Currency Management by International Fixed Income Mutual Funds*

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Abstract

Investments in international fixed income securities are exposed to significant currency risks. We collect novel data on mutual fund currency derivatives and document that around 90% of U.S. international fixed income funds use currency forwards to manage their foreign exchange exposure. Funds' currency forward positions differ substantially based on risk management demands related to portfolio currency exposures, return-enhancement motives such as currency momentum and carry trade, and strategic considerations related to past performance and fund clienteles. Funds that hedge their currency risk exhibit lower return variability, but do not generate inferior abnormal returns.

I. Introduction

Currency exchange rate fluctuations are an important contributor to the risk and return of globally-diversified investments, particularly fixed income portfolios. Indeed, over the last three decades (1990 to 2019), the average U.S. dollar return of the Bloomberg Barclays Global Aggregate Total Return Index, a widely-used global investment grade debt index, was 0.47% per month, and its standard deviation was 1.54%. During the same period, its U.S. dollar-hedged counterpart had a similar average return of 0.49% per month and a standard deviation of 0.86% – almost one half lower.[1] Despite such an economically significant impact, we know little about the determinants and the consequences of currency management strategies of international fixed income funds.

Conceptually, mutual funds that are domiciled in the U.S. but invest outside of the U.S. can manage their currency exposures by changing portfolio allocations or by deploying currency derivatives.[2] In the first approach, a fund adjusts its portfolio between U.S. dollar denominated foreign bonds and local-currency denominated foreign bonds. Maggiori, Neiman, and Schreger (2020) show that mutual funds prefer to hold securities denominated in home currencies, reducing their currency exposure. However, investing in only U.S. dollar-denominated bonds constrains a fund's investment universe, as some foreign issuers only issue in local currency. Alternatively, funds may hold currency derivatives, which enable them to alter their currency exposures independent of their portfolio holdings. However, primarily due to data availability, researchers have not been able to examine mutual funds' use of currency derivatives and how derivative holdings affect overall portfolio currency management.[3]

Our paper fills this gap by documenting the prevalent use of currency derivatives by bond mutual funds and by analyzing the factors that determine funds' currency management poli-

[1]The U.S. dollar-hedged Bloomberg Barclays Global Aggregate Total Return Index uses hypothetical one-month currency forwards to hedge its currency exposures.

[2]Investors of US-domiciled mutual funds have to be based in the U.S. for tax and regulatory reasons (Khorana, Servaes, and Tufano, 2005).

[3]Information on mutual funds' derivative positions is not available in commonly-used databases such as Thomson Reuters, CRSP, or Morningstar. Without information on funds' currency derivatives, prior studies assume that a fund's currency exposure is determined by the currency denomination of its assets.

cies. We assemble the first dataset of currency forward contracts used by U.S.-domiciled fixed income funds investing in international markets, together with the currency denominations of their portfolio holdings. Our final sample contains 476,622 currency forward contracts used by 6,457 fund–quarters between 2010Q2 and 2018Q4. This novel dataset provides detailed quarterly snapshots of fund currency exposures that allow us to examine funds' currency management practices, especially through their use of currency derivatives.

Currency forwards are the predominant type of currency derivatives used by the funds in our sample. During our sample period, about 90% of international fixed income funds use currency forwards. For an average fund, the notional amount of foreign currency forward sales is equivalent to 19.9% of fund total net assets (TNA), and the notional amount of forward purchases (of other foreign currencies) is equivalent to 13.1% of fund TNA, resulting in a net currency exposure reduction of 6.8% through currency forwards. The distribution of funds' net currency forward positions is as dispersed as the distribution of funds' foreign-denominated assets. Some funds use forwards to completely or selectively hedge their currency exposures from bond holdings, while others use forwards to increase their exposures to foreign currencies. These stylized facts highlight the importance of accounting for currency derivatives when studying funds' currency exposures.

Theories suggest that bond funds' use of currency derivatives can be driven by both risk management demands and speculative motives. For risk management, the key determinants of currency positions are currency return volatility and the covariance between currency returns and asset returns. Campbell, Serfaty-De Medeiros, and Viceira (2010) show that global bond returns are almost uncorrelated with currency returns. A mean-variance efficient portfolio hence hedges its currency exposures almost completely. For speculative purposes, investors may condition their derivative positions on currency characteristics that are known to predict currency returns. When the expected excess return of particular currencies is relatively high, investors may buy (or sell less) currency forwards.

Consistent with risk management demands, we find that funds' use of currency forwards

is largely associated with their asset currency exposures. In the cross-section, every dollar of portfolio holdings denominated in G10 currencies (i.e., developed markets) is associated with 26.9 cents of net forward sales. In contrast, assets denominated in emerging market currencies are typically not hedged. Furthermore, the sale of currency forwards is positively associated with the concentration of foreign currencies, as a more concentrated portfolio currency composition prevents diversification across currencies. In the time-series, the selling of foreign currency forwards intensifies when the economic uncertainty in foreign markets is high. These findings suggest that risk management is one of the primary drivers of funds' use of currency forwards. As a case study, we examine how funds adjust their forward positions around the Brexit referendum. As the uncertainty around future British pound exchange rate is heightened, funds' sales of British pound forwards increase significantly in the quarters around the referendum.

With respect to the return-enhancement role of currency forwards, we posit that fund managers condition their forward positions on currency characteristics that have been shown to predict future currency returns. For example, currency returns have momentum (e.g., Burnside, Eichenbaum, and Rebelo, 2011; Menkhoff, Sarno, Schmeling, and Schrimpf, 2012b) and are related to interest differentials between the foreign countries and the United States (Fama, 1984; Brunnermeier, Nagel, and Pedersen, 2008; Burnside et al., 2011; Lustig, Roussanov, and Verdelhan, 2014). Consistent with these conjectures, we find that funds' currency forward sales decrease following periods of higher foreign currency returns (relative to the U.S. Dollar) and periods when the foreign interest rates are higher, controlling for fund fixed-effects. These findings are consistent with investment strategies that follow currency momentum and carry trades.

We further examine the heterogeneity in funds' use of currency forwards across different currencies. The granularity of our data allows us to use fund–by–quarter fixed effects to isolate the variation in the currency-specific hedge ratio across currencies but within a fund in a given period. We find that funds tend to hedge more in currencies that have depreciated

recently. Furthermore, the hedge ratio is negatively associated with the country-specific interest rate. The results suggest that fund managers adjust their currency-specific hedging strategy to take advantage of the cross-sectional predictive power in past currency returns and interest rates.

We then investigate two institutional features specific to the mutual fund industry that might affect fund managers' incentives to manage their currency exposure. First, currency forwards allow funds to change their risk profile relatively quickly, and funds may strategically alter their currency exposures in response to their past performance (Brown, Harlow, and Starks, 1996). International fixed income funds may face higher costs of outflows when holding illiquid assets (Goldstein, Jiang, and Ng, 2017) and are thus more incentivized to hedge their currency risks after poor performance. Our empirical analyses show that flows are more sensitive to negative returns than positive returns in our sample of international fixed income funds. To avoid extreme outflows induced by underperformance, funds reduce their foreign currency exposures by selling more currency forwards following periods of relatively poor performance.

Second, we find that mutual fund clienteles are related to the risk management of a fund. The sale of foreign currency forwards is negatively associated with the fraction of fund assets in institutional share classes. Since fund investors in institutional share classes are likely more sophisticated than investors in retail share classes, this finding is consistent with the argument that hedging at the fund level is more valuable when funds' investors are unable to hedge currency exposures themselves. On the other hand, institutional investors can manage the currency exposures themselves.

In the last part of our paper, we examine the performance implications of funds' currency management. It is interesting to study the actual performance consequences of fund currency management as trading currency derivatives involves explicit and implicit transaction costs as well as implementation risks. We sort funds into quintiles based on their foreign currency exposure, taking into account the forward positions. Funds with the lowest level of foreign

currency exposure exhibit higher returns, lower volatility, and higher Sharpe ratios than funds with the highest level of foreign currency exposure. When we decompose fund returns into a component that is driven by a funds' currency exposures and a currency-adjusted component, the outperformance of low-currency-exposure funds is primarily driven by the currency returns. Our results suggest that currency-hedged funds provide at least a similar level of performance to unhedged funds while also substantially reducing portfolio risks. One caveat to our performance analyses is that U.S. dollar significantly appreciated against foreign currencies in our sample, so the realized returns of hedged and unhedged portfolios do not necessarily reflect their expected returns.

Our paper helps us understand how delegated portfolio managers use derivatives to change the return and risk profiles of their portfolios. Most extant studies examine domestic equity funds and find limited use of derivatives.[4] The focus of our study is international fixed income funds, which have a natural demand for currency derivatives for risk management purposes. The analyses in this paper suggest that these funds use forwards not only to hedge their exposure to certain currencies, but sometimes also to expand their currency exposure. Our work is also related to Aragon, Li, and Qian (2019) and Jiang, Ou, and Zhu (2020), who examine the use of credit default swaps (CDS) in corporate bond mutual funds. Both CDS and currency forwards can serve the dual purpose of hedging funds' risk exposure as well as expanding funds' exposure to certain risk factors.[5]

The hand-collected dataset on fund currency forward contracts used in this paper provides a complete picture of international fixed income funds' portfolio allocations and currency exposures. This novel dataset allows us to evaluate the empirical relevance of several international portfolio allocation theories pertaining to currency trading. Our findings complement the influential work of Maggiori, Neiman, and Schreger (2020), who focus on the currency

[4]See, for example, Koski and Pontiff (1999), Deli and Varma (2002), Almazan, Brown, Carlson, and Chapman (2004), Cici and Palacios (2015), Natter, Rohleder, Schulte, and Wilkens (2015), and Kaniel and Wang (2021).

[5]In addition, Aragon and Martin (2012) examine the use of derivatives in hedge funds and conclude that hedge fund managers have skill in using equity options.

denomination of international bond portfolios. Previously, most studies on international portfolio management assume that mutual funds do not hold much currency derivatives and that a fund's currency exposure is determined entirely by the denomination of its assets (Massa, Wang, and Zhang, 2016; Camanho, Hau, and Rey, 2018; Maggiori, Neiman, and Schreger, 2020; Koijen and Yogo, 2020). Our data suggest that currency forwards contribute significantly to funds' variation in currency exposures.

Finally, our paper relates to the extensive literature on corporate hedging. Theory works suggest that corporate hedging should be determined by taxes, financial distress costs, investment opportunities, and external financing costs (Smith and Stulz, 1985; Froot, Scharfstein, and Stein, 1993). Adam, Dasgupta, and Titman (2007) examine hedging decisions of firms where the hedging choice depends on the hedging decisions of its competitors. Empirical analyses show that roughly half of large U.S. companies use derivatives to hedge various sources of risks (Géczy, Minton, and Schrand, 1997), although the magnitude of hedging might be small (Guay and Kothari, 2003).[6] One empirical challenge is that it is sometimes difficult to delineate hedging and speculation in firms' use of derivatives (Géczy, Minton, and Schrand, 2007; Chernenko and Faulkender, 2011). Our setting mitigates this concern because it is reasonable to classify funds' currency forward use based on whether the contracts purchase or sell foreign currencies. We also observe the currency exposures based on the bond holdings denominated in different currencies.

Section II describes the data sources and the sample selection and Section III reports the summary statistics. We analyze the determinants of the use of forward contracts in Section IV and the performance implications in Section V. Section VI concludes.

[6]See also Tufano (1996), Allayannis and Weston (2001), Jin and Jorion (2006), Purnanandam (2007), and Campello, Lin, Ma, and Zou (2011).

II. Data

We describe in this section the data sources, the sample selection procedure, and the various measures used to capture the use of forwards by international bond mutual funds.

A. Data sources

The main data used in this paper are mutual fund currency forward positions manually collected from quarterly SEC filings (N-Q and NCSR/S) via the EDGAR system. In addition, we use the CRSP Survivor-Bias-Free Mutual Fund database, the CRSP Mutual Fund Portfolio Holdings database, and S&P Global for CUSIP information.

