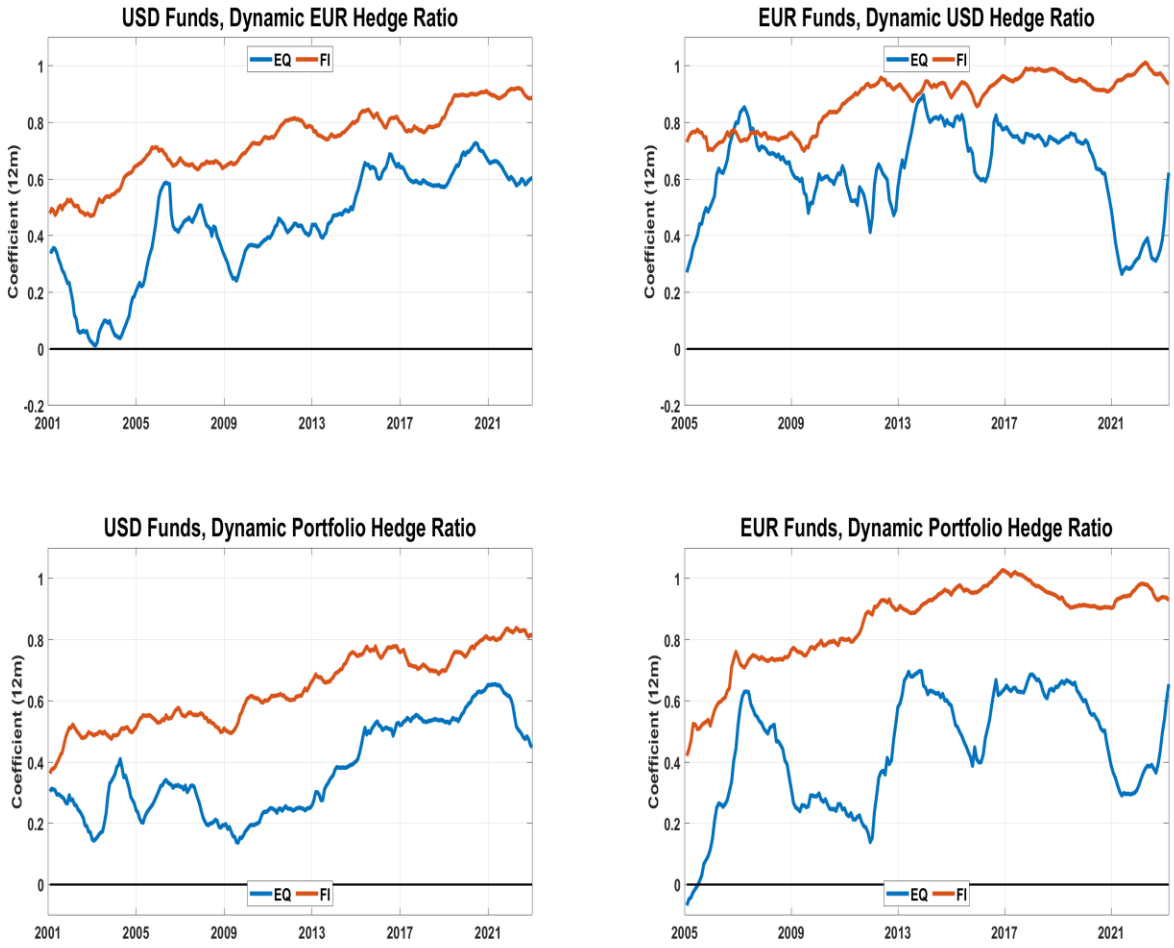
	Equity funds				Fixed income funds			
	25th	**Median**	**75th**	**Mean**	**25th**	**Median**	**75th**	**Mean**
EUR	0.02	0.27	0.56	0.30	0.20	0.61	0.90	0.57
Avg. (All)	0.10	0.37	0.66	0.35	0.22	0.65	0.93	0.56
Portfolio	0.00	0.14	0.44	0.23	0.10	0.41	0.75	0.41

Panel B: EUR funds

	Equity funds				Fixed income funds			
	25th	**Median**	**75th**	**Mean**	**25th**	**Median**	**75th**	**Mean**
USD	0.11	0.34	0.71	0.43	0.28	0.72	0.99	0.60
Avg. (All)	0.23	0.51	0.86	0.47	0.45	0.79	0.97	0.65
Portfolio	0.03	0.28	0.72	0.39	0.30	0.64	0.93	0.61

In our examination of static hedge ratios, we noted a general upward trend in typical levels of hedging over the course of our sample, particularly for USD investors. In Figure 5 we see a similar pattern unfold in dynamic hedging across time, using a rolling pooled regression to estimate how DHR evolves over time.

Figure 5: Dynamic Hedging Through Time: This figure shows rolling panel (over funds and months) coefficients of dynamic hedging regressions (equations (6) and (7) above, pooling all fund-currency observations over a rolling window) using a 12 month differencing horizon. We conduct one regression each month, using 24 months of historical fund-currency observations. Reported for EUR and USD base investors, equity and fixed-income portfolios. We report: US investors' dynamic hedging of EUR assets, EUR investors' hedging of USD assets, and for each base the respective dynamic portfolio hedge ratio regressions. See appendix for details on the set of funds and observations used ("hedger funds" and "hedger positions"). We require at least 12 observations for each monthly regression.

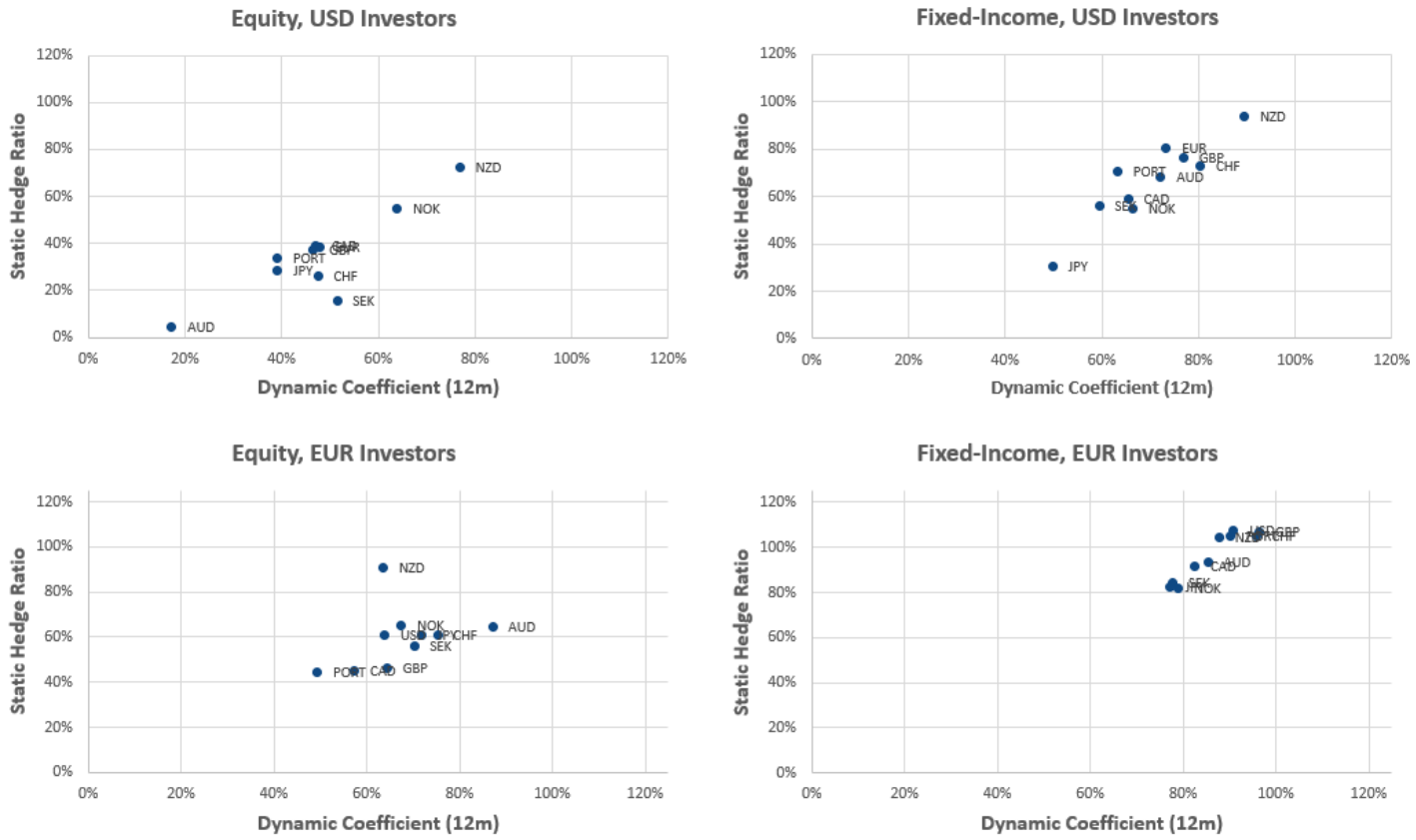


Do funds stick to their hedges?

We suggested earlier that it would be natural to expect our results for dynamic hedge ratios to be closely aligned with the instantaneous hedge ratios we reported earlier. But we can analyze this directly, which we do in Figure 6. Here we plot the average hedge ratio against the dynamic hedge ratio coefficient estimated from pooled regressions across funds. We do so for equity and fixed income investors, and for USD and Euro-based investors. The figure reveals a close alignment between the two For example, the bottom right panel shows that for EUR

fixed income investors, both estimated dynamic hedge ratios and mean static hedge ratios are in the 80% to 100% for most hedged currencies.