Mutual funds are required to disclose their derivative positions in their SEC filings.[7] We manually collect mutual funds' holdings of currency forward contracts from N-Q and NCSR/S filings from the SEC EDGAR system. The international bond funds in our sample predominately manage their currency-related derivatives in the form of forward contracts.[8]

Although the reporting format for currency forward positions varies across funds, most funds include information on the following items for each of their currency forward positions: (1) the currency purchased, (2) the purchase amount (denominated in the purchase currency), (3) the currency sold, (4) the sale amount (denominated in the sale currency), (5) the settlement date of the contract, (6) the counterparty of the contract (typically a bank), and (7) the unrealized gains or losses of the contract as of the reporting date. Figure 1 shows an excerpt of this disclosure from JPMorgan Emerging Markets Debt Fund based on its N-Q filing as of May 31, 2018. The granular nature of the data allows us to construct detailed measures of mutual funds' exposures to various currencies.

[7] See rule 12-13 of Regulation S-X.

[8] Forward contracts are substantially more common than options, swaps, or futures. In our sample, 89% of funds employ currency forwards in at least one of their reporting quarters. Besides currency forward contracts, 18% of our sample funds hold currency options and around 3% of sample funds hold cross-currency swaps. For funds that use currency options, the total notional amount of currency options is around one-quarter of the total notional amount of currency forwards. We therefore focus our data collection effort on currency forwards. We show in Table A3 in the Appendix that sample funds' returns have a similar coefficient on positive currency returns and negative currency returns, further suggesting that the impact of currency options is limited.

The CRSP Mutual Fund Portfolio Holdings database provides holdings of mutual funds at a quarterly frequency.[9] The sample period runs from 2010Q2 to 2018Q4.[10] The CRSP database provides the 9-digit CUSIP for the vast majority of sample funds' holding positions, excluding cash, funds, and derivatives. In addition, the CRSP database lists the market value of each position and its associated issuer name. For fixed income securities, the CRSP database further provides information on maturity dates and coupon rates.

We merge fund portfolio positions with issuer-level and issue-level information provided by the S&P Global database. For each 9-digit CUSIP, the S&P Global provides information on issuer name, issuer domicile, issuer type (sovereign or corporate), security type (equity or fixed income), and the currency denomination of the issue. For positions without a valid CUSIP, we manually collect issuer and issue information (particularly issuer domicile and issue currency denomination) from Thomson Eikon by searching issuer name, maturity date, and coupon rate provided by the the CRSP Holdings database. At the fund–quarter level, we are able to assign issuer domicile and currency denomination for 90.3% of the average fund's assets under management.

B. Sample selection

We start by selecting mutual funds in the CRSP Survivor-Bias-Free Mutual Fund database that specialize in international fixed income investments. Such funds are mainly designated by CRSP objective code ($crsp\_obj\_cd$) "IF", which covers six Lipper objectives.[11] In addition, a number of international fixed income funds are designated by other CRSP and Lipper objective codes (e.g., Lipper Objective Code "HY", referring to High Yield Funds). To include these additional funds in our sample, we examine all funds with a Lipper asset code

[9] Some mutual funds provide holdings information every month. We keep the last available holdings information for each fund–quarter.

[10] Holdings information from the CRSP Mutual Fund Portfolio Holdings database is incomplete before 2010Q2 and covers only a subset of sample funds, as discussed by Zhu (2020).

[11] These Lipper objectives include Emerging Markets Debt Funds (EMD), Emerging Markets Local Currency Funds (EML), Global High Yield Funds (GHY), Global Income Funds (GLI), International Income Funds (INI), and Short World Multi-Market Income Funds (SWM).

of "TX" (Taxable Fixed Income Funds) and manually select funds that focus on international fixed income securities. Multiple share classes of the same fund are aggregated at the fund level (identified by distinct *crsp_cl_grp*). The initial sample contains 457 distinct funds during our sample period of 2010Q2 to 2018Q4.

Since we are interested in international fixed income funds' discretionary holdings and hedging decisions, we exclude 68 passively-managed index funds and ETFs from the sample. Furthermore, after carefully examining fund holdings, we find that 19 of our candidate funds are structured as funds of funds, while ten funds hold exclusively cash or Treasuries and invest in currency forwards; another eight funds are misclassified and mainly invest in domestic securities. We also exclude two funds that invest a considerable fraction of their assets in bank loans. Finally, we require sample funds to have valid holdings data from the CRSP Mutual Fund Holdings database (linked by *crsp_portno*) for at least four quarters during the 2010–2018 sample period. Our final sample contains 302 distinct international fixed income funds.

Table I shows the number of funds and their total assets under management in our sample each year. The number of international fixed income funds increases from 126 funds in 2010 to 236 funds in 2016, then slightly decreases to 227 funds in 2018. The total assets under management increase from $188.04 billion in 2010 to $288.53 billion in 2013 before declining to $225.09 billion at the end of the sample. In each year, we further tabulate the number of distinct funds with non-zero currency forward use. Throughout the sample period, between 87.5% to 92.1% of sample funds report using currency forwards.

C. Measurement of fund currency forwards

Our data structure allows us to observe funds' use of currency forwards at the individual contract level. To calculate a fund's use of currency forward contracts, we first calculate the U.S. dollar-equivalent notional amount for each currency forward contract at the report date. To this end, we use the report-date spot rate of the foreign currency involved in the forward

and convert the contract's foreign currency notional amount to its U.S. dollar-equivalent value. For example, if a forward contract *sells* CAD11,232,000 in exchange for U.S. dollars, and the report-date USD/CAD spot rate is 1.2894, then we calculate that this contract sells Canadian dollars with a notional amount equivalent to USD8,711,028 (11,232,000/1.2894). Similarly, if a forward contract *purchases* AUD1,401,000 in exchange for US dollars, and the USD/AUD spot rate is 1.3208, then we calculate that this contract purchases Australian dollars with a notional amount equivalent to USD1,060,721 (1,401,000/1.3208).

For the subset of cross-currency forwards involving two foreign currencies, we separately calculate the U.S. dollar-equivalent notional amount of each non-U.S. dollar currency as of the report date. For example, if a forward contract purchases EUR6,518,000 in exchange for PLN28,121,000, then we record a forward position that purchases Euro with a notional amount of USD7,603,826 (6,518,000/0.8572) and another forward that sells Polish Zloty with a notional amount of USD7,617,152 (28,121,000/3.6918), assuming that the USD/EUR spot rate is 0.8572 and the USD/PLN spot rate is 3.6918 on the reporting date.[12]

Currency forward positions are then aggregated at the fund–currency level. In this step, we net out a fund's long and short positions with regard to the same currency in the same quarter. In the currency forward market, funds typically close out their existing forward positions by entering into a new forward contract with the same notional amount but the opposite buy/sell direction. For example, if a fund purchases USD100,000 notional amount of JPY and sells USD75,000 notional amount of JPY in the same quarter, we record a USD25,000 notional amount of purchase for the JPY position of this fund–quarter. Specifically, for a given foreign currency c in fund i's portfolio:

$$Forward^{c}_{i,t} = \frac{\sum_j ForwardSales^{c}_{i,t,j} - \sum_j ForwardBuys^{c}_{i,t,j}}{TNA_{i,t}}. \tag{1}$$

The *Forward* is normalized by the fund's TNA. This measure is positive if a fund sells

[12]As this example shows, the report-date U.S. dollar-equivalent notional amount for the two legs of a forward contract can be slightly different because changes in forward rates and spot rates between the reporting date and the date when the forward was entered.

foreign currency in exchange for U.S. dollars in the forward markets. This corresponds to a hedging position if the fund has a long exposure in the underlying currencies.

We further construct several variables that characterize currency forward positions at the fund level. First, we sum a fund's forwards across all non-U.S. dollar currencies to calculate the fund-level *net forward* position:

$$Forward^{net}_{i,t} = \sum_{c \neq USD} Forward^{c}_{i,t}. \tag{2}$$

In some tests, we are also interested in the gross foreign-currency forward sales and forward purchases of a fund. We define gross forward sales and forward purchases as:

$$Forward^{sales}_{i,t} = \sum_{c \neq USD} max(Forward^{c}_{i,t}, 0), \tag{3}$$

$$Forward^{buys}_{i,t} = \sum_{c \neq USD} max(-Forward^{c}_{i,t}, 0). \tag{4}$$

Another measure we use to evaluate a fund's currency strategy is its overall forward hedge ratio with respect to its non-U.S. dollar denominated holdings. This measure is defined as the ratio between a fund's net foreign currency forwards and its portfolio weight denominated in non-U.S. dollar assets:

$$Hedge\_ratio_{i,t} = \frac{Forward^{net}_{i,t}/(1+r_T)^T}{\sum_{c \neq USD} \omega^{c}_{i,t}}, \tag{5}$$

where ω^c denotes the portfolio weight of assets denominated in currency c, and r_T denotes the U.S. interest rate associated with the maturity T for the forward contracts.[13] To reduce the noise in $Hedge\_ratio_{i,t}$, we winsorize this variable at the 1% and 99% level.

[13]We adjust the numerator of *Hedge_ratio* by the interest rate to obtain the present value of the future forward payments denominated in U.S. dollars. This is consistent with the computation of the a fund's TNA, which is also capturing the present values of the bonds in U.S. dollars. Meanwhile, the asset value of foreign holdings is their present value discounted to the reporting date. This adjustment by the interest rate has a small impact on the hedge ratio since the maturity of a forward contract is typically only a few months and interest rates are relatively low during our sample period.

When we expand our observations to the fund-quarter-currency level, we similarly construct the hedge ratio for a given currency c as:

$$Hedge\_ratio^c_{i,t} = \frac{Forward^c_{i,t}/(1+r_T)^T}{\omega^c_{i,t}}, \qquad for\ c \neq USD. \tag{6}$$

A fund's currency exposure is jointly determined by its asset denomination and its use of currency forwards. We denote a fund's total exposure to a specific currency c as:

$$Exposure^c_i = \omega^c_i - Forward^c_i/(1+r_T)^T, \tag{7}$$

and a fund's total exposure to all foreign currencies as:

$$Exposure_i = \sum_{c \neq USD} (\omega^c_i - Forward^c_i/(1+r_T)^T). \tag{8}$$

Given that the holdings of assets are denominated in foreign currencies, the concentration of currency denomination may matter for funds' currency strategies. Hence, we construct a measure of currency concentration based on the Herfindahl-Hirschman index as follows: First, we re-weigh the portfolio weight denominated in currency c as the fraction of all foreign-currency-denominated assets in the portfolio. The portfolio currency concentration is then calculated as the sum of squares for each currency's adjusted weight in the portfolio:

$$Concentration_{i,t} = \sum_{c \neq USD} \left(\frac{\omega^c_{i,t}}{\sum_{c \neq USD} \omega^c_{i,t}} \right)^2. \tag{9}$$

The concentration index ranges from $1/N$ for a portfolio equally distributed in the N available currencies to one for a portfolio fully concentrated in one foreign currency.

III. Descriptive Statistics

We describe in this section the summary statistics and provide an example of currency risk management in practice.

A. Summary Statistics

Our paper is the first to assemble a sample of currency forward contracts used by US-based fixed income funds investing in international markets. Our final sample contains 476,622 currency forward contracts used in 6,457 fund–quarters. Panel A of Table II shows some contract-level summary statistics that allow us to take a first glimpse at mutual funds' foreign currency management practices.

At the contract-level, 48.4% of forward contracts purchase U.S. dollar and sell a foreign currency, while 43.3% sell U.S. dollar and purchase a foreign currency. The rest (8.3%) involve two non-U.S. dollar foreign currencies. The average (median) notional amount of a currency forward is $11.8 million ($1.27 million) and the distribution is right-skewed primarily because of differences in funds' assets under management. The average (median) time to maturity as of the fund reporting date is 63.7 (49.5) days. The relative short maturity of forward contracts used by sample funds may reflect the fact that currency forwards are more liquid at the short-end.[14] It also suggests that mutual funds need to frequently roll-over their forward contracts if they want to maintain a stable currency hedge ratio.

We provide summary statistics at the fund–quarter level in Panel B of Table II. Within our sample, 86.8% of fund–quarters utilize currency forward contracts. For this subset of forward users, the average (median) number of forward contracts used in a given fund–quarter is 80.6 (43). These contracts are sourced from, on average, 7.78 different counterparties. Across the full sample of fund–quarters, the average (median) percentage of fund assets issued by entities domiciled outside of the U.S. is 78.3% (88.6%). At the same time, the average

[14]For example, a survey by BIS (2016) shows that, in terms of notional volume, 59% of foreign exchange forwards initiated in 2016 have a maturity of between seven days and one year. The use of short-term currency forwards may also reflect some funds' strategy to capture a term premium.

(median) percentage of assets denominated in foreign currencies is only 42.8% (42.6%). For fund assets denominated in foreign currencies, on average 21.7% of a fund's portfolio assets are denominated in G10 currencies, while 21.1% of assets are denominated in other foreign currencies.[15]

Panel B of Table II also tabulates the amount of foreign currency forward sales by sample funds. On average, sample funds sell foreign currency forwards equivalent to 6.83% of their TNA, indicating that they, on average, hedge part of their foreign currency exposure back to U.S. dollars. It should be noted that the net amount of foreign currency forwards understates sample funds' utilization of currency forwards, as it nets out sales and purchases across different currencies for the same fund–quarter. If we separate currency forward purchases and sales, the gross notional amount of foreign currency forward purchases equals 13.1% of the average fund's TNA, whereas the gross notional amount of currency forward sales equals 19.9% of the average fund's TNA. Finally, considering both the percentage of foreign-denominated assets and currency forward positions, sample funds' average (median) net exposure to foreign currencies is 37.1% (23.9%) of their TNAs.

In our sample, about 10.2% of funds track benchmark indices that are currency hedged. We confirm in our data that those funds indeed use currency forwards to hedge their currency exposures. The rest of our sample funds follow benchmark indices that are not currency hedged. Such funds exercise discretion in their currency forward strategies. We provide two examples in the next section.

Figure 2 shows the histogram of the distribution of sample funds' portfolio weight in assets issued by foreign entities, assets denominated in foreign currencies, net sales of foreign currency forwards, and the net exposure to foreign currencies. The upper left panel shows that most funds have a large fraction of assets issued by foreign entities, while the upper right panel shows the distribution of the weight of foreign currency-denominated assets is

[15]The G10 currencies include the Australian dollar (AUD), Canadian dollar (CAD), Swiss franc (CHF), Danish krone (DKK), euro (EUR), British pound (GBP), Japanese yen (JPY), Norwegian krone (NOK), New Zealand dollar (NZK), and Swedish krona (SEK). These currencies are considered the most liquid currencies in the foreign exchange market.

more dispersed, and there is a nontrivial fraction of funds that invest entirely in U.S. dollars. This suggests that sample funds hold a significant amount of U.S. dollar bonds issued by foreign entities. This is consistent with the finding of Maggiori et al. (2020) that investor holdings are biased towards their own currencies rather than their home-country issuers.

The lower left panel of Figure 2 shows the distribution of net foreign currency forwards scaled by total assets. The distribution is roughly centered around zero. It is surprising that many funds on net purchase additional foreign currency forwards and thereby increase their currency exposure. This suggests that funds' purposes of utilizing forward contracts are not confined to hedging foreign exchange risks. The lower right panel shows the distribution of sample funds' net foreign currency exposure, which takes into account both their asset denominations and their currency forwards. The distribution is wide and multi-modal. The most dense distribution is located around zero foreign currency exposure, indicating funds that follow a fully-hedged strategy. Additional modes occur at a currency exposure of 100% and surprisingly at 50%. The overall exposure of the latter funds is one-half in U.S. dollars and one-half in foreign currencies.

We then examine the joint distribution of a funds' portfolio weights in assets denominated in foreign currencies and their net exposures to foreign currencies, taking into account forward contracts. Figure 3 displays a scatter plot of sample funds' portfolio weight in foreign currency-denominated assets against their net portfolio exposure to foreign currencies. There is a wide dispersion of currency management practices by sample funds. A number of funds almost fully hedge their foreign currency exposure regardless of their portfolio weight of foreign-denominated assets, as their net currency exposures are near zero (located near the horizontal axis). At the same time, there are also a large number of funds that do not hedge their foreign currency exposures on average. These funds are located along the 45-degree line, where a fund's portfolio weight of foreign-denominated assets equals its net exposure to foreign currencies. Finally, a number of funds partially hedge their foreign currency exposures and are located between the 45-degree line and the horizontal axis.

Figure 4 shows the time-series trend in sample funds' use of currency forwards at the aggregate level. The purchases of foreign currency forwards stay relatively stable during the sample period, while the sales of foreign currency forwards rise slightly. As a result, the net currency forward sales increase from close to zero at the beginning of 2011 to almost 10% of fund TNA by the end of the sample period.[16]

B. Examples

To shed some light on some foreign exchange management practices adopted by our sample funds, we study two examples of mutual funds' use of currency forwards.

The first example is the DFA Five-Year Global Fixed Income Portfolio. Based on its prospectus, this fund explicitly commits to fully-hedged currency strategies. Its prospectus states: "The DFA Five-Year Global Fixed Income Portfolio is designed to provide a market rate of return by investing in U.S. and foreign government securities, high-quality corporate fixed income securities, and currency-hedged global fixed income instruments maturing in five years or less. The currency exposure associated with non-U.S. dollar-denominated securities within the Portfolio is generally hedged back to the U.S. dollar." Examining our measure of currency forwards and currency exposure for this fund confirms the validity of our empirical measures. Figure 5a displays the portfolio weight of securities denominated in foreign currencies, the net sale amount of currency forwards scaled by TNA, and the total foreign currency exposure of this fund. The figure shows that our data capture the currency hedging strategy of the DFA Five-Year Global Fixed Income Portfolio quite well: the total foreign exposure is consistently close to zero. Although the amount of assets denominated in foreign currencies changes quite dramatically over the sample period, the currency forward sales closely track the amount of foreign-denominated assets.

We contrast the example of the fully-hedged DFA fund with the Oppenheimer International Bond Fund. Figure 5b shows that, while the fraction of non-U.S. dollar denominated

[16]The use of currency forwards for a given fund is also fairly persistent, as summarized in Table A1 in the Appendix.

assets in the fund is relatively stable during the whole sample period, the Oppenheimer fund significantly alters its currency forward sales from quarter to quarter. As a result, the overall foreign currency exposure of the fund fluctuates from close to 100% in 2011 to close to zero in 2015. This is consistent with the fund's "active" management of foreign currency exposure, as stated in its prospectus. It states that "[t]he Fund actively manages foreign currency exposure, both to reduce risk and to seek to enhance return. To do so, the Fund may invest in foreign exchange derivatives, including forwards and options that reference foreign currencies, including currencies of developing and emerging market countries." While the Oppenheimer fund tracks a benchmark index that is not currency-hedged, Figure 5b indicates that fund managers are given much discretion in determining the usage of currency forwards, both in terms of magnitude and the direction of currency exposure.

IV. Determinants of funds' use of currency forwards

The currency forward use by mutual funds depends on several factors. First, funds have risk management demands. For example, funds that hold a larger portfolio weight of foreign-denominated bonds should have an incentive to hedge their currency exposure by selling forward contracts. Furthermore, foreign-currency risks are more pronounced if the fund portfolios are more concentrated in a few currencies. We capture the portfolio concentration using the Herfindahl-Hirschman index from Equation (9). Hedging is also more valuable during episodes of political and economic uncertainty, when currency returns tend to be more volatile.

Second, funds may use currency forwards to enhance return if fund managers have certain expectations about future currency movements. Past studies have shown that certain currency characteristics have predictive power, and mutual funds may enter forward contracts to take advantage of these investment strategies. These strategies include currency momentum strategies (e.g., Menkhoff et al., 2012b; Asness, Moskowitz, and Pedersen, 2013),

carry trades (e.g., Menkhoff, Sarno, Schmeling, and Schrimpf, 2012a; Lustig, Roussanov, and Verdelhan, 2014; Koijen, Moskowitz, Pedersen, and Vrugt, 2018), and risk timing strategies.

Third, funds may differ in their incentives of using derivative contracts and in the preferences of their clienteles. Mutual funds may also strategically change their risk exposures with the prior performance to increase their money flows, as discussed by Brown, Harlow, and Starks (1996). With respect to the clienteles of mutual funds, retail investors may not be able to hedge their currency exposures themselves and may not be as well diversified as institutional investors. Thus, funds with non-institutional clienteles may hedge more than funds with institutional clienteles.

A. Cross-sectional determinants

To investigate the determinants of currency forward use in the cross-section of mutual funds, we regress fund characteristics on various measures of currency forward usage, controlling for time fixed effects:

$$Forward_{i,t} = \alpha_t + \sum_j \gamma_j P^j_{i,t} + \sum_k \beta_k X^j_{i,t-1} + \epsilon_{i,t}, \tag{10}$$

where the vector P measures the portfolio composition (e.g., fraction of assets in foreign currency, foreign currency concentration) at the concurrent period. The vector X captures lagged fund characteristics, such as assets denominated in foreign currency, currency concentration, weight in corporate bonds, fund size, family size, fund age, expense ratio, and turnover ratio. Standard errors are clustered at the fund level and are shown in parentheses.

The first outcome we examine is a fund-level indicator variable, $\mathbb{1}_{\text{Forwards}}$, that takes the value of one if a fund has a nonzero amount of currency forwards in a given quarter. In our sample, 86.8% of fund–quarters use currency forward contracts. Column (1) of Table III shows that funds with more assets denominated in non-U.S. dollar currencies (either in G10 currencies or other foreign currencies) are more likely to use currency forwards, as they

have more hedging needs. Consistent with Koski and Pontiff (1999), funds that belong to larger fund families are more likely to use currency forwards, potentially because larger fund families have more expertise in using derivative contracts and enjoy economies of scale.

In the next set of regressions, we use the following continuous variables as the outcome variables: the net currency forwards ($Forward^{net}$) scaled by fund TNA, the gross forward sales ($Forward^{sale}$) scaled by TNA, the gross forward purchases ($Forward^{buy}$) scaled by TNA, and the fund-level hedge ratio ($Hedge\_ratio$).

Column (2) of Table III displays the determinants of fund net forward sales. For each dollar increase in the portfolio assets denominated in G10 currencies, a fund sells 27.5 cents more in currency forwards, which is significant at the 1% level. This is in stark contrast with the effect of assets denominated in non-G10 currencies (mostly emerging market currencies). The coefficient on other foreign currency-denominated assets is close to zero and statistically insignificant. There are two potential explanations for this difference: First, the interest rates of emerging markets tend to be higher than the U.S. interest rate, so selling currency forwards may dampen fund returns. Second, some of the emerging markets impose capital restrictions to foreign investors on investing in underlying assets and buying currency forwards may help U.S. funds to increase their exposure to those markets.

At the same time, the coefficient on portfolio currency concentration is significantly positive. This suggests that managing currency exposure through forward contracts is more important for funds whose asset currency denomination is highly concentrated in a few currencies, holding the level of asset currency exposure constant. Currency risk management is more important if the underlying portfolio assets cannot diversify away currency risks.

We also find that the fraction of a fund's assets sold through institutional shares is negatively associated with their sales of currency forwards. Assuming that institutional shares are mainly sold to relatively sophisticated investors, this negative association between institutional assets and forward sales is consistent with the argument that hedging may be less valuable for investors who are more likely able to access currency derivatives themselves.

For retail investors, on the other hand, fund-level currency hedging provides a valuable service.