Figure 6: Static vs Dynamic Hedging (Pooled): This figure plots average hedge ratios (averaged over time by fund-currency, then averaged across funds) against dynamic hedge ratio coefficients estimated from pooled regressions across funds . Reported for EUR and USD base investors, equity and fixed-income portfolios. Dynamic coefficients reported for a 12 month differencing horizon. See appendix for details on the set of funds and observations used ("hedger funds" and "hedger positions"). We further require that each fund-currency is hedged for at least 12 months (not necessarily contiguous), and for dynamic coefficients require at least 12 observations be present to estimate, after imposing the previous restrictions.



Although these results reveal that funds appear to have target hedge ratios, they do not explain whether funds closely adhere to these ratios. Table VIII conducts such an analysis. Here we compute for each USD-based fund, the average hedge ratio *HR* for a given base-currency-foreign currency pair. We also estimate via equation (6) that fund's dynamic hedge ratio *DHR* for the same base-currency-foreign currency pair. The table reports the correlation between these two quantities across funds. We also report the correlation between the R-squared from estimating equation (6) with the average hedge ratio. Table VIII shows the following results. First, when studying the correlation between DHR and average HR, these average approximately 50%. We interpret this as most funds

adhering to target hedge ratios but with some noise. Second, there is a positive correlation between DHR R-squared and the average HR, which can be interpreted as saying that funds with higher hedge ratios also tend to stick to the hedge ratio more. We have repeated the analysis in Table VIII for Euro-based investors, with similar results (Appendix table A6). Figure 7 examines this pattern visually for USD investors, depicting the bivariate distribution of fund-level dynamic versus static hedge ratios. We see a positive correlation – higher static hedge ratios cluster alongside higher dynamic hedge ratios. Figure 8 depicts the same pattern for EUR investors.

Table VIII: Hedging Tightness – Avg. HR vs Dynamic Coefficients, USD Funds

This table presents statistics across portfolios of funds' relating to funds' dynamic hedge ratio coefficients and average static hedge ratios. First we correlate, over funds, dynamic hedging coefficients with their respective average static hedge ratios. Second, we correlate the same average static hedge ratios to the adjusted R^2 from dynamic hedging regressions. Reported for USD base investors, equity and fixed-income portfolios. We report for: US investors' hedging of EUR assets, USD portfolio hedging, and averages across groups of foreign currencies. Currency group averages are of the associated single currencies' correlations. We report two differencing horizons, 1 and 12 months. These refer to the differencing horizons in equations (6) and (7) above. See appendix for details on the set of funds and observations used ("hedger funds" and "hedger positions"). Each individual fund-currency regression and static hedge ratio used requires at least 12 fund-currency-month observations underlying the average or coefficient. We further require that dynamic hedge ratio coefficients are of <= 2 in absolute value.

Panel A: Equity Funds

		EUR	Avg. (Majors)	Avg. (Non-Majors)	Avg. (All)	Portfolio
1 M	Corr(*DHR*, Avg *HR*)	63%	45%	46%	45%	59%
	Corr(*DHR* R^2, Avg *HR*)	44%	36%	39%	38%	35%
12 M	Corr(*DHR*, Avg *HR*)	62%	47%	56%	52%	68%
	Corr(*DHR* R^2, Avg *HR*)	46%	43%	42%	43%	41%

Panel B: Fixed-Income Funds

		EUR	Avg. (Majors)	Avg. (Non-Majors)	Avg. (All)	Portfolio
1 M	Corr(*DHR*, Avg *HR*)	52%	47%	37%	42%	44%
	Corr(*DHR* R^2, Avg *HR*)	33%	33%	26%	29%	32%
12 M	Corr(*DHR*, Avg *HR*)	56%	53%	40%	46%	55%
	Corr(*DHR* R^2, Avg *HR*)	46%	48%	46%	47%	45%

Figure 7: Connecting Dynamic and Static Hedging, USD Funds
This figure shows a kernel density plot across funds of average static hedge ratios (x axis) and dynamic hedge ratio coefficients (y axis). Blue indicates low density, yellow high density of funds. Reported for USD base investors, equity and fixed-income portfolios. We report USD investors' hedging of EUR assets and USD portfolio hedging. Dynamic hedge ratios are reported for a 12 month differencing horizon. These refer to the differencing horizons in equations (6) and (7) above. See appendix for details on the set of funds and observations used ("hedger funds" and "hedger positions"). Each individual fund-currency regression and static hedge ratio used requires at least 12 fund-currency-month observations underlying the average or coefficient. We further require that dynamic hedge ratio coefficients are of <= 2 in absolute value.

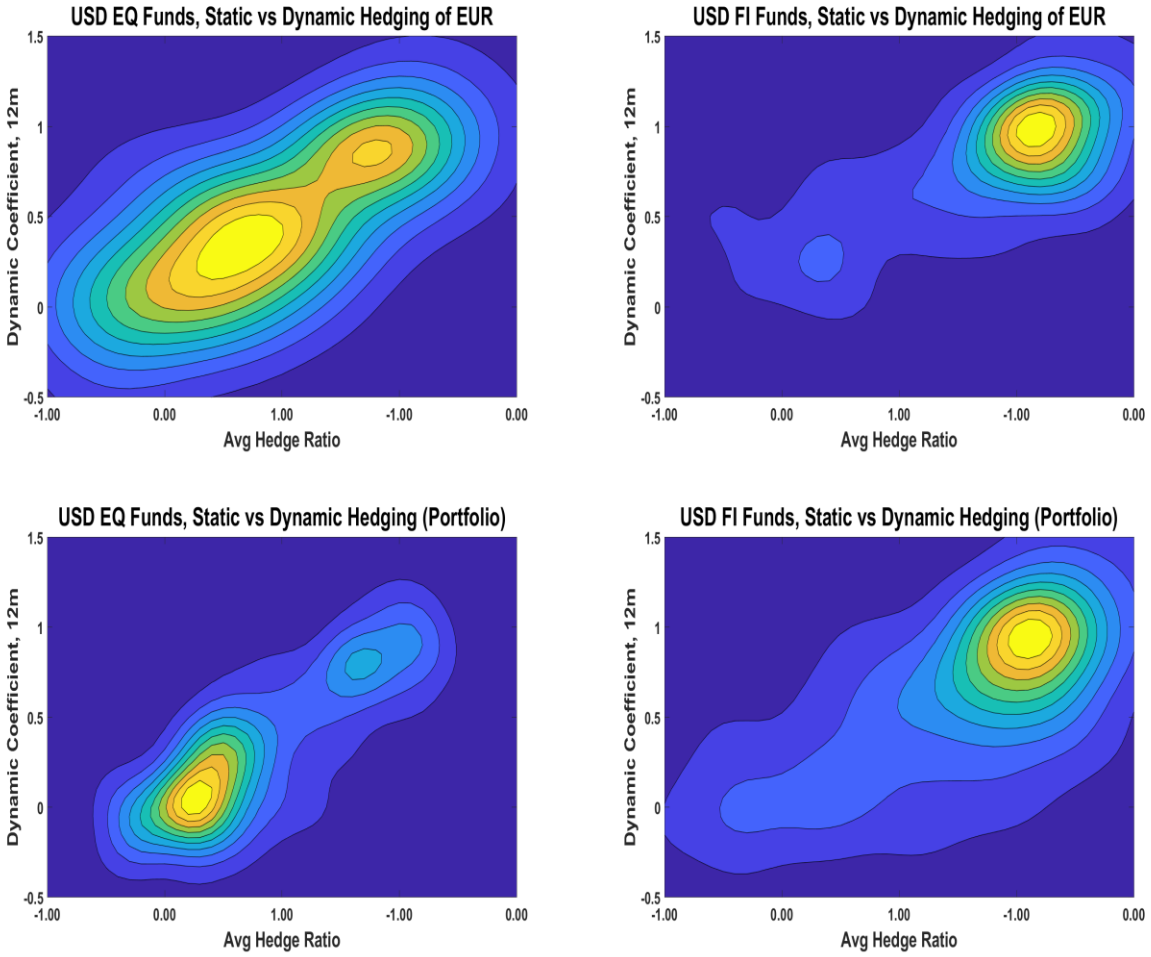
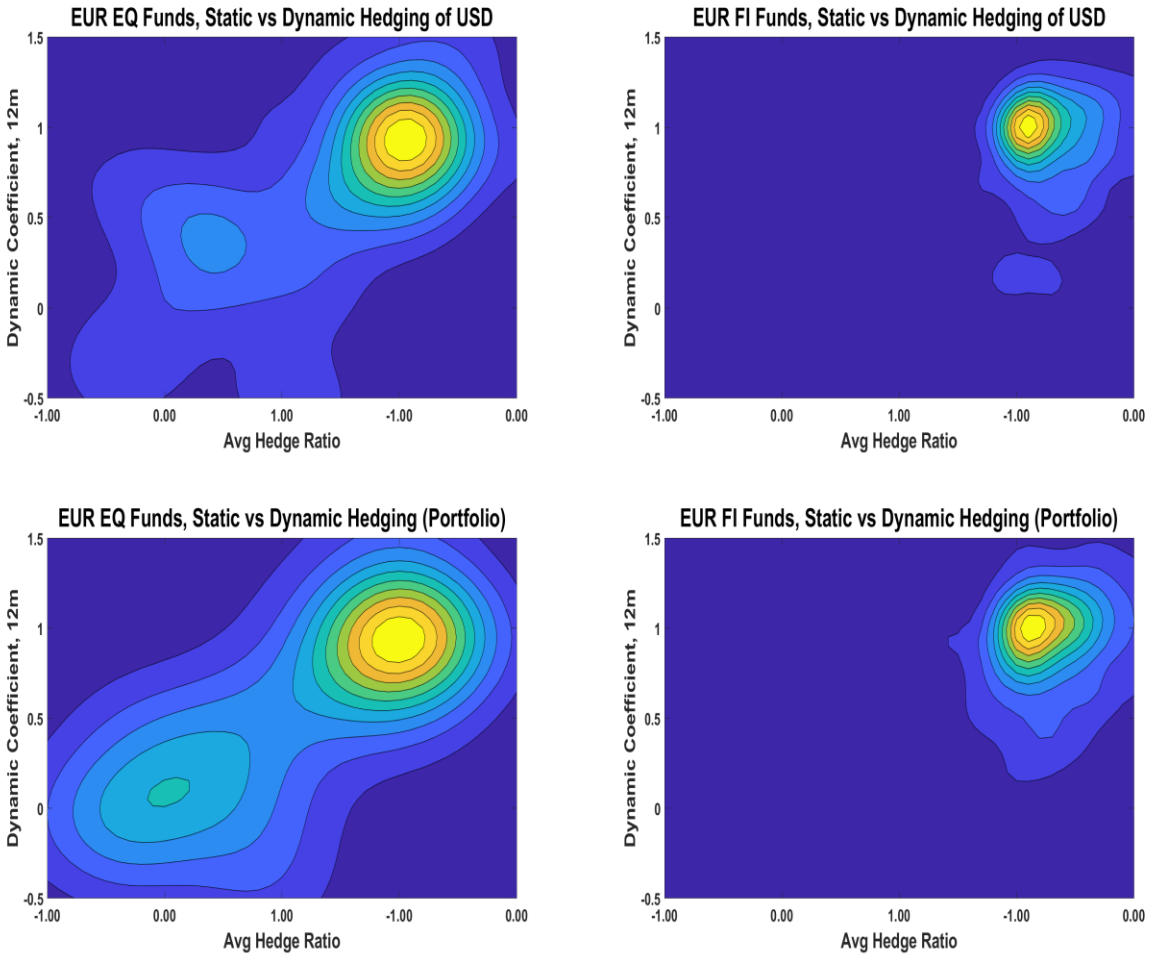