In columns (3) and (4), we separately examine the sales and purchases of foreign currency forwards. One can think the former as forwards used for "hedging" purposes and the latter for "speculative" purposes. For each dollar of portfolio assets denominated in G10 (developed markets) currencies, an average fund sells 35.5 cents of forwards in those currencies and purchases 9.0 cents of forwards. For each dollar of assets in non-G10 currencies, however, the amounts of currency sales and purchases are similar and hence offsetting. We also find that funds' turnover ratio is positively associated with both forward purchases and forward sales. This is consistent with the argument that currency forwards facilitate more flexible and active trading strategies.[17]

Column (5) of Table III examines funds' use of currency forwards using the the hedge ratio. The portfolio weight of assets denominated in G10 currencies is positively associated with funds' hedge ratio, again suggesting that international funds are more likely to hedge their exposure to developed-market currencies. A higher asset concentration of foreign currencies is also associated with a higher hedge ratio, indicating the need to hedge concentrated currency risks. More expensive funds on average have a lower hedge ratio. This may reflect the fact that expensive funds' usually provide more sophisticated strategies rather than a plain-vanilla fully-hedged product. Finally, funds that have a higher fraction of assets in institutional shares tend to have a lower hedge ratio, consistent with a clientele effect in funds' hedging choice.

[17]For example, as Oppenheimer Global Strategic Income Fund states in its prospectus in relation to its use of forward foreign currency contracts, "Central to those strategies are features inherent to derivatives that make them more attractive for this purpose than equity and debt securities: they require little or no initial cash investment, they can focus exposure on only certain selected risk factors, and they may not require the ultimate receipt or delivery of the underlying security. This may allow the Fund to pursue its objectives more quickly and efficiently than if it were to make direct purchases or sales of securities..."

B. Time-series variation in funds' use of currency forwards

Mutual funds' use of currency forwards may also vary with market conditions. We first consider two strategies that the literature has shown to increase expected returns of currency portfolios. The first one is the currency momentum strategy (Menkhoff et al., 2012b). If funds' use of currency forwards is partially motivated by return-enhancement considerations and fund managers follow a currency momentum strategy, they should sell less currency forwards after periods of high foreign currency returns (relative to the U.S. dollar). The second strategy is the "dollar carry trade" in Lustig, Roussanov, and Verdelhan (2014). Under this strategy, funds should hedge more of their foreign currency exposures when the average short-term foreign interest rate is lower than the U.S. interest rate.

To investigate how a given fund's currency forward strategy changes in the time-series, we regress funds' hedge ratios and sales of currency forwards on market condition variables, controlling for fund fixed effects. The fixed effects absorb the average difference in hedge ratios across funds. Standard errors are double-clustered at the fund level and at the time level.

Table IV shows that funds reduce their hedge ratios when the average excess return of foreign currencies is higher in the previous quarter. A one standard deviation increase in foreign currency excess returns (2.9 percentage points) is associated with a 3.3 percentage points decrease in funds' average hedge ratio. Similarly, column (2) of Table IV shows that a higher foreign currency return in the previous quarter is associated with a smaller amount of net currency forward sales. These results suggest that sample funds' use of currency forwards is consistent with a currency momentum strategy, as they reduce their sales of foreign currency forward when foreign currencies have appreciated against the U.S. dollar.

The currency forward positions of mutual funds are also influenced by the three-month interest differentials between the U.S. and foreign currencies. Consistent with the dollar carry strategy, Column (1) of Table IV shows that mutual funds' hedge ratios are lower during periods when the average interest rate differential between G10 countries and the

U.S. are higher.

Currency management is potentially more valuable during times of heightened political and economic uncertainty. We examine the time-series variation in funds' use of currency forwards in relation to uncertainty using the World Uncertainty Index (WUI) developed by Ahir, Bloom, and Furceri (2018). A higher WUI represents higher economic and political uncertainty in a specific country.[18] Table IV shows that the hedge ratio and the purchases of U.S. dollar forwards are significantly positively associated with the WUI. Column (1) shows that a one standard deviation increase in WUI (i.e., 4.4 units) is associated with a 6.1 percentage points increase in the hedge ratio, and a 0.97 percentage point increase in funds' sales of foreign currency forwards (column 2).

In columns (3) and (4) of Table IV, we examine the impact of recent currency returns, foreign-U.S. interest rate differentials, and the aggregate uncertainty on funds' portfolio weights of foreign-denominated assets and their overall foreign currency exposure. The results suggest that while the portfolio weight of foreign-denominated assets also changes in a way that is consistent with the return predictability of the momentum, dollar carry, and risk timing strategies, the adjustment of fund currency exposure in response to aggregate market conditions seems to be mostly driven by changes in funds' currency forward positions. This is particularly apparent in the case of currency momentum, in that the relationship between past foreign currency return and fund foreign currency exposure can be entirely attributed to changes in forward positions. These findings are consistent with the argument that currency forwards are more flexible to adjust then underlying foreign bonds, and hence are used by fund managers to implement momentum, carry, and other currency strategies.

[18]The World Uncertainty Index is constructed by textually analyzing the quarterly Economist Intelligence Unit country reports and using the frequency of the word "uncertainty" and its variants (Ahir, Bloom, and Furceri, 2018). The global level of uncertainty using the simple average across all countries.

C. *Within-fund differences in currency management across currencies*

We proceed to examine the between-currency determinants of hedging strategies, taking advantage of the granularity of our data. To this end, we first disaggregate our data set to the fund–quarter–currency level. For each fund–quarter–currency pair, we calculate a currency-specific hedge ratio. We then regress the currency-specific hedge ratio of a fund–quarter–currency pair on characteristics of each currency, controlling for fund-by-quarter fixed effects. This setting allows us to tease out currency traits that are associated with a more active use of currency forward by mutual funds.

We consider several currency-specific characteristics that might affect funds' hedging decisions: recent currency returns against the U.S. dollar in the previous quarter, the volatility of monthly currency returns in the past 12 months, the three-month interest differential against the U.S. dollar, the country specific World Uncertainty Index (WUI), and the average bid-ask spread in three-month forward contracts. For currency c held by fund i at quarter t, the regression specification is as follows:

$$\begin{aligned} Hedge\_ratio^{c}_{i,t} = \alpha_{i,t} + \beta_1 CurrencyRet^{c}_{t-1,t} + \beta_2 CurrencyVol^{c}_{t-1,t} + \beta_3 IntDiff^{c}_{t-1} \\ + \beta_4 WUI^{c}_{t} + \beta_5 BAspread^{c}_{t} + \gamma\omega^{c}_{t} + \epsilon^{c}_{i,t} \end{aligned} \tag{11}$$

Table V shows the determinants of hedging strategies across currencies for a given fund-quarter. Columns (1) and (2) examine all fund–currency pairs where a fund holds a positive amount of assets whereas columns (3) and (4) examine only positions involving G10 currencies. Standard errors are clustered at the fund-currency pair level.

We find that funds tend to hedge less of a foreign currency position if the currency has recently appreciated. This is consistent with a cross-sectional currency momentum strategy discussed in the previous subsection. In terms of economic magnitude, a one standard deviation increase in the past-quarter currency return (5.6%) is associated with a hedge ratio that is about one percentage point lower (-0.169*5.6). This is suggestive that fund managers

take advantage of currency momentum strategies (Menkhoff et al., 2012b). Furthermore, funds hedge more of their exposures to currencies that have a lower interest rate differential relative to the U.S. A one standard deviation decrease in the interest rate differential (3.4%) is associated with a hedge ratio that is 2.1 percentage points higher (-0.644*3.4). This is consistent with a cross-sectional carry trade strategy that expect high-interest currency to appreciate (Fama, 1984).

The hedge ratio is higher for currencies that have more volatile returns, which is plausible given the higher risk exposures. The country-specific WUI is positively associated with funds' hedge ratio with respect to the currency of the given country. A one standard deviation increase in the country-specific WUI (0.25) is associated with a hedge ratio that is 3.0 percentage points higher (11.95*0.25, column (1)). This corroborates our time-series results that funds hedge more of their foreign currency exposures during times of high economic and political uncertainty.

Finally, we find that currency-specific forward bid-ask spreads have a negative coefficient on the currency hedge ratio and the amount of forward sales. This suggests that funds take into account the transaction costs in the derivative markets when making their hedging decisions.

D. Funds use of currency forwards around the Brexit Referendum

We illustrate mutual funds' utilization of currency forwards in response to heightened uncertainty using the episode around the Brexit referendum on June 23, 2016. To isolate the impact of the impending Brexit vote from funds' overall currency hedging policies, we use the augmented fund–quarter–currency sample and regress funds' sale of GBP forwards on indicators of quarters around the Brexit referendum. The regression specification is as

follows:

$$Y_{i,c,t} = \alpha_{i,t} + \delta_{i,c} + \beta_1 \mathbb{1}_{c=GBP} Brexit(t-2) + \beta_2 \mathbb{1}_{c=GBP} Brexit(t-1) + \beta_3 \mathbb{1}_{c=GBP} Brexit(t)$$
$$+ \beta_4 \mathbb{1}_{c=GBP} Brexit(t+1) + \beta_5 \mathbb{1}_{c=GBP} Brexit(t+2) + \beta_6 \mathbb{1}_{c=GBP} Brexit(t \geq 3) + \epsilon, \qquad (12)$$

where i denotes a fund, c a currency, and t a quarter. The outcome variable $Y_{i,c,t}$ is either a fund's hedge ratio with respect to currency c, a fund's sale of currency c forwards ($forward^c$), or a fund's exposure to currency c.

We report regression coefficients in the Appendix Table A2 and plot β_1 through β_6 in Figure 6. The figure shows an increased level of currency hedging by selling GBP forwards in both the quarter of the Brexit referendum and the quarter after. Since the Brexit referendum takes place only one week before the end of 2016Q2, a large fraction of the increased amount of GBP forward sales reported at the end of the referendum quarter may be entered prior to the referendum. The increased GBP forward sales are not offset by changes in funds' portfolio asset denominations, as fund exposures to GBP are significantly lower from one quarter before the referendum to one quarter after. These results demonstrate that funds use currency forwards as a flexible risk management tool in times of political and economic uncertainty.

E. Fund past performance and the use of currency forwards

We further relate funds' use of currency forwards to their past performance. There are several possibilities of how mutual funds' past performance may affect their currency forward positions. On the one hand, the literature on fund tournaments (e.g., Brown, Harlow, and Starks, 1996) suggests that funds that trail in recent performance may take more risks, presumably by increasing their exposure to exchange movements in the hope of improving their rankings. On the other hand, hedging may be more valuable when the expected cost of financial distress is high (Smith and Stulz, 1985) and when funds with more illiquid holdings

suffer more outflows from low performance (Chen, Goldstein, and Jiang, 2010). This suggests that low-performing funds should increase their hedging activities using currency forwards.

A key difference between the two hypotheses is whether the flow-performance relation is concave or convex for our sample of funds. To empirically investigate this, we first estimate the flow-performance sensitivity of sample funds, with an emphasis of separating positive returns from negative returns:

$$Flow_{i,t} = \alpha_i + \alpha_t + \beta_1 \min(Perf_{i,t-1}, 0) + \beta_2 \max(Perf_{i,t-1}, 0) + \sum_j \beta_j X^j_{i,t-1} + \epsilon_{i,t}, \quad (13)$$

where $Perf_{i,t-1}$ is measured by a fund's style-adjusted return measured over the 12 preceding months. Standard errors are clustered at the fund level.

Column (1) of Table VI shows that the flow of our sample of international fixed income funds is more sensitive to negative returns than to positive returns. In fact, the coefficient on $\min(Perf_{i,t-1}, 0)$ is positive and significant whereas the coefficient on $\max(Perf_{i,t-1}, 0)$ is insignificant. Such concavity in flow-performance relationship is consistent to Goldstein, Jiang, and Ng (2017), who document the fragility of corporate bond funds. Given that international fixed income funds may similarly suffer from holding illiquid portfolio assets, it is reasonable to expect that investor flows are also more sensitive to downside returns.

We therefore hypothesize that funds with relatively poor performance should increase their sales of currency forwards in order to hedge their downside risks. To empirically evaluate this, we run the following regression:

$$Y_{i,t} = \alpha_i + \alpha_t + \beta_1 \min(Perf_{i,t-1}, 0) + \beta_2 \max(Perf_{i,t-1}, 0) + \sum_j \beta_j X^j_{i,t-1} + \epsilon_{i,t}. \quad (14)$$

The outcome variable $Y_{i,t}$ includes the net currency forwards ($Forward^{net}$) scaled by fund TNA, the gross forward sales ($Forward^{sale}$) scaled by TNA, and the gross forward purchases ($Forward^{buy}$) scaled by TNA. We include fund fixed effects in these regressions in order to capture the *deviation* of a fund's currency forward strategy relative to its time-series mean

in response to its recent performance.

In column (2) of Table VI, the coefficient on $\min(Perf_{i,t-1}, 0)$ is negative and significant, suggesting that the lower a fund's past performance, the more currency forwards it sells, presumably to hedge future exchange rate risks. This is consistent with the hedging motive associated with downsize returns and large fund outflows. In contrast, the coefficient on $\max(Perf_{i,t-1}, 0)$ is statistically insignificant, indicating that well-performing funds do not tend to adjust their currency forward positions.

We further separate funds' use of forwards into sales of currency forwards and purchases of currency forwards in columns (3) and (4). We find that funds with poor past performance are more likely to hedge their exposure to foreign currencies by selling forwards (column (3)), while funds with superior past performance are more likely to increase their foreign currency exposure by purchasing currency forwards (column (4)). Finally, column (5) shows that fund foreign currency exposure decreases following a period of relatively poor performance, confirming that funds' adjustments to their forward positions are not offset by changes in their underlying currency denominations.

In sum, we find that funds that have performed poorly in the recent past hedge more of their exposures to exchange movements by selling more currency forwards. Such behavior is likely motivated by the enhanced sensitivity of fund flows to negative returns.

V. Fund performance

In this section, we investigate the relationship between sample funds' use of currency forwards and their performance.

A. Performance measurement

Besides reporting the raw fund returns, we also decompose the monthly returns into a component driven by exchange rate movements and a component that is not currency-driven.

Since we do not observe intra-quarter changes in asset currency denominations and positions in currency derivatives, we assume that the currency exposures are held constant over the entire quarter. Under this assumption, the funds' currency returns are calculated as:

$$Ret_{i,t}^{Currency} = \sum_{c \neq USD} Exposure_{i,t-1}^{c} * r_{i,t}^{c}, \tag{15}$$

where $r_{i,t}^{c}$ is the spot rate change of currency c relative to U.S. dollar during month t. The currency exposures include both the exposures from the direct bond holdings and from the forward positions. If funds do not have any foreign currency exposures at the beginning of the quarter, their $Ret^{Currency}$ is zero.

We term the difference between the raw return of a fund and its currency return as its currency-adjusted return:

$$Ret_{i,t}^{CurAdj} = Ret_{i,t}^{Fund} - Ret_{i,t}^{Currency}. \tag{16}$$

The average monthly $Ret^{Currency}$ and Ret^{CurAdj} are -0.13% and 0.34%, respectively.

We further employ two factor-based models to examine sample funds' systematic risk exposures and abnormal performance. In Model 1, we regress monthly fund net excess returns on the unhedged global bond market excess returns, the emerging bond market excess returns, the term factor, and the credit factor:[19]

$$\begin{aligned} Return_{i,t} - rf_t = {} & \alpha_i^{Model1} + \beta^{GlobalUnhedged}(GlobalMarket_t^{Unhedged} - rf_t) \\ & + \beta^{Emerging}(EmeMarket_t - rf_t) + \beta^{term}Term_t + \beta^{credit}Credit_t + \epsilon_{i,t}. \end{aligned} \tag{17}$$

[19]The unhedged global bond market excess return is measured by the Bloomberg Barclays Global Aggregate Bond Index return. The Bloomberg Barclays Global Aggregate Bond Index includes investment grade debt from 24 local currency markets, including the U.S. The emerging bond market excess return is measured by returns of the JPMorgan Emerging Market Bond Index Global (i.e., EMBI Global). The JPMorgan EMBI Global Index tracks total returns of U.S. dollar-denominated bonds issued by sovereign and quasi sovereign entities in emerging markets. The term factor is defined as the difference between the ten-year Treasury return minus the one-month Treasury return. The credit factor is the difference between the Barclays U.S. Aggregate BAA Index return and the AAA Index return.

This model benchmarks funds' net returns with unhedged global bond market returns, implicitly assuming that fund investors do not have access to currency hedging tools or direct currency investments.

In Model 2, we replace the unhedged global bond market returns with the U.S. dollar-hedged global bond market returns.[20] In addition, we include as factors the dollar risk factor (average excess return of foreign currencies) and the currency carry factor, as in Lustig, Roussanov, and Verdelhan (2011). The abnormal return from this model is thus less likely to be directly impacted by the realized U.S. dollar returns during the sample period.

$$\begin{aligned} Return_{i,t} - rf_t = \alpha_i^{Model2} + \beta^{GlobalHedged}(GlobalMarket_t^{Hedged} - rf_t) \\ + \beta^{Emerging}(EmeMarket_t - rf_t) + \beta^{term}Term_t + \beta^{credit}Credit_t + \\ + \beta^{FX}RXMean_t + \beta^{Carry}HML_t^{FX} + \epsilon_{i,t}. \end{aligned} \tag{18}$$

B. Full sample-period analyses

To investigate the relation between currency exposures and return and risk levels of international bond mutual funds, we sort our funds into quintile groups based on their time-series average foreign currency exposure during the sample period. Only funds with a return history of at least 36 months are included in this analysis. For each fund, we compute over the available time period its average excess return relative to the U.S. one-month Treasury rate, its standard deviation of monthly fund returns, and its Sharpe ratio.[21]

Table VII shows the statistics for the five groups of funds. The currency exposures differ dramatically across the five groups. Whereas the lowest group has close to zero exposure to foreign currencies (i.e., the average foreign currency exposure is -1% relative to TNA), the highest group has a close to complete exposure to foreign currencies (i.e., the average foreign

[20] The hedged global bond market return is proxied by the return of the Bloomberg Barclays Global Aggregate Bond Index (U.S. dollar-hedged).

[21] The Sharpe ratio is defined as the ratio between the average excess return and the standard deviation of the return. The annualized Sharpe ratio is calculated as the monthly Sharpe Ratio multiplied by $\sqrt{12}$.

currency exposure is 97%). Average returns and risk levels vary across the five groups sorted by their foreign currency exposures. The group with the highest currency exposure (Group 5) has the lowest average monthly excess return of 0.037% per month, while the average excess return is 0.296% for Group 2 and 0.263% for Group 1. Meanwhile, the average standard deviation and the value at risk at the fifth percentile of the monthly returns is monotonically increasing in funds' foreign currency exposures. The monthly return standard deviation of the lowest-currency-exposure group of 1.18% is less than half the standard deviation of the highest-currency-exposure group of 2.58%. The differences in both the average monthly returns and the return volatilities contribute to the monotonicity in the Sharpe ratio by the currency exposure-sorted groups. Funds in the lowest group, on average, have an annualized Sharpe ratio of 0.79, whereas funds in the highest group have a Sharpe ratio of 0.09.

We also calculate the difference of average returns, standard deviations, and Sharpe ratios between low- (Group 1) and high-exposure funds (Group 5). To test whether these differences are statistically different from zero, we simulate the empirical distribution of the differences by randomly assigning funds into quintiles.[22] The p-values from the simulated empirical distribution show that the differences between Groups 1 and 5 in the excess returns, standard deviations, and Sharpe ratios are statistically significant at the 1% level.

Table VII also shows that funds' currency returns are monotonically decreasing in their foreign currency exposures. The monthly currency return for the quintile of funds that have the lowest foreign currency exposure is -0.039%, while the currency return for the highest-exposure funds is -0.252% per month. The difference, 0.213% per month, is statistically significant at the 1% level. This result occurs partially because the U.S. dollar appreciates compared to other currencies over our sample period.

In contrast, the currency-adjusted return is relatively flat across the groups sorted by foreign currency exposures. The lowest-exposure quintile has a slightly higher currency-adjusted return than the highest-exposure quintile (0.341% vs. 0.313%), but the difference

[22] We run the simulation for 1,000 times to obtain the empirical distribution.

is not statistically significant at conventional levels. Thus, the return differences across the portfolios are primarily driven by changes in the currency returns.

Table VII also reports the abnormal returns from Model 1 and Model 2 for groups of funds sorted by their foreign currency exposures. There is a monotonically decreasing relationship between a fund's currency exposure and its risk-adjusted performance. The group of funds with the lowest foreign currency exposure has an average α^{Model1} of 0.075% per month and an α^{Model2} of 0.035%. The group of funds with the highest foreign currency exposure, in contrast, has an average α^{Model1} of -0.239% per month, and an α^{Model2} of -0.108%. The differences of alphas between low- and high-exposure groups are also significant at a 1% level based on our simulated empirical distributions.

In addition, the estimated β_{FX} is monotonically increasing in a fund's foreign currency exposure. Funds in the lowest quintile have an average foreign-exchange beta of 0.03 while funds in the highest quintile have an average foreign-exchange beta of 1.10. The estimated β_{FX} corresponds closely with our foreign currency exposure measure, suggesting that our currency exposure measure accurately reflects sample funds' total exposure to exchange rate movements, regardless of whether they are estimated based on holdings or returns.

C. Panel regressions

To further analyze the relationship between a fund's exposure to currencies and its performance, we conduct panel regressions taking into account a host of fund characteristics. To this end, we regress fund performance (measured by monthly raw return, $Ret^{Currency}$, Ret^{CurAdj}, α^{Model1}, or α^{Model2}) on the amount of a fund's currency forward sales (relative to TNA), fund portfolio weight of foreign-currency assets, and various fund characteristics, controlling for style–by–time fixed effects:

$$Performance_{i,t} = \alpha + \beta_1 Forwards^{net}_{i,t-1} + \beta_2 \omega^{nonUSD}_{i,t-1} + \gamma FundCharacteristics_{i,t-1} + \epsilon, \quad (19)$$

where $\omega_{i,t-1}^{nonUSD}$ denotes a fund's portfolio assets denominated in foreign currencies.

An advantage of panel regression analysis is that we can separately estimate the performance implications of currency exposure derived from forward positions and currency exposure derived from asset currency denominations. In other words, coefficient β_1 should estimate the performance effect of funds' currency forward sales conditional on the same portfolio holdings of foreign-currency assets.

Table VIII displays the results. Columns (1) to (3) show that, controlling for fund characteristics including the currency denominations of portfolio assets, a fund's amount of foreign currency forward sales is positively and consistently associated with its performance. A one standard deviation increase in the amount of a fund's currency forward sales (0.25) is associated with a 5.3 basis point increase in monthly raw return, a 6.1 basis point increase in monthly α^{Model1}, and a 1.1 basis point increase in monthly α^{Model2}. These relationships are statistically significant at least at a 10% level.

Furthermore, Column (4) of Table VIII regresses a fund's estimated loading on foreign currency return on the fund's sale of currency forwards and its portfolio weight of assets denominated foreign currencies. Controlling for a fund's holdings of non-U.S. dollar assets, the amount of currency forward sales is one-to-one negatively associated with β_{FX} with a coefficient of -0.980. This highlights the importance of considering *both* a fund's asset denomination and its currency forward positions in considering the fund's currency exposure. Such measurement is made possible only by the comprehensive data of currency forward positions we collect for our paper.

We further regress funds' currency return ($ret^{Currency}$) and currency-adjusted return (ret^{CurAdj}) on funds' currency forward sales and fund characteristics. Columns (5) and (6) of Table VIII display the results. The amount of foreign currency forward sales is positively associated with the currency-driven component of fund returns. A one standard deviation increase in the amount of a fund's currency forwards (0.25) increases fund currency returns by 4.6 basis points. At the same time, the amount of currency forwards a fund sells does

not correlate with the currency-adjusted component of fund returns (Column (6)). This is consistent with what we find in full-sample performance analysis that the performance difference induced by fund currency forward positions is driven by currency returns.