Figure 8: Connecting Dynamic and Static Hedging, EUR Funds
This figure shows a kernel density plot across funds of average static hedge ratios (x axis) and dynamic hedge ratio coefficients (y axis). Blue indicates low density, yellow high density of funds. Reported for USD base investors, equity and fixed-income portfolios. We report EUR investors' hedging of USD assets and EUR portfolio hedging. Dynamic hedge ratios are reported for a 12 month differencing horizon. These refer to the differencing horizons in equations (6) and (7) above. See appendix for details on the set of funds and observations used ("hedger funds" and "hedger positions"). Each individual fund-currency regression and static hedge ratio used requires at least 12 fund-currency-month observations underlying the average or coefficient. We further require that dynamic hedge ratio coefficients are of <= 2 in absolute value.



IV. Determinants of Hedge Ratios over Time and across Currencies

Above we have shown that many institutional investors, especially fixed income investors, hedge their currency risk and tend to adjust their hedges quickly in response to underlying asset movements. However, we also showed earlier that the average hedge ratio has moved around over time and varies cross-sectionally by base-currency-hedged-currency pair. In this section of the paper, we study what drives this variation at the currency-pair month level. Specifically, we investigate how hedge ratios evolve and whether there are characteristics that explain variation across currencies and over time. A similar analysis is done by Du and Huber (2024) who analyze

cross-sectional determinants of USD hedging. Relative to previous work, an attractive feature of our panel data is that we can use variation across both base and hedge currencies, as well as variation over time.

Motivated by a large literature on foreign exchange, we study variables of three types (1) measures of risk and correlation (2) measures of hedging cost or carry, and (3) measures related to return forecasts such as momentum (features are summarized in Appendix tables A7 and A8). Specifically, we study:

Asset and Currency Risk: Mean-variance logic suggests that currencies with higher correlation with local currency asset returns should be more aggressively hedged than currencies with lower correlations. For this reason, Campbell, Serfaty-de Medeiros, and Viceira (2010) suggest that optimal currency positions tend to be long the US dollar, the Swiss franc and the euro, and short the other currencies. Following the same logic, they show that most currency returns are almost uncorrelated with bond returns and thus investors should fully currency hedge their bond positions. We examine the impact of the following variables: FX volatility σ_{FX} measured as the standard deviation of weekly currency spot returns vis-à-vis base currency spot, over the past year; Asset volatility σ_A measured as the weekly foreign equity or bond index return volatility over the prior year, measured in local currency terms; $\rho_{FX,A}$ as the correlation between monthly foreign equity or fixed income index local return and foreign currency USD spot returns over the same period.

Hedging cost or "carry": Hedging currencies with high interest rates relative to the base currency imposes a high flow cost on the investor (even if uncovered interest parity suggests the investor should recover this differential in expectation through currency appreciation). Hedgers may be dissuaded by these costs and hedge less when the cost is greater. We measure the hedging cost from the perspective of the hedging fund: *Carry* is the 3-month foreign yield minus the base currency 3-month yield.

Momentum: Momentum strategies are popular among institutional investors, although a number of studies have shown a lack of efficacy in recent years. Following Asness, Moskowitz, and Pedersen (2013) we define FX momentum, MOM_{FX} as the cumulative currency spot return between *t*-12 months and *t*-1 months relative to month *t*. Asset momentum, MOM_A, is the foreign equity or bond index local market return between *t*-12 months and *t*-1 months relative to month *t*.

Understanding average hedge ratios

We start by analyzing hedge ratios averaged across funds for the same currency-pair. The dependent variable in Tables IX, X, and XI is the same, namely the mean hedge ratio for that currency, $\overline{HR_{c,t}}$.[13] Note that these hedge ratios are computed only over the set of funds engaged in hedging – this means we are attempting to explain variation in the intensive margin of hedgers (how much funds hedge given they have chosen to hedge) and setting aside variation in extensive margin (whether funds are choosing to hedge).

We begin by examining correlations between these features and hedge ratios in Table IX. We start by reporting time series correlations between the average hedge ratio of USD funds hedging Euro, shown in the first column of the table. Significant results are shown in bold. As can be seen, a number of strong time series correlations emerge. First, the mean hedge ratio is positively correlated with a Post-GFC dummy (ρ=81%) and with correlations between local asset returns and FX spot rates (ρ=65%), and negatively correlated with the hedging cost (ρ=-51%), FX volatility (ρ=-44%), and local asset return volatility (ρ=-31%). These results conform with intuition, except for FX volatility which has the opposite sign. Column (2) extends these results to the full panel of currency pairs with the USD. Here, the results are considerably weaker, in part because they mix time-series correlations with cross-currency correlations.

Columns (3) and (4) show the results for USD-fixed income funds. Many of the patterns mirror those seen with equity funds: hedge ratios are larger when hedging costs are low and FX volatility is low. The impact of correlation between local asset returns and FX spot flips sign, however, for both the EUR time series as well as the full panel.

Columns (5)-(8) repeat the analysis for Euro domiciled investors, beginning with Euro-based equity investors. As can be seen, the patterns are quite different. Hedge ratios over time are positively correlated with hedging cost (significantly for the USD in particular), and only weakly correlated with other predictors. For Euro-based fixed income investors hedging of the USD, no significant relationships emerge.

[13] This raises the question of how much these results explain fund-level variation in hedge ratios. We return to this question below, but to preview, fund-level fixed effects explain more of the variation than any of the time-series predictors that we study.

Table IX: Determinants of Hedging – Correlations

This table shows correlations between aggregate foreign hedge ratios (averaged across funds in each month for each currency) and various economic and financial features of these currencies (See Appendix table A7 for definitions of the features). Correlations are computed from 1998-2023 for USD base currency results, 2003-2023 for EUR base currency results. We report panel correlations (across all currency hedge ratios and their associated financial characteristics) for USD and EUR investors across their different foreign hedge ratios, and timeseries correlations for USD investors' hedging of EUR and EUR investors' hedging of USD respectively. See appendix for details on the set of funds used. We further require that each currency-month has at least 3 observations, and that each currency has 12 months of observations after imposing the previous restrictions. **Bold** indicates the correlation is significant at the 95th percent confidence level; we adjust standard errors for the correlations by Newey-West (1987) modified for use in a panel (Petersen 2009).

	USD Funds				**EUR Funds**			
	EQ Funds		**FI Funds**		**EQ Funds**		**FI Funds**	
	EUR TS	**Panel**	**EUR TS**	**Panel**	**USD TS**	**Panel**	**USD TS**	**Panel**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Post GFC Dummy	**81%**	**24%**	**88%**	**26%**	4%	**15%**	-18%	**19%**
Hedging Cost	**-35%**	0%	-20%	**13%**	**27%**	10%	9%	7%
FX Spot Momentum	-19%	**-19%**	-9%	-5%	5%	**13%**	-15%	**-18%**
Local Asset Momentum	22%	7%	-32%	-6%	0%	**17%**	-9%	-4%
FX Volatility	**-41%**	-12%	**-31%**	-9%	-16%	-15%	14%	-7%
Asset Local Volatility	-23%	**-13%**	**34%**	**26%**	-6%	-15%	14%	**33%**
Correl (Asset Local, FX Spot)	**63%**	**13%**	**-38%**	-8%	**25%**	-9%	-17%	**-15%**

Table X shows multivariate regressions of the determinants of mean hedge ratios for USD-domiciled investors. Compared with the results shown in Table IX, there are two advantages to this specification. First, we can study the collective impact of these variables in a multivariate regression. Second, and more importantly, we can separate time-series and cross-sectional variation through the use of currency-pair fixed effects.