D. Calendar-time portfolio analyses

We conduct calendar-time portfolio analyses to examine the performance of funds with low- and high-exposure to foreign currencies. Each quarter, we sort all sample funds into quintile portfolios based on their foreign currency exposure measured at the previous quarter-end. We then hold each quintile portfolio for the next three months before rebalancing. We also consider a long-short portfolio that buys funds with the lowest foreign currency exposures and sells funds with the highest foreign exposures. The time-series returns of this long-short strategy, as well as Portfolios 1 to 5, are presented in Table IX. We consider raw returns, currency returns, currency-adjusted returns, and risk-adjusted returns (α) from Models 1 and 2. Panel A shows value-weighted and Panel B shows equal-weighted results.

Panel A shows that funds with the lowest exposures to foreign currencies tend to have a higher return than funds with the highest exposures to foreign currencies. In terms of raw returns, the difference between Portfolios 1 and 5 is 26.5 basis points per month and is significant at the 10% level. When we decompose raw returns into the currency and currency-adjusted components, we do not find a statistically significant difference. When we use factor models, the abnormal return of Portfolio 1 is positive and significant while the abnormal return of Portfolio 5 is negative and significant. The long-short portfolio thus generates an alpha of between 25.8 and 40.7 basis points per month, depending on the factor model. The differences in the alphas are again not significantly different using currency-adjusted returns.

The equal-weighted results in Panel B are similar to the value-weighted results. Portfolio returns tend to decrease with fund exposures to foreign currencies, though the difference is insignificant if we measure performance by currency-adjusted returns.

In the Appendix (Table A4), we further conduct sequential double sorting on a fund's foreign currency exposure and its sale of currency forwards. The results presented suggest that, controlling for a foreign currency exposure of a fund, whether a fund achieves such currency exposure through underlying asset denominations or currency forward positions does not significantly affect fund risk-adjusted return. This indicates that the trading costs associated with these currency forward positions are relatively small.

The findings in the section provide suggestive evidence that funds that hedge their foreign currency exposure provide at least equal performance as compared to unhedged funds.

VI. Conclusions

We show that the risk properties of international fixed income funds are substantially altered by the use of currency forward contracts. Whereas some funds reduce their currency risk exposure using forward contracts, other funds increase their currency exposures using forwards. We find that funds' use of currency forwards depends on risk management considerations, return-enhancement motives, and fund clienteles. Furthermore, mutual funds also increase their hedging using forward contracts after experiencing poor performance. The currency hedging also varies over time and across different currencies as mutual funds follow carry trade, currency momentum, and risk timing strategies. Funds that hedge their currency risk exhibit lower return variability, but do not generate inferior risk-adjusted performance.

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Figure 1: Example of mutual fund currency forward disclosure

This figure shows a partial list of the currency forward contracts of JPMorgan Emerging Markets Debt Fund, disclosed in its N-Q filing as of May 31, 2018.

JPMorgan Emerging Markets Debt Fund

SCHEDULE OF PORTFOLIO INVESTMENTS

AS OF MAY 31, 2018 (Unaudited) (continued)

(Amounts in U.S. Dollars, unless otherwise noted)

Forward foreign currency exchange contracts outstanding as of May 31, 2018 (amounts in thousands):

Currency Purchased		Currency Sold		Counterparty	Settlement Date	Unrealized Appreciation (Depreciation) ($)
AUD	1,401	USD	1,058	Goldman Sachs International	6/19/2018	2
CNH	44,623	USD	6,946	Goldman Sachs International**	6/19/2018	10
COP	21,171,857	USD	7,204	Goldman Sachs International**	6/19/2018	116
EUR	6,518	PLN	28,121	Barclays Bank plc	6/19/2018	15
INR	76,340	USD	1,118	Goldman Sachs International**	6/19/2018	12
USD	8,947	AUD	11,472	Australia & New Zealand Banking Group Ltd.	6/19/2018	271
USD	8,709	CAD	11,232	Credit Suisse International	6/19/2018	42
USD	7,914	CNH	50,441	Goldman Sachs International**	6/19/2018	52
USD	790	CNH	5,032	HSBC Bank, NA**	6/19/2018	6
USD	930	CNH	5,847	Royal Bank of Canada**	6/19/2018	19
USD	8,435	COP	23,317,854	Credit Suisse International**	6/19/2018	373
USD	8,913	COP	25,678,768	Goldman Sachs International**	6/19/2018	34
USD	9,084	CZK	185,532	HSBC Bank, NA	6/19/2018	677
USD	906	CZK	19,261	Societe Generale	6/19/2018	33
USD	24,823	EUR	20,540	Credit Suisse International	6/19/2018	783
USD	7,290	EUR	6,218	Goldman Sachs International	6/19/2018	13
USD	8,785	EUR	7,074	Royal Bank of Canada	6/19/2018	506
USD	8,902	HUF	2,223,902	Goldman Sachs International	6/19/2018	765
USD	8,943	INR	589,890	Merrill Lynch International**	6/19/2018	212
USD	7,929	INR	527,939	Standard Chartered Bank**	6/19/2018	115
USD	7,389	KRW	7,977,765	Goldman Sachs International**	6/19/2018	2
USD	9,171	KRW	9,764,729	Goldman Sachs International**	6/19/2018	130
USD	17,171	MXN	323,800	Credit Suisse International	6/19/2018	980
USD	8,521	PHP	446,245	Citibank, NA**	6/19/2018	46
USD	8,827	PHP	463,439	Merrill Lynch International**	6/19/2018	25
USD	8,817	PLN	29,995	HSBC Bank, NA	6/19/2018	696
USD	9,178	RON	34,748	HSBC Bank, NA	6/19/2018	466
USD	17,283	RUB	1,006,182	Credit Suisse International**	6/19/2018	1,183
USD	851	THB	26,761	HSBC Bank, NA	6/19/2018	14

Figure 2: Fund asset denominations and currency exposures

This figures show histograms of sample funds' (a) fractions of assets issued by foreign domiciled issuers, (b) fractions of assets denominated in non-U.S. dollar currencies, (c) net sales of foreign currency forwards scaled by TNA, and (d) net exposures to non-U.S. dollar currencies.

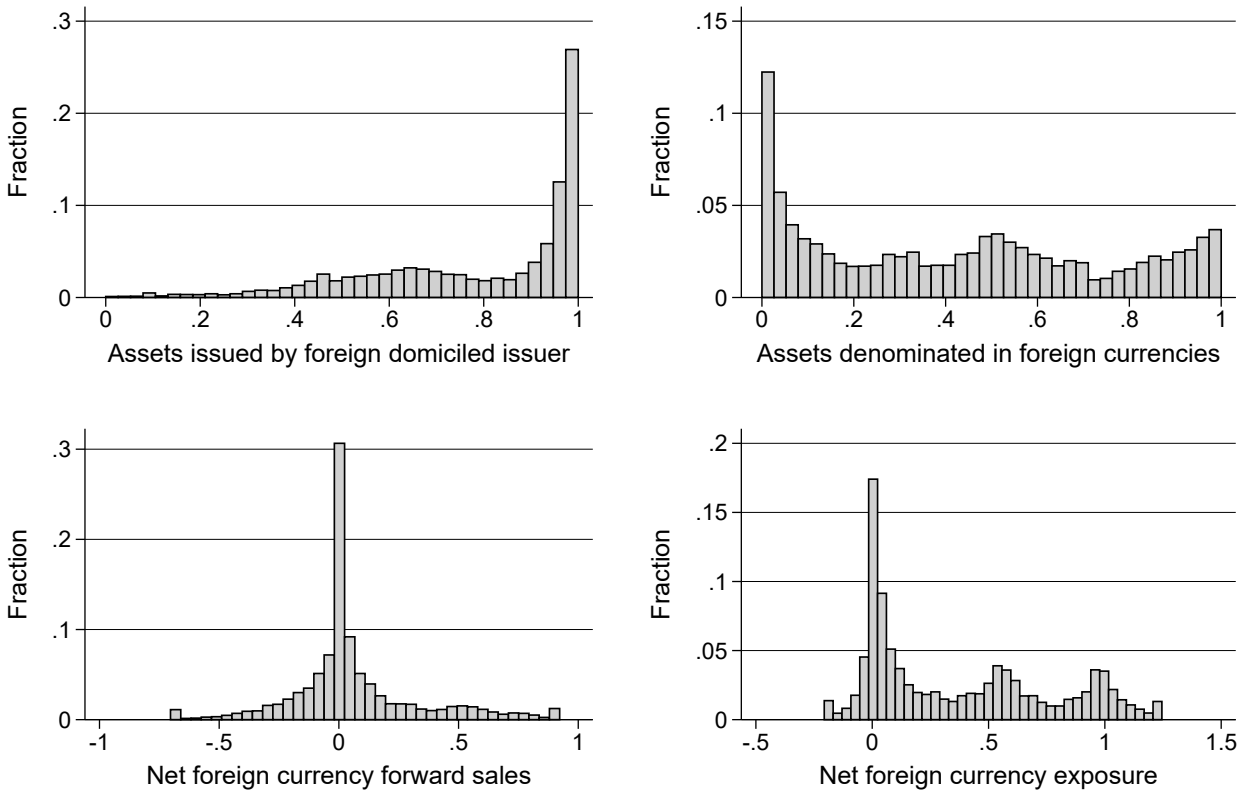


Figure 3: Portfolio asset currency denominations and net foreign currency exposures

This figure shows scatter plots of sample funds' portfolio weights of assets denominated in foreign currencies and the net exposure to foreign currencies taking into account forward contracts. Each circle represents a fund. The size of each circle corresponds to the TNA of each fund. For a given fund, the portfolio weight of assets denominated in foreign currencies and net foreign currency exposures are averaged across the sample periods. The 45-degree line represents cases where the portfolio net currency exposure is equal to the portfolio weight of assets denominated in non-U.S. dollar currencies.

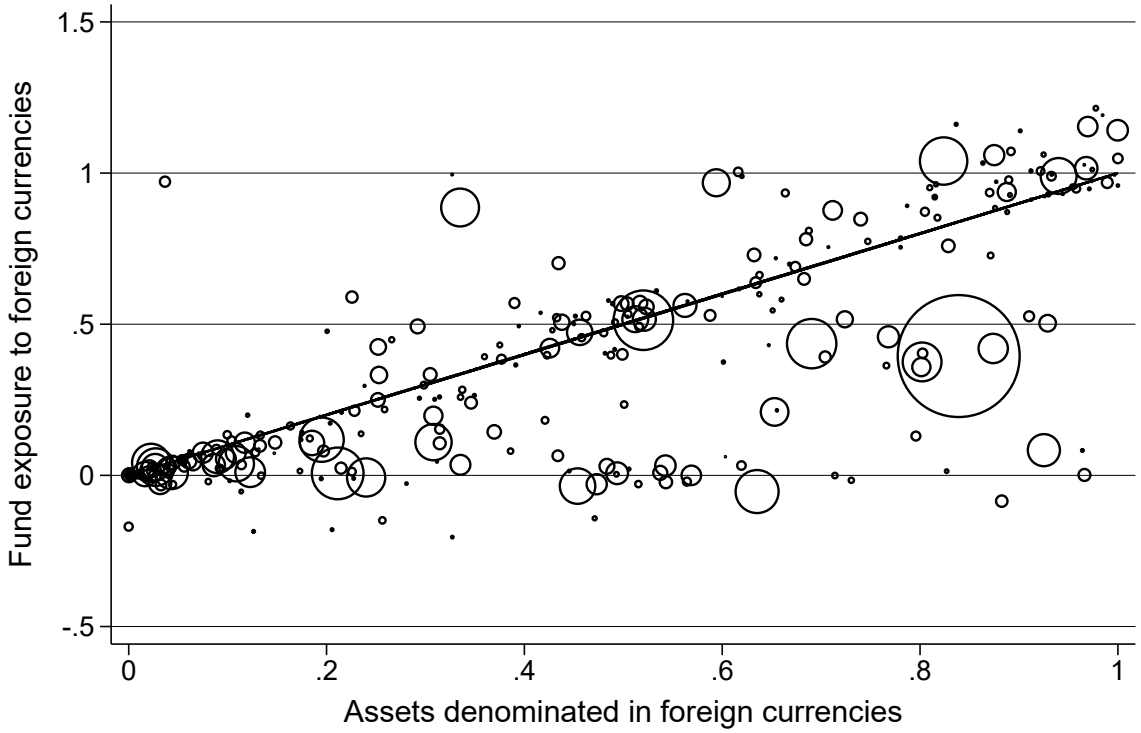


Figure 4: Time-series of fund aggregate currency forward use

This figure shows the time series of sample funds' (a) gross purchases, (b) gross sales, and (c) net sales of foreign currency forwards, scaled by total TNAs.