Column (1) shows that for equity investors, currency fixed effects explain a substantial share (37%) of the variation in hedge ratios for US investors. Column (2) shows that in a multivariate specification, dropping the fixed effects but adding covariates. As can be seen, he post-GFC dummy, hedging cost, FX spot momentum, FX volatility, correlation between local and FX are significant explanatory variables. However, the variation explained by these characteristics is less than explained by fixed effects alone. Column (3) shows the same multivariate regression but with both the covariates and currency fixed effects included. There are some notable changes, such as the sign on Carry coefficient switching from positive to negative. Put differently, column (3) shows that for any given currency hedge, as the hedging cost falls investors are likely to increase their hedging, but hedging cost does not much explain patterns across different currencies, such as why USD investors are more

likely to hedge Euros compared to Swedish Krona. But column (2) suggests that comparing across currency pairs, higher hedging costs predict more hedging. While currency fixed effects explain more variation than our set of controls, the adjusted R^2 obtained by adding controls is additive, taking us from ~37% with fixed effects alone to ~48% by including controls.

Columns (4), (5), and (6) in Panel B repeat the analysis for USD-based fixed income investors. The results on Carry are similar to Panel A, namely that carry is positively related to hedge ratios, but negatively related once you include currency fixed effects. Compared to Panel A, however, the results related to risk measures (FX and local volatility, and correlations) are much stronger, and in line with theory. Hedge ratios are higher when asset volatility is high and correlations are high and when FX volatility is low. For fixed-income investors, controls are less additive to explanatory power than for equity investors: adjusted R^2 increases from ~35% with fixed effects alone to ~47% after adding controls.

Table XI shows the same panel regressions for Euro investors. We generally see weaker relationships for Euro investors than for USD investors, and several effects point in opposite directions. Among Euro equity investors, we again in Column (3) see a positive coefficient for the post-GFC dummy and for hedging costs, however the relation to FX spot momentum has flipped from positive to negative. While USD equity investors hedge winning currencies less, Euro investors hedge them more. When we include currency fixed effects in Column (4) we see the strength of the hedging cost effect diluted but, unlike for USD investors, it does not reverse. The inclusion of controls is similarly additive in adjusted R^2 , rising from ~7% with fixed effects to ~16% after adding controls.

Table X: Determinants of Hedging – Aggregate Regressions, USD Base

This table shows the result of panel regressions (equation (8) above) of aggregate foreign hedge ratios (averaged across funds in each month for each currency) on various economic and financial features of these currencies (See Appendix table A3 for definitions of the features). Estimated from 1998-2023, USD investors' monthly foreign hedge ratios. See appendix for details on the set of funds used. We further require that each currency-month has at least 3 observations, and that each currency has 12 months of observations after imposing the previous restrictions. We adjust standard errors by Newey-West (1987) modified for use in a panel (Petersen 2009) with a 12 month window. For currency fixed effects, AUD is the reference group.

	Panel A: Equity Investors			**Panel B: Fixed-Income Investors**		
	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	0.04	0.42	0.17	0.68	0.54	0.71
t-statistic	*2.09*	*12.01*	*5.90*	*45.03*	*16.37*	*22.69*
Post GFC Dummy		0.13	0.13		0.18	0.21
t-statistic		*8.86*	*10.32*		*9.52*	*12.23*
Hedging Cost (Carry)		0.76	-1.53		3.19	-1.67
t-statistic		*2.27*	*-4.18*		*8.37*	*-4.26*
FX Spot Momentum		-0.62	-0.45		-0.19	-0.09
t-statistic		*-7.65*	*-6.81*		*-2.12*	*-1.38*
Local Asset Momentum		0.08	0.05		0.23	0.01
t-statistic		*1.78*	*1.35*		*1.52*	*0.12*
FX Volatility		-1.34	-1.77		-3.36	-2.41
t-statistic		*-5.18*	*-7.69*		*-6.41*	*-4.83*
Asset Local Volatility		-0.12	0.05		8.91	2.63
t-statistic		*-1.16*	*0.50*		*14.22*	*3.35*
Correl (Asset Local, FX Spot)		0.04	0.03		0.13	0.25
t-statistic		*2.34*	*1.30*		*4.97*	*9.30*
R^2 Adj	36.96%	11.74%	48.49%	35.30%	18.17%	47.55%
N Obs.	2753	2753	2753	2660	2660	2660
Currency Fixed Effects	y	n	y	y	n	y

For Euro fixed-income investors, Column (5) generally echoes results for US investors, excepting the relation to asset-FX correlation. When we include currency fixed effects in Column (6), while the coefficient on hedging costs does not reverse as sharply as for USD investors, it does fade to insignificance. FX and asset momentum are more negatively related to Euro fixed-income investors' hedging, after including fixed effects, than for USD investors. As in the USD investor case, including controls is less additive to adjusted R^2 for fixed-income than Euro equity investors.

Table XI: Determinants of Hedging – Aggregate Regressions, EUR Base

This table shows the result of panel regressions (equation (8) above) of aggregate foreign hedge ratios (averaged across funds in each month for each currency) on features of these currencies (See Appendix table A3 for definitions of the features). Estimated from 2003-2023, EUR investors' monthly foreign hedge ratios. See appendix for details on the set of funds used. We further require that each currency-month has at least 3 observations, and that each currency has 12 months of observations after imposing the previous restrictions. We adjust standard errors by Newey-West (1987) modified for use in a panel (Petersen 2009) with a 12 month window. For currency fixed effects, AUD is the reference group.

	Panel A: Equity Investors			**Panel B: Fixed-Income Investors**		
	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	0.65	0.56	0.62	0.94	0.86	0.87
t-statistic	*18.40*	*10.90*	*11.52*	*48.92*	*30.64*	*26.08*
Post GFC Dummy		0.10	0.07		0.05	0.05
t-statistic		*4.15*	*2.89*		*2.93*	*2.41*
Hedging Cost (Carry)		2.05	3.15		1.13	-0.24
t-statistic		*2.54*	*3.00*		*3.09*	*-0.55*
FX Spot Momentum		0.34	0.35		-0.29	-0.35
t-statistic		*3.16*	*3.49*		*-5.50*	*-6.95*
Local Asset Momentum		0.19	0.14		0.18	-0.28
t-statistic		*2.97*	*2.07*		*1.83*	*-3.42*
FX Volatility		-0.20	-0.98		-1.06	-0.07
t-statistic		*-0.44*	*-2.30*		*-4.89*	*-0.30*
Asset Local Volatility		-0.17	-0.10		3.58	0.82
t-statistic		*-0.87*	*-0.46*		*12.95*	*2.87*
Correl (Asset Local, FX Spot)		-0.09	0.03		-0.02	-0.08
t-statistic		*-3.61*	*0.93*		*-0.89*	*-3.16*
R^2 Adj	7.02%	8.18%	15.63%	25.23%	16.82%	32.34%
N Obs.	1839	1839	1839	2098	2098	2098
Currency Fixed Effects	y	n	y	y	n	y

The bottom line from Table X and XI is that (a) there is a large and robust post-GFC effect across currency pairs (b) hedging costs are not reliably related to average hedge ratios, and (c) currency-pair fixed effects matter.

Understanding fund level ratios

Now we drill down into fund-level hedging in Table XII, reporting only the R-squared. In the first row, we first run analogous regressions as we did for average hedge ratios and see similar patterns – controls have some

explanatory power, though currency fixed effects matter somewhat more. When we omit fund and currency fixed effects, the explanatory power of the controls is very low, ranging from 0.74% to 3.9%.

Next, we add in the vast number of fund-level fixed effects in a separate group of specifications. Given the number of funds is substantial, it is unsurprising that fund-level fixed effects explain a higher degree of variation than controls or currency effects. This indicates that variation across funds exceeds variation across currencies or over time. Nonetheless, adding currency fixed effects and controls does provide further explanatory power at the fund-currency level after including fund fixed effects.

The variance across fund-currency hedging through time explained by fund effects, currency effects, and controls is of comparable magnitude to the variance across average hedge ratios and through time controls with currency fixed effects. The smoothing obtained from averaging across funds parallels the cross-fund variation captured by fund fixed effects.

Table XII: Determinants of Hedging Variance Decomposition – Adjusted R^2

This table shows the adjusted R^2 obtained from a set of panel regressions (equation (9) above) estimated from fund-currency foreign hedge ratios regressed on features of these currencies (See Appendix table A3 for definitions of the features). Estimated from 1998-2023 for USD base investors, from 2003-2023 for EUR base currency investors. See appendix for details on the set of funds and observations used ("hedger funds" and "hedger positions"). We further require that each fund has 12 months of hedged observations for inclusion, after imposing the previous restrictions. Standard errors are clustered by fund and month. For currency fixed effects, AUD is the reference group. Fund FE refers to the inclusion of fund-level fixed effects. Currency FE refers to the inclusion of currency fixed effects. For currency fixed effects, AUD is the reference group.

			USD Funds		EUR Funds	
Fund FE	**Currency FE**	**Controls**	**EQ**	**FI**	**EQ**	**FI**
N	N	Y	3.93%	3.45%	0.74%	2.26%
N	Y	N	4.29%	3.99%	2.51%	3.44%
N	Y	Y	7.10%	6.47%	3.05%	4.05%
Y	N	N	38.21%	42.49%	58.53%	35.09%
Y	N	Y	39.05%	43.21%	58.69%	35.97%
Y	Y	N	40.41%	43.94%	59.28%	36.41%
Y	Y	Y	40.82%	44.09%	59.42%	36.80%

V. Conclusions

In this paper, we use portfolio data from one of the world's largest custodian banks to study how global portfolio investors hedge foreign exchange risk. As we have shown, hedging activity has increased steadily over time, both for USD-domiciled and non-USD-domiciled investors. With respect to hedging, USD domiciled investors have become more like their global counterparts over time. And, consistent with conventional market wisdom, fixed income investors are more likely to hedge, but equity investors increasingly hedge their currency exposure as well. We document a number of other patterns across different currency markets, and show how they vary across equity and fixed income investors. A remarkably large number of investors appear to adjust their currency hedges quickly in response to change in the underlying assets, consistent with them having target hedge ratios. We also investigate a number of variables that have been predicted by theory to influence hedge ratios. Remarkably, we find only mixed evidence relating higher hedging cost with less hedging.

One implication of our findings is that asset allocation decisions, such as selling stocks and buying bonds in a market, have implications for foreign exchange because of variation in the hedge ratios. Similarly, local return shocks can lead to variation in currency demand. For example, if Euro equities appreciate in local terms, to maintain hedges investors will sell Euros, potentially leading to price effects. A more subtle implication is that symmetric demand for assets (for example, a Euro investor selling USD equity to a USD investor who buys Euro equity) is not neutral with respect to currency demand.

Our findings leave open a number of other questions that we hope can be addressed by future work. What fraction of investor currency demand is driven by hedging decisions compared to portfolio decisions about the underlying assets, with fixed hedge ratios? What is the relationship between investor hedging and demand for global safe assets? And most importantly, what hedging practices have contributed to investor risk and returns?

Appendix: Data Cleaning

Data Cleaning: Aggregate Analyses

A portfolio of equity or fixed income assets is classified as **matched** if it has traded any FX forwards in the prior year, and if it holds assets whose local currency differs from the fund's base currency. This condition is determined at the fund level. For example, a USD based equity investor holding Japanese equities that has not undertaken any trading in FX forwards over the prior year would not be classified as matched, but a USD based equity fund that holds Japanese equities and traded an FX forward in EURUSD would be classified as matched.[14]

Once we have gathered the set of matched funds, we apply data filters ("Basic Fund Filters") at each fund-month before tabulating statistics below**.** We first remove funds with:

1. Fewer than 1 million USD in foreign assets
2. Under 10 underlying asset positions (securities, not currencies).
3. More than 20% of underlying assets allocated to non-G10 currency securities.

After having summed over positions within each fund, aggregated by asset currency, and computed static hedge ratios as defined above, we apply fund-currency-month filters:

1. Remove fund-currency-month observations with underlying asset values under 10,000 USD
2. Remove fund-currency-month observations with absolute hedge ratios exceeding 250%.

We then enumerate a set of "hedger" positions before averaging across funds: fund-currency observations with non-trivial hedge ratios. To qualify as a "hedger position" we:

- Remove fund-currency-month observations with absolute hedge ratios under 5%.

A fund or position failing to meet conditions in one fund-currency-month may later qualify (for instance, if a fund has grown a very small initial position up to a size matching our threshold). Where we compute cross-fund average hedge ratios, we compute these averages over the set of cleaned "hedger" fund-currency-month observations.

Note that classification as a hedger is specific to a given currency in a fund. Suppose a fund holds equity assets in all G10 currencies. The fund may count as a hedger for NZD equity if it has a nontrivial hedge ratio in NZD equity in a given month. The same fund may fail to count as a hedger in NOK if it has below threshold hedge ratio for its NOK equity. Note also that we tabulate portfolio and foreign hedge ratios separately for the above. A fund with a USD base currency that hedges EUR and JPY sufficiently, but holds unhedged positions in CAD

[14] The latter portfolio could hold unhedged Japanese equities. We would include such a position – a fund that has traded FX forwards currently holding Japanese equities without any FX position in JPY – in our hedge ratio calculations (in this case with a hedge ratio of zero). We analyze these daily data on a monthly basis.

would count as hedger with regard EUR and JPY foreign hedge ratios as well as the USD portfolio hedge ratio, but not for CAD. After the above filtering we have 2,483,437 fund-currency-month observations, and 916,806 observations for hedgers.

Data Cleaning: Fund-Currency Analyses

For our regression and other analyses performed at the fund-currency level, we begin with the same fund and fund-currency filters as above. We then add additional requirements below to exclude funds without a sufficient track record and funds that generally do not actually hedge any currencies. We require that funds have:

1.) At least 24 months of historical observations in some currency (including zero hedge ratios)
2.) At least 6 months of non-trivial (absolute value >= 5%) hedge ratios in some (not necessarily the same) currency

The above are applied separately for portfolio and individual foreign currency hedge ratios. We then again enumerate "hedger *funds*", and we do so foreign currency by foreign currency, and separately at the portfolio level. A fund might be labeled as a hedger for AUD, but not for CAD, depending on its behavior. For fund-currency level analysis, we first tag a given fund in a given currency as a hedger by averaging over time. We require that:

- Average (over time) fund-currency absolute hedge ratio >= 5%.

for a fund to qualify as a hedger in a given currency. This is a classification that binds across time for a given fund in a given foreign currency or, separately, for the portfolio hedge ratio.

For analyses of **extensive** margin, we include fund-currency-months where a fund might have ceased to hedge a currency for which it otherwise qualified as a hedger. For instance if a fund has an average hedge ratio in AUD of 10% but has over time flipped between 100% hedging and 0% hedging, we would include its unhedged observations in analyses of extensive margin. This enables us to gauge how frequently these funds in these currencies, which we know at least occasionally hedge, choose to hedge, while excluding non-hedger funds that rarely hedge particular currencies at all.

For analyses focused on **intensive** margins, we focus specifically on hedged observations of hedger funds (fund-currency-months where the absolute fund-currency hedge ratio exceeds 5%). These analyses impose the more granular filter to limit to hedger *positions*, all of which come from hedger *funds*:

- Remove fund-currency-month positions with absolute hedge ratios under 5%.

The additional filters yield 1,839,167 fund-currency-month observations with 871,547 for hedgers (in the most restrictive case where we exclude any fund-currency-months failing to meet the |5%| hedge ratio threshold). For

the same AUD hedging fund example above, we would only use its hedged observations, yielding an average hedge ratio of 100%.

Data Cleaning Glossary:

Matched Funds: portfolios that both hold foreign asset and have traded FX forwards in the past year

Hedger Funds: funds having an average absolute hedge ratio of at least 5% in at least one currency

Hedger Positions: fund-currency positions having a hedge ratio with absolute value of at least 5% in that specific currency in that month.

Appendix: Figures and Tables

Table A1: Hedging Variability (Aggregate)

This table presents, for EUR and USD base investors, the standard deviation, over time, of average hedge ratios for equity and fixed-income portfolios. We report: US investors' hedging of EUR assets, EUR investors' hedging of USD assets, and for each base the respective portfolio hedge ratios as well as average standard deviations of foreign hedge ratios across groups of foreign currencies. The column All Base Average refers to the average standard deviation across all base currencies we cover (EUR, USD, CAD, AUD, and GBP funds). See appendix for details on the set of funds used ("hedger" funds and "hedger" positions). We further require that each currency-month has at least 3 observations, and that each currency has 12 months of observations after imposing the previous restrictions.

	Equity			Fixed-Income		
	EUR Base	**USD Base**	**All Base Average**	**EUR Base**	**USD Base**	**All Base Average**
EUR		23%	29%		19%	25%
USD	18%		25%	14%		21%
Avg. (Majors)	23%	18%	25%	17%	23%	24%
Avg. (Non-Majors)	31%	28%	38%	22%	24%	29%
Avg. (All)	27%	24%	32%	20%	23%	27%
Portfolio	17%	15%	22%	12%	18%	18%

Table A2: Proportion of Time Hedged (Extensive Margin) – Fund Distributions

This table presents statistics across portfolios of the proportion of time asset positions were hedged (the number of months where we observe a hedged underlying position divided by the number of months an underlying position is held for each currency in each fund). These are first computed for each fund, then distributions are calculated across funds. Reported for EUR and USD base investors, equity and fixed-income portfolios. We report: US investors' hedging of EUR assets, EUR investors' hedging of USD assets, and for each base the respective portfolio hedging as well as averages of statistics (first computed currency by currency) across groups of foreign currencies. See appendix for details on the set of funds used ("hedger funds"). We further require that each fund-currency underlying is held for at least 12 months (not necessarily contiguous) after imposing the previous restrictions.

Panel A: USD Funds

	EQ Funds				FI Funds			
	25th	**Median**	**75th**	**Mean**	**25th**	**Median**	**75th**	**Mean**
EUR	29%	67%	91%	59%	82%	94%	100%	87%
Avg. (Majors)	21%	59%	88%	55%	77%	94%	100%	83%
Avg. (Non-Majors)	1%	28%	76%	39%	54%	85%	96%	71%
Avg. (All)	10%	42%	82%	46%	65%	89%	98%	77%
Portfolio	52%	73%	96%	71%	84%	96%	100%	89%

Panel B: EUR Funds

	EQ Funds				FI Funds			
	25th	**Median**	**75th**	**Mean**	**25th**	**Median**	**75th**	**Mean**
USD	55%	88%	100%	73%	93%	98%	100%	92%
Avg. (Majors)	30%	77%	97%	64%	82%	96%	100%	87%
Avg. (Non-Majors)	0%	42%	92%	45%	72%	89%	98%	79%
Avg. (All)	13%	59%	94%	54%	78%	93%	99%	83%
Portfolio	63%	90%	100%	79%	94%	99%	100%	94%

Table A3: Hedging Selectivity

This table presents statistics across portfolios of fund-level averages of: numbers of currencies held (including unhedged), the number hedged, the proportion hedged, and, for hedged positions, the cross-sectional standard deviation of hedge ratios (for hedged positions only) within each fund over currencies. These are first computed for each fund-month and averaged over time for each fund; we then calculate distributions below, across the fund averages. These are reported for equity and fixed-income portfolios, USD and EUR base investors. We report the foreign hedging of USD and EUR investors. See appendix for details on the set of funds used ("hedger funds"). We further require that each fund-currency underlying is held (in the case of hedge ratio cross-sectional standard deviations, held and hedged) for at least 12 months (not necessarily contiguous) after imposing the previous restrictions. Standard deviations require at least 2 currencies be hedged on a given month.