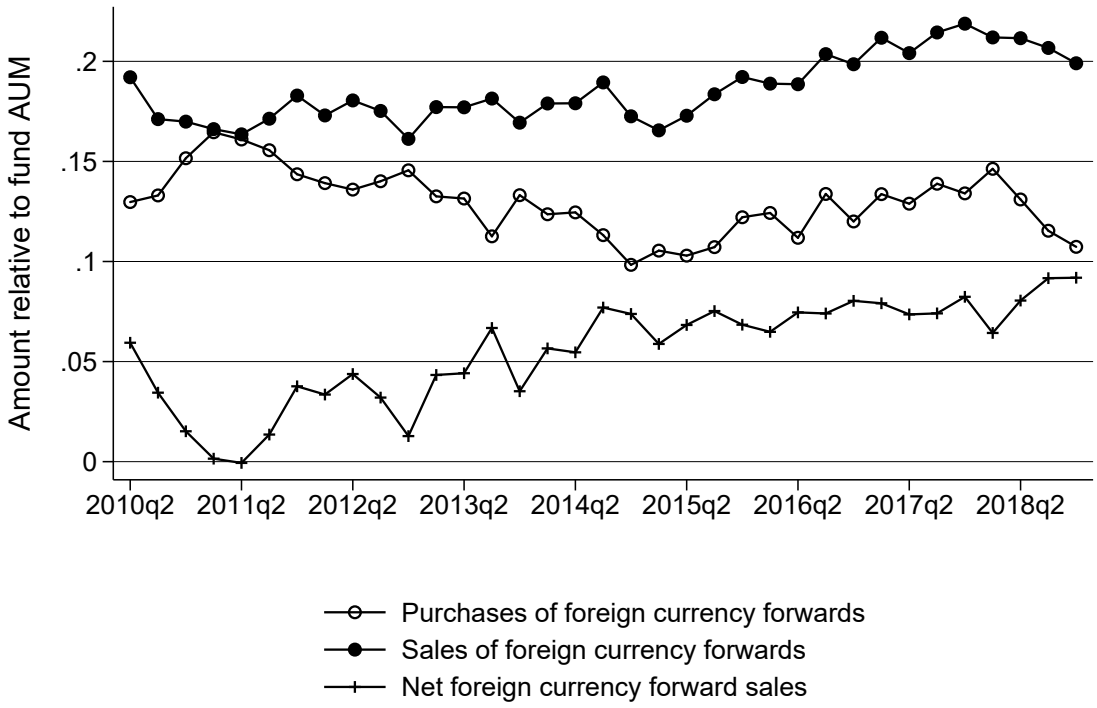
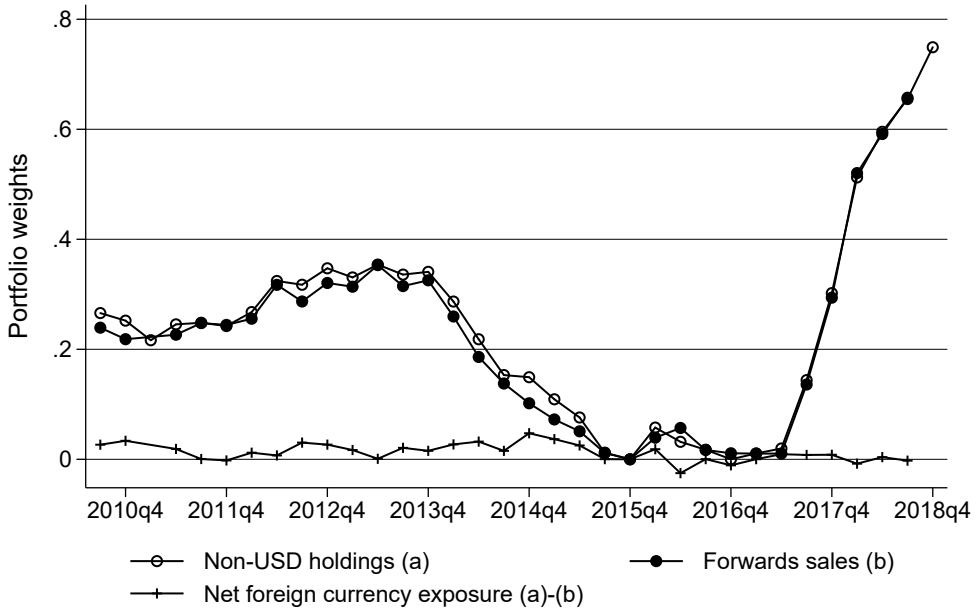
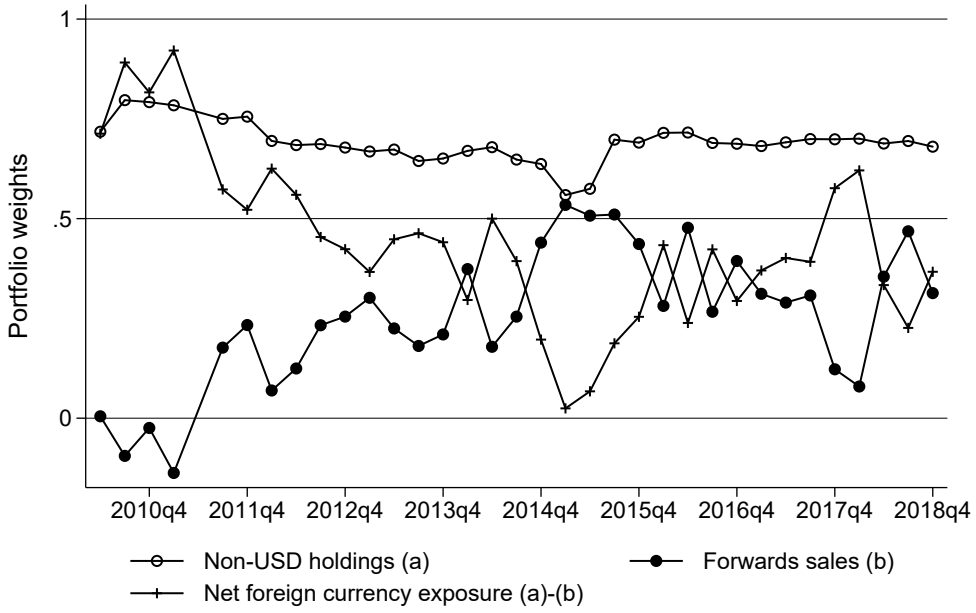


Figure 5: Examples of fund currency forward positions

This figures show the fractions of assets denominated in foreign currencies, the net currency forward sales, and the net exposures to foreign currencies of the DFA Five-Year Global Fixed Income Portfolio in Panel (a) and the Oppenheimer International Bond Fund in Panel (b).



(a) DFA Five-Year Global Fixed Income Portfolio



(b) Oppenheimer International Bond Fund

Figure 6: Mutual fund use of GBP currency forwards around the Brexit referendum

This figures show sample funds' hedge ratios, forward sales, and net exposures to GBP around quarters before and after the Brexit referendum on Jun 23, 2016. Quarter 0 corresponds to 2016Q2. Point estimates are plotted as squares alongside the 95% confidence intervals.

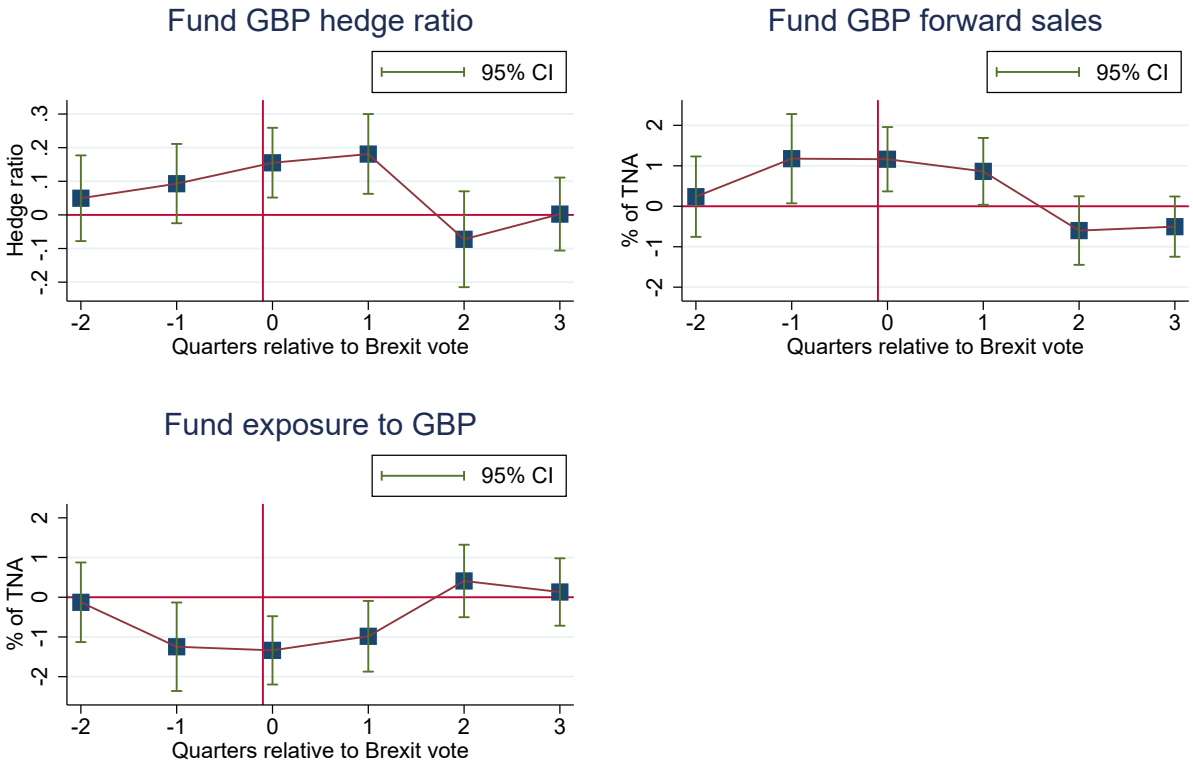


Table I: Sample of US-based global fixed income funds

This table shows the number of sample funds, their total assets under management (AUM) and the number of funds that use currency forwards in each of the sample years.

Year	# of funds	Total AUM ($ billion)	# of currency forward users	% of currency forward users
2010	126	188.04	116	92.1%
2011	158	228.33	141	89.2%
2012	184	288.53	163	88.6%
2013	208	273.95	183	88.0%
2014	226	271.75	200	88.5%
2015	224	235.72	196	87.5%
2016	236	225.24	212	89.8%
2017	229	224.85	207	90.4%
2018	227	225.09	203	89.4%

Table II: Summary Statistics

This table shows the summary statistics of sample currency forwards, sample fund–quarters, and time-series variables. The sample period is from 2010Q2 to 2018Q4.