		Equity Funds				Fixed-Income Funds			
		#Held	**#Hedged**	**%Hedged**	**Stdev(HR)**	**#Held**	**#Hedged**	**%Hedged**	**Stdev(HR)**
USD Funds	**25th**	3.96	1.15	25%	11%	1.43	1.01	76%	12%
	Median	5.86	2.20	48%	25%	2.00	1.72	91%	26%
	75th	6.92	4.00	82%	46%	3.55	2.70	97%	46%
	Mean	5.37	2.70	53%	30%	2.62	2.09	83%	33%
EUR Funds	**25th**	3.00	0.98	27%	6%	1.00	1.00	88%	6%
	Median	4.38	1.89	64%	21%	1.76	1.56	97%	18%
	75th	6.59	4.00	93%	47%	2.34	2.00	100%	36%
	Mean	4.66	2.65	60%	29%	2.06	1.82	90%	24%

Table A4: Hedging Variability- Fund Distributions

This table presents statistics across portfolios of hedge ratio standard deviations for funds over time. These are first computed for each fund, then distributions are calculated across funds. Reported for EUR and USD base investors, equity and fixed-income portfolios. We report: US investors' hedging of EUR assets, EUR investors' hedging of USD assets, and for each base the respective portfolio hedge ratios as well as averages of foreign hedging across groups of foreign currencies of statistics (first computed currency by currency) across groups of foreign currencies. See appendix for details on the set of funds and observations used ("hedger funds" and "hedger positions"). We further require that each fund-currency is hedged for at least 12 months (not necessarily contiguous) after imposing the previous restrictions.

Panel A: USD Funds

	Equity Funds				Fixed-Income Funds			
	25th	**Median**	**75th**	**Mean**	**25th**	**Median**	**75th**	**Mean**
EUR	11%	18%	31%	24%	21%	35%	53%	40%
Avg. (Majors)	12%	22%	40%	29%	20%	35%	56%	41%
Avg. (Non-Majors)	17%	35%	59%	42%	25%	45%	73%	51%
Avg. (All)	15%	29%	51%	36%	23%	40%	65%	46%
Portfolio	6%	12%	19%	16%	21%	36%	57%	42%

Panel B: EUR Funds

	Equity Funds				Fixed-Income Funds			
	25th	**Median**	**75th**	**Mean**	**25th**	**Median**	**75th**	**Mean**
USD	12%	22%	41%	29%	16%	29%	44%	33%
Avg. (Majors)	11%	22%	39%	28%	16%	29%	49%	34%
Avg. (Non-Majors)	10%	18%	38%	26%	14%	30%	52%	36%
Avg. (All)	11%	20%	39%	27%	15%	30%	50%	35%
Portfolio	7%	15%	22%	17%	15%	28%	41%	32%

Table A5: USD Asset Hedging by non-USD Investors: Pre vs. Post GFC Average Hedging Frequencies and Levels

This table presents, for each base currency excluding the USD, the differences between average hedging frequencies and average hedging levels for USD assets for the pre-GFC vs post-GFC periods (excluding the GFC itself, which we specify as extending from March 2007 until March 2009). We first compute the % funds hedging and hedge ratios (of those that hedge) each month for each base currency, then average these over time. See appendix for details on the set of funds used. We further require that each currency-month has at least 3 observations, and that each currency has 12 months of observations after imposing the previous restrictions. The row average reflects the average across base currencies.

Base Currency	**Equity**		**Fixed-Income**	
	Δ %Hedged	Δ Hedge Ratio	Δ %Hedged	Δ Hedge Ratio
AUD	23%	25%	4%	-15%
CAD	32%	26%	11%	41%
EUR	24%	12%	8%	5%
GBP	16%	36%	18%	14%
Average	24%	25%	10%	11%

Table A6: Hedging Tightness – Avg. HR vs Dynamic Coefficients, EUR Funds

This table presents statistics across portfolios of funds' relating to funds' dynamic hedge ratio coefficients and average static hedge ratios. First we correlate, over funds, dynamic hedging coefficients with their respective average static hedge ratios. Second, we correlate the same average static hedge ratios to the adjusted R^2 from dynamic hedging regressions. Reported for USD base investors, equity and fixed-income portfolios. We report for: EUR investors' hedging of USD assets, EUR portfolio hedging, and averages across groups of foreign currencies. Currency group averages are of the associated single currencies' correlations. We report two differencing horizons, 1 and 12 months. These refer to the differencing horizons in equations (6) and (7) above. See appendix for details on the set of funds and observations used ("hedger funds" and "hedger positions"). Each individual fund-currency regression and static hedge ratio used requires at least 12 fund-currency-month observations underlying the average or coefficient. We further require that dynamic hedge ratio coefficients are of <= 2 in absolute value.

Panel A: Equity Funds

		USD	Avg. (Majors)	Avg. (Non-Majors)	Avg. (All)	Portfolio
1 M	Corr(*DHR*, Avg *HR*)	41%	46%	49%	48%	61%
	Corr(*DHR* R^2, Avg *HR*)	43%	45%	29%	36%	43%
12 M	Corr(*DHR*, Avg *HR*)	46%	53%	55%	54%	72%
	Corr(*DHR* R^2, Avg *HR*)	49%	55%	55%	55%	52%

Panel B: Fixed-Income Funds

		USD	Avg. (Majors)	Avg. (Non-Majors)	Avg. (All)	Portfolio
1 M	Corr(*DHR*, Avg *HR*)	27%	38%	26%	28%	28%
	Corr(*DHR* R^2, Avg *HR*)	11%	10%	19%	17%	18%
12 M	Corr(*DHR*, Avg *HR*)	54%	31%	28%	29%	48%
	Corr(*DHR* R^2, Avg *HR*)	30%	19%	32%	26%	30%

Table A7: Determinants of Hedging – Feature Definitions

This table enumerates definitions of economic and financial features used in panel regressions above.

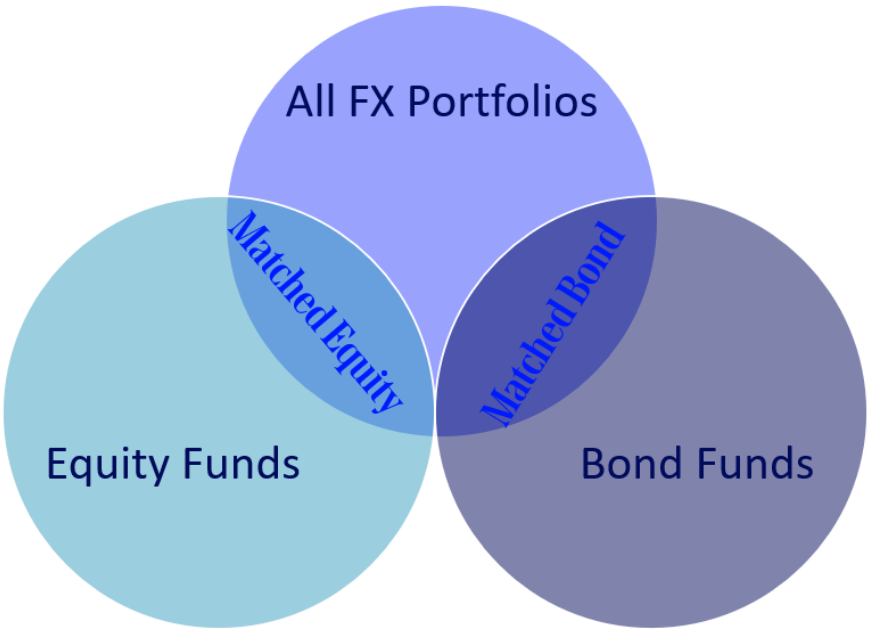
FEATURE	DEFINITION	RATIONALE
Post GFC Dummy	True after March 2009, false before	Gauge difference in hedging levels pre vs post GFC
Hedging Cost (Carry)	3m foreign yield minus the base currency 3m yield. This corresponds to the cost of hedging, (long base, short foreign). Higher number means hedging is more expensive.	Investors may either hedge less when the cost is greater (negative coefficient), or, if yields reflect a risk premium, hedge riskier currencies more, despite the cost (positive coefficient).
FX Momentum	12-1 currency spot return (vs base currency). Positive number means the foreign currency appreciated vs the base currency (EUR or USD)	Hedgers may engage in market timing - hedging outperformers less than underperformers (negative coefficient), or expect reversion (positive coefficient).
Asset Momentum	12-1 foreign equity country or bond index momentum, in local currency terms	Mechanically, positive asset returns reduce the hedge ratio by growing the denominator. Absent rebalancing, hedge ratios would be lower (negative coefficient), while if investors pre-hedge in anticipated of further returns, hedge ratios would be higher (positive coefficient).
FX Volatility	Weekly foreign currency (vs base currency spot) volatility over prior year.	Where FX volatility is high, investors may hedge the FX risk more aggressively (positive coefficient). Conversely, relatively high volatility may leave investors unwilling to commit to FX positions and to hedge less (negative coefficient).
Asset Volatility	Weekly foreign equity or bond index volatility over prior year, in local currency terms	Investors may hedge currency risk less aggressively where underlying local market asset returns are themselves more volatile (negative coefficient).
Correl(Asset, FX)	Correlation between monthly foreign equity or fixed-income index local return and foreign currency USD spot returns (monthly) over prior 5 years	Higher hedge ratios, indicating larger currency shorts, may reduce volatility when the currency is positively correlated to the underlying asset (positive coefficient).

Table A8: Determinants of Hedging, Summary Statistics

This table shows panel means and standard deviations (across currencies and months) of regressors utilized in panel regressions (equation (8) above) of aggregate foreign hedge ratios (averaged across funds in each month for each currency) on features of these currencies (See Appendix table A7 for definitions of the features). Estimated from 2003-2023 for EUR , 1998-2023 for USD investors.

	USD Base		EUR Base	
	Mean	**Stdev**	**Mean**	**Stdev**
Hedging Cost (carry)	0.0%	2.0%	0.8%	1.5%
FX Mom	-0.3%	10.0%	0.1%	10.0%
EQ Mom	7.6%	17.1%	8.7%	15.7%
FI Mom	3.4%	4.9%	2.9%	4.9%
FX Vol	4.9%	1.6%	4.8%	1.7%
EQ Vol	8.4%	3.3%	8.0%	3.3%
FI Vol	1.9%	0.9%	2.0%	0.9%
ρ(EQ, FX)	9.1%	35.8%	6.9%	38.1%
ρ(FI, FX)	-7.3%	27.0%	-12.0%	28.0%

Figure A1: Dataset Components This figure shows schematics of the different components of the dataset used, and the sequence of filters that winnow the dataset for various stages of analysis.



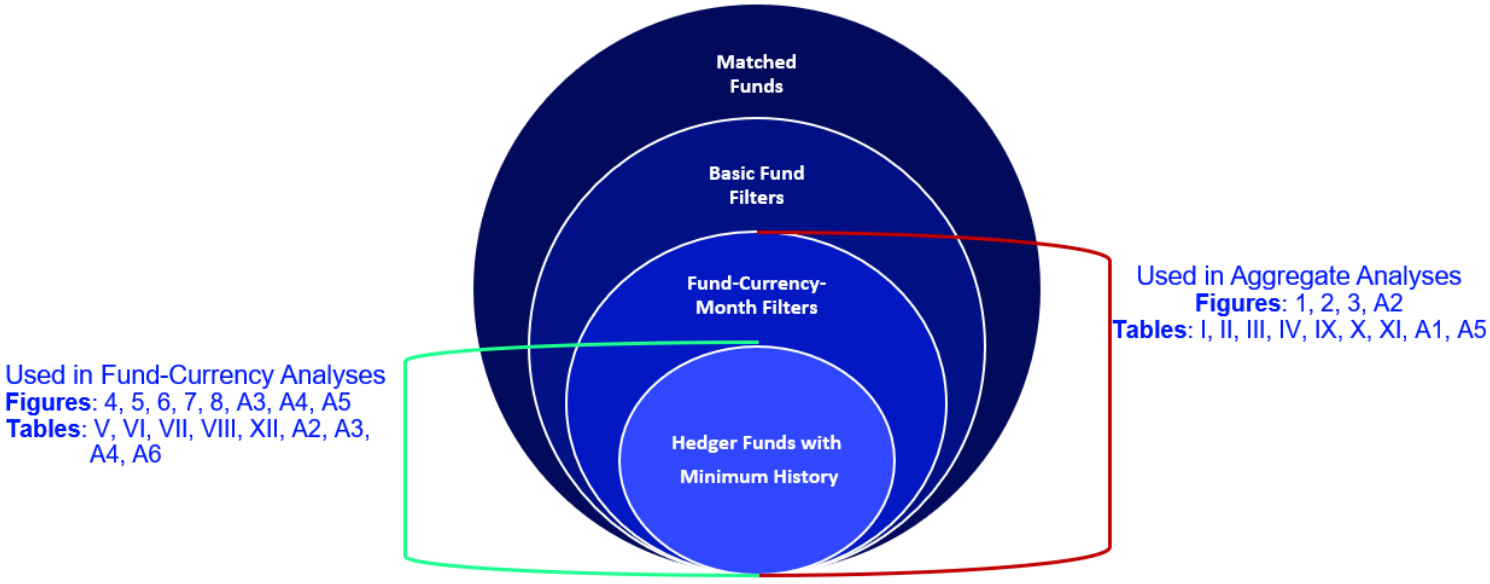


Figure A2: Average Hedging Frequency by Band: This figure shows the average (over time) proportion of US and European equity and fixed-income funds between February 1998 and November 2023 with hedge ratios within several ranges: under 25%, 25% to 75%, 75% to 125%, and over 125%. Each month we compute the proportion of funds with hedge ratios in the given range before averaging across time. We restrict to funds with nonzero hedge ratios (see appendix for details; "hedger" funds and "hedger" positions). We further require that each currency-month has at least 3 observations, and that each currency has 12 months of observations after imposing the previous restrictions.

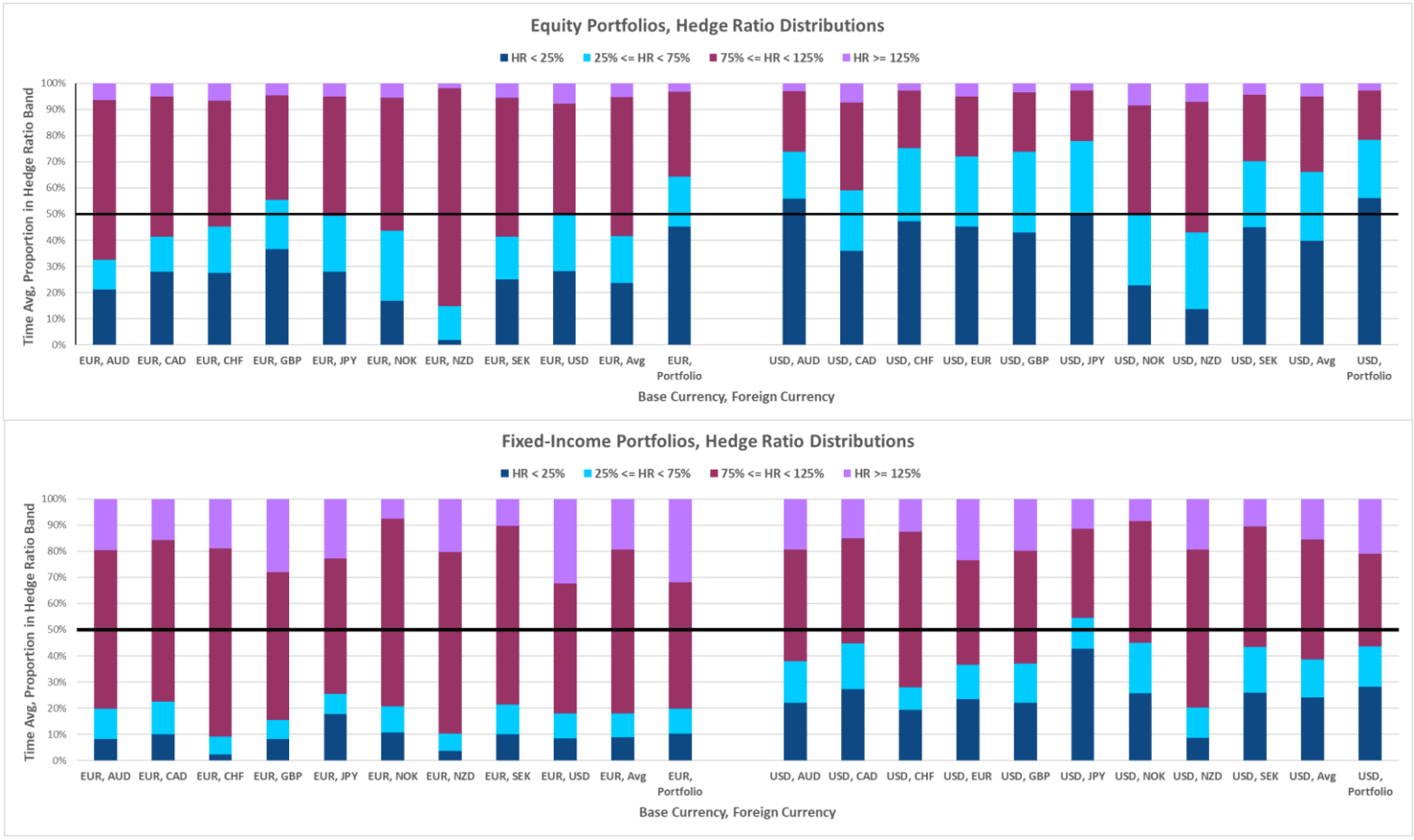


Figure A3: Static Hedge Ratio CDFs: This figure shows the cumulative distribution functions across funds of average hedge ratios. We compute an average across time for each fund-currency and plot the averages. Reported for EUR and USD base investors, equity and fixed-income portfolios. We report: US investors' hedging of EUR assets, EUR investors' hedging of USD assets, and for each base the respective portfolio hedge ratios. See appendix for details on the set of funds and observations used ("hedger funds" and "hedger positions"). We further require that each fund-currency is hedged for at least 12 months (not necessarily contiguous) after imposing the previous restrictions.

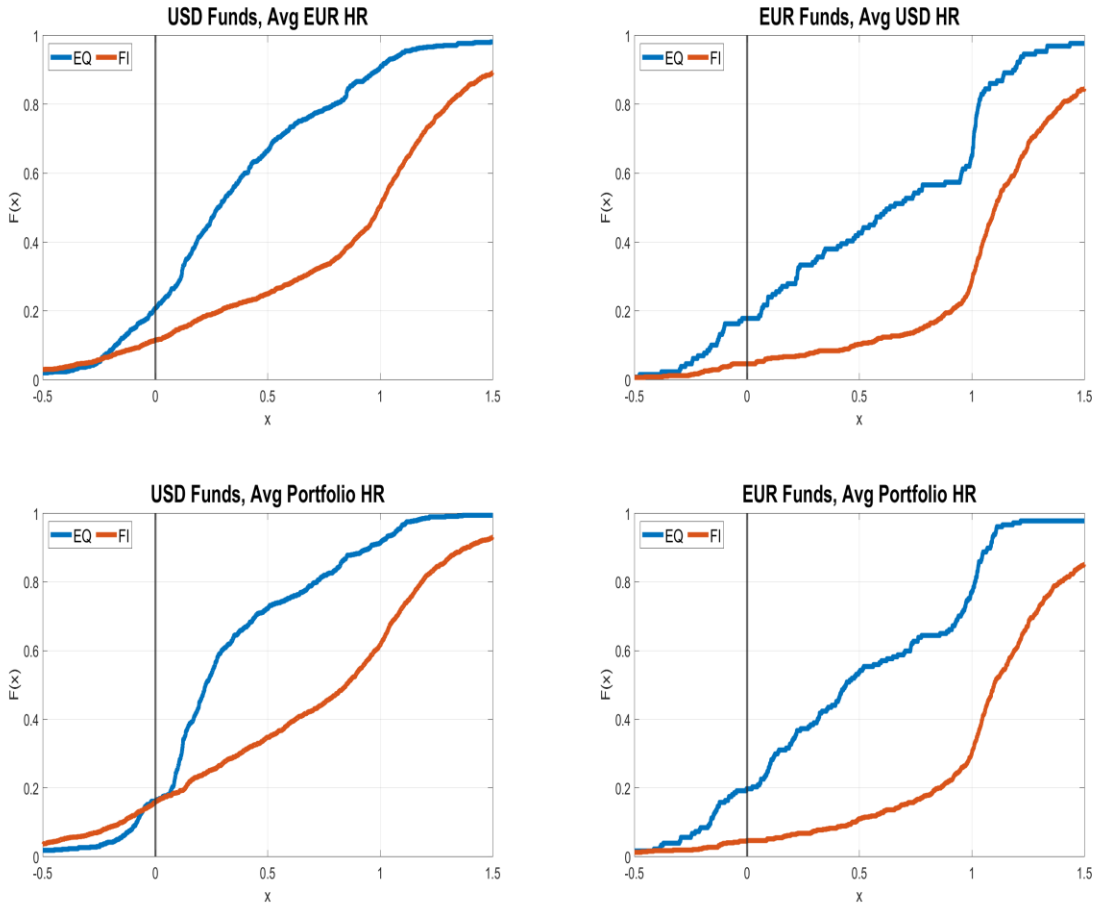


Figure A4: Dynamic Hedge Ratio CDFs, USD Funds: This figure shows the cumulative distribution functions across funds of dynamic hedge ratio coefficients for USD base investors, equity and fixed-income portfolios. We report US investors' hedging of EUR assets and USD portfolio hedge ratios. See appendix for details on the set of funds and observations used ("hedger funds" and "hedger positions"). We further require at least 12 observations (for 1 month horizon, 12 monthly differences; for 12 month horizon, 12 distinct 12-month differences) to estimate a given coefficient.

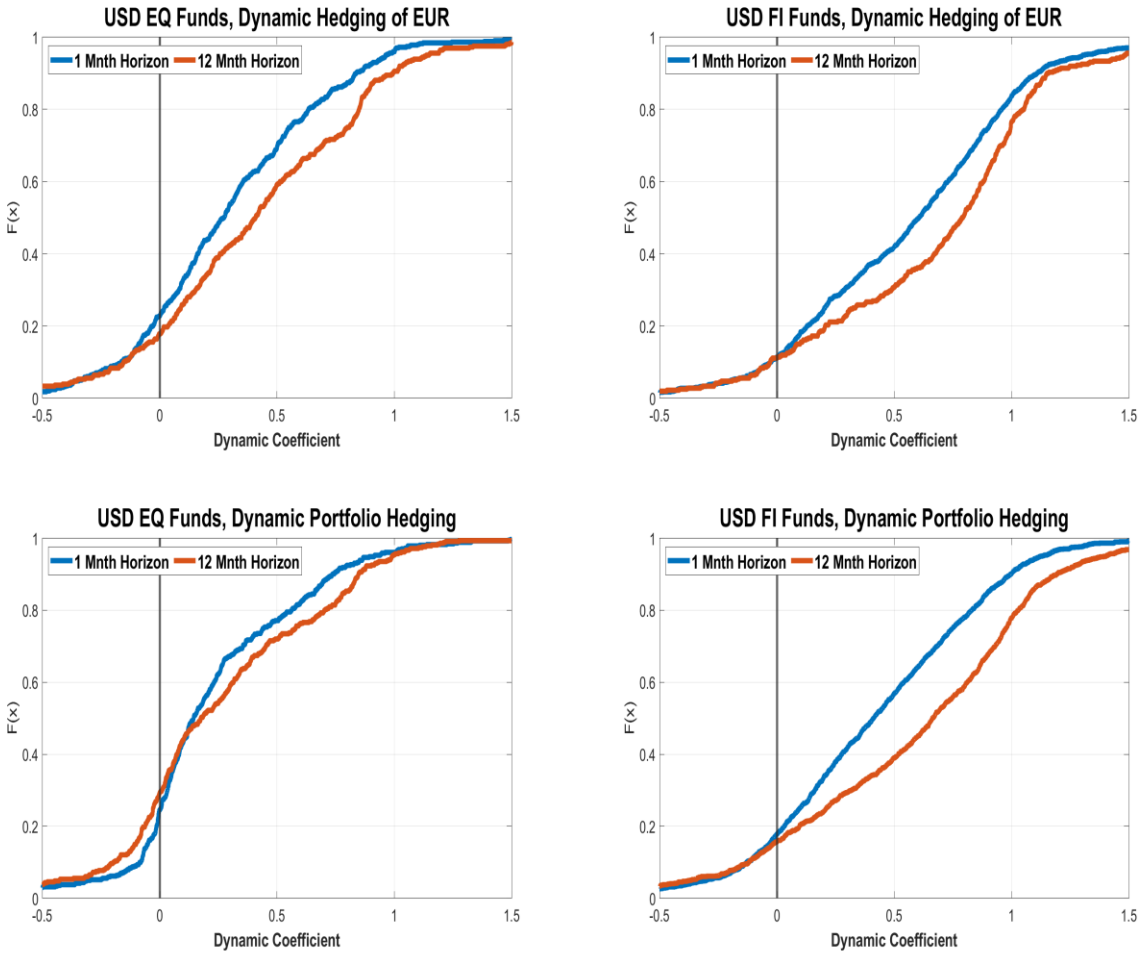
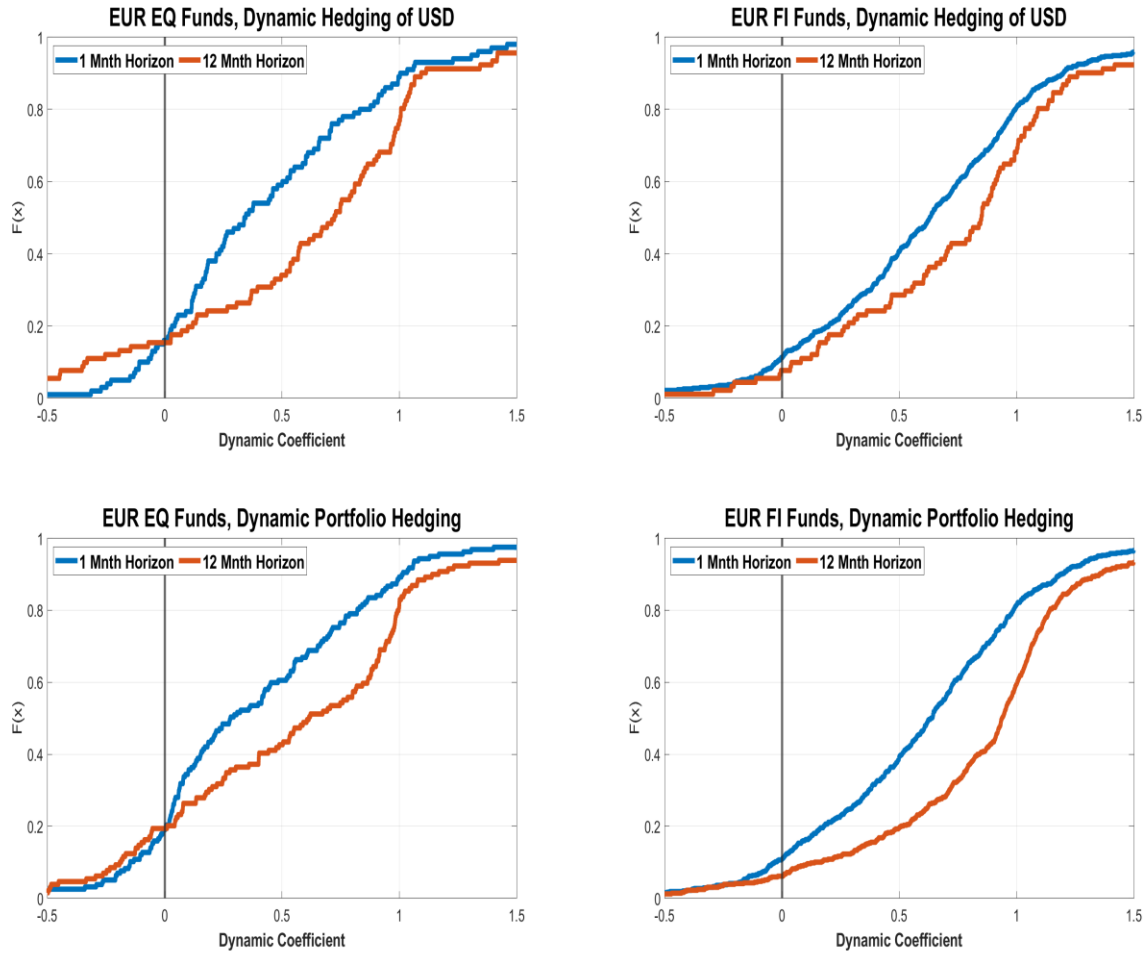


Figure A5: Dynamic Hedge Ratio CDFs, EUR Funds: This figure shows the cumulative distribution functions across funds of dynamic hedge ratio coefficients for EUR base investors, equity and fixed-income portfolios. We report EUR investors' hedging of USD assets, and EUR portfolio hedge ratios. See appendix for details on the set of funds and observations used ("hedger funds" and "hedger positions"). We further require at least 12 observations (for 1 month horizon, 12 monthly differences; for 12 month horizon, 12 distinct 12-month differences) to estimate a given coefficient.



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