Panel A: Forward contract-level statistics

	Obs.	Mean	Stdev	25th	50th	75th
$\mathbb{1}_{\text{USD as purchase currency}}$	476,622	0.484	0.499	0	0	1
$\mathbb{1}_{\text{USD as sale currency}}$	476,622	0.433	0.496	0	0	1
$\mathbb{1}_{\text{Involve two non-USD currencies}}$	476,622	0.083	0.275	0	0	1
Notional amount (in million USD)	476,622	11.8	33.6	0.343	1.27	5.44
Remaining Days to settlement (as of reporting date)	476,622	63.7	49.5	32.4	48.2	72.6

Panel B: Fund-quarter-level statistics

	Obs.	Mean	Stdev	25th	50th	75th
$\mathbb{1}_{\text{Have currency forwards}}$	6,457	0.868	0.338	1	1	1
Number of forward contracts	5,614	80.6	102.1	12	43	114
Number of counterparties	5,614	7.78	5.23	3	7	11
Percentage of assets issued by foreign-domiciled entities (%)	6,457	78.3	22.7	62.1	88.6	97.6
Percentage of assets denominated in foreign currencies (%)	6,457	42.8	32.4	10.5	42.6	68.4
Percentage of assets denominated in G10 currencies (%)	6,457	21.7	26.4	0.24	6.7	41.5
Percentage of assets denominated in other foreign currencies (%)	6,457	21.1	28.2	2.1	8.0	26.4
Net foreign currency forward sales scaled by assets (%)	6,457	6.83	30.0	-0.43	0.25	11.6
Gross foreign currency forward purchases scaled by assets (%)	6,457	13.1	16.9	0	5.23	21.4
Gross foreign currency forward sales scaled by assets (%)	6,457	19.9	24.7	2.00	9.85	27.3
Net foreign currency exposure scaled by assets (%)	6,457	37.1	39.3	1.9	23.9	66.1
Fund hedge ratio (*Hedge_ratio*) (%)	6,457	18.0	84.1	-9.76	2.35	69.8
Portfolio foreign currency concentration (HHI)	6,457	0.286	0.230	0.121	0.232	0.360
$\mathbb{1}_{\text{Currency-hedged benchmark}}$	6,457	0.102	0.303	0	0	0
Fund characteristics						
Total Net Assets (in million USD)	6,457	1,237	4,343	47.3	232	800
Fund family TNA (in million USD)	6,457	6,684	12,443	292	1,233	7,934
Quarterly raw return (%)	6,449	0.64	3.37	-1.05	0.87	2.61
Previous 12-month style-adjusted return (%)	6,449	-0.00	3.81	-2.28	-0.01	2.34
Quarterly fund flow (%)	6,306	2.32	17.3	-3.78	-0.09	4.35
Fund age (# of years)	6,457	10.3	8.6	3	7	18
Expense ratio (%)	6,457	0.90	0.31	0.76	0.94	1.11
Turnover ratio (%)	6,457	105.6	84.5	52	90	122
Portfolio weight of corporate bonds (%)	6,457	46.8	21.7	32.6	44.1	70.7
Weighted average maturity (# of years)	6,457	8.61	3.54	6.78	8.98	10.86
Fraction of assets in institutional shares	6,457	0.53	0.42	0	0.64	0.97

Panel C: Time-series statistics

	Obs.	Mean	Stdev	25th	50th	75th
Average foreign currency quarterly excess return (%)	35	-0.16	2.90	-2.25	0.55	2.02
Average G10 - U.S. 3-month interest rate differential (%)	35	0.13	0.98	-0.58	0.49	0.84
World Uncertainty Index (WUI)	35	21.7	4.4	18.6	21.9	23.6

Table III: Cross-sectional determinants of fund use of currency forwards

This table shows the cross-sectional determinants of sample funds' use of currency forwards. In column (1), the dependent variable is an indicator for a non-zero amount of currency forwards. In columns (2), (3), and (4), the dependent variables are the net currency forward sales, the gross forward sales, and the gross forward purchases, respectively. In column (5), the dependent variable is a fund's hedge ratio with respect to all foreign currencies. Specification (1) uses a logistic model, while the rest of the specifications use OLS. All specifications include time fixed effects. Standard errors are clustered at the fund level and are shown in parentheses. ***, **, and * represent result significant at 1%, 5%, and 10% level, respectively.

Model	Logit	OLS			
Dependent variable	$\mathbb{1}_{\text{Forwards}}$	$Forward^{net}$	$Forward^{sale}$	$Forward^{buy}$	$Hedge\_ratio$
	(1)	(2)	(3)	(4)	(5)
Assets denominated in G10 currencies	0.0273***	0.275***	0.355***	0.0900***	0.270*
	(0.010)	(0.072)	(0.056)	(0.032)	(0.163)
Assets denominated in other foreign currencies	0.0243**	0.0445	0.260***	0.221***	-0.0207
	(0.010)	(0.059)	(0.056)	(0.031)	(0.126)
Portfolio currency concentration	0.0464	7.248**	4.968*	-2.140	43.02**
	(0.501)	(3.441)	(2.634)	(2.270)	(20.381)
Portfolio weight of corporate bonds	-0.00942	0.0454	-0.0315	-0.0737***	0.259
	(0.007)	(0.050)	(0.041)	(0.028)	(0.165)
Log(Fund TNA)	-0.0481	0.623	0.159	-0.443	1.068
	(0.086)	(0.899)	(0.678)	(0.512)	(2.138)
Log(Fund family TNA)	0.192***	0.561	0.655	0.111	2.755
	(0.066)	(0.752)	(0.565)	(0.433)	(1.693)
Fund age	0.0578**	0.167	0.332**	0.164	0.138
	(0.024)	(0.231)	(0.164)	(0.131)	(0.693)
Expense ratio	-0.439	-10.73**	-8.449*	1.888	-26.38**
	(0.558)	(4.864)	(4.461)	(2.026)	(10.363)
Turnover ratio	0.00540**	0.00405	0.0251**	0.0211*	-0.00737
	(0.002)	(0.019)	(0.012)	(0.011)	(0.051)
Fraction of assets in institutional shares	0.336	-6.776**	-2.806	3.626*	-17.29*
	(0.357)	(3.322)	(2.562)	(1.987)	(9.305)
Observations	6457	6457	6457	6457	6457
Adjusted R^2	0.179	0.126	0.264	0.213	0.076
Time FE	Y	Y	Y	Y	Y

Table IV: Time-series determinants of fund use of currency forwards

This table shows the relationship between a fund's use of currency forwards and (a) the average foreign currency return relative to the U.S. dollar, (b) the average interest rate difference between G10 countries and the US, and (c) the World Uncertainty Index constructed by Ahir, Bloom, and Furceri (2018). The outcome variables are a fund's hedge ratio to all foreign currencies, its net currency forward sales (relative to the TNA), its portfolio weight of foreign currency-denominated assets, and its total exposure to foreign currencies. Average foreign currency returns and three-month interest rate differentials are measured at quarter $t-1$, while the outcome variables are measured at quarter t. All specifications include time fixed effects. Standard errors are double-clustered at the fund level and the time level, and are shown in parentheses. ***, **, and * represent result significant at 1%, 5%, and 10% level, respectively.

Dependent variable	$Hedge\_ratio$	$Forward^{net}$	$\omega^{foreign}$	$Exp^{foreign}$
	(1)	(2)	(3)	(4)
Average foreign currency excess return	-1.135**	-0.257**	0.0136	0.240**
	(0.551)	(0.118)	(0.044)	(0.112)
Average G10-US interest rate differential	-9.123*	-2.707**	2.934***	4.617***
	(4.699)	(1.174)	(0.751)	(1.151)
World Uncertainty Index	1.394***	0.221***	-0.0909**	-0.277***
	(0.347)	(0.064)	(0.041)	(0.069)
Assets denominated in G10 currencies	1.066***	0.399***		
	(0.294)	(0.102)		
Assets denominated in other foreign currencies	0.620**	0.473***		
	(0.281)	(0.131)		
Portfolio currency concentration	32.79*	6.046***		
	(16.560)	(1.952)		
Portfolio weight of corporate bonds	0.283*	0.0934*	-0.286***	-0.258***
	(0.152)	(0.052)	(0.052)	(0.065)
Log(Fund TNA)	0.563	-0.673	-0.206	0.532
	(1.266)	(0.479)	(0.308)	(0.498)
Log(Fund family TNA)	-1.457	-0.794*	0.510	1.130**
	(1.155)	(0.469)	(0.317)	(0.489)
Fund age	0.849	0.0804	0.114	0.00472
	(1.699)	(0.387)	(0.248)	(0.390)
Turnover ratio	0.0555	0.0107	-0.000851	-0.00972
	(0.044)	(0.013)	(0.008)	(0.014)
Observations	6457	6457	6457	6457
Adjusted R^2	0.518	0.764	0.934	0.878
Fund FE	Y	Y	Y	Y

Table V: Within-fund, between-currency determinants of hedging strategies

This table examines the determinants of a fund's hedging with regard to a specific currency. The observations are at the fund–quarter–currency level. Columns (1) and (2) use the full sample of fund–quarter–currency observations where a fund–quarter has a nonzero amount of assets denominated in the given currency. Columns (3) and (4) restrict the sample to G10 currencies. Currency return volatility is the standard deviation of monthly currency returns in the past 12 months. The country-specific World Uncertainty Index is from Ahir, Bloom, and Furceri (2018). All specifications include fund-by-quarter fixed effects. Standard errors are clustered at the fund-currency pair level, and are shown in parentheses. ***, **, and * represent result significant at 1%, 5%, and 10% level, respectively.

Sample	All currencies		G10 currencies	
Dependent variable	$Hedge\_ratio_c$	$Forward_c$	$Hedge\_ratio_c$	$Forward_c$
	(1)	(2)	(3)	(4)
Currency return relative to USD last quarter	-0.169***	-0.00675*	-0.219*	-0.00892
	(0.057)	(0.004)	(0.114)	(0.012)
Three-month Interest rate differential relative to US	-0.644**	-0.117***	-1.191	-0.382**
	(0.268)	(0.031)	(2.050)	(0.153)
Currency daily return volatility last quarter	0.616***	0.0488***	0.610***	0.153***
	(0.147)	(0.013)	(0.179)	(0.055)
Country-specific World Uncertainty Index	11.95***	0.362**	7.243**	1.306***
	(1.745)	(0.152)	(3.030)	(0.415)
Currency forward market bid-ask spread	-0.101**	-0.0115**	-0.810*	-0.111*
	(0.041)	(0.005)	(0.492)	(0.061)
Portfolio weight of assets denominated in this currency	0.594***	0.285***	1.024***	0.338***
	(0.092)	(0.026)	(0.175)	(0.029)
Observations	50009	50009	20078	20078
Adjusted R^2	0.260	0.257	0.392	0.327
Fund-by-Quarter FE	Y	Y	Y	Y

Table VI: Fund use of currency forwards and past performance

This table shows the relationship between a fund's past performance and its use of currency forwards. The performance measure is a fund's return in the 12 months preceding quarter t in excess of the average return of all funds in the same Lipper investment style during the same period. The outcome variables are measured in quarter t. All specifications include time fixed effects and fund fixed effects. Standard errors are clustered at the fund level and are shown in parentheses. ***, **, and * represent result significant at 1%, 5%, and 10% level, respectively.

Dependent variable	$FundFlow$	$Forward^{net}$	$Forward^{sale}$	$Forward^{buy}$	$Exp^{foreign}$
	(1)	(2)	(3)	(4)	(5)
Min(0, 12-month style-adj return)	0.734***	-0.542***	-0.460***	0.000549	0.378**
	(0.144)	(0.150)	(0.120)	(0.105)	(0.151)
Max(0, 12-month style-adj return)	0.140	-0.130	0.160*	0.260***	0.103
	(0.126)	(0.133)	(0.096)	(0.085)	(0.133)
Assets denominated in G10 currencies	-0.0253	0.392***	0.256***	-0.148**	
	(0.036)	(0.096)	(0.081)	(0.057)	
Assets denominated in other foreign currencies	0.0185	0.465***	0.387***	-0.0466	
	(0.034)	(0.128)	(0.107)	(0.052)	
Portfolio currency concentration	0.444	6.271***	3.208**	-2.547**	
	(1.883)	(1.924)	(1.324)	(1.079)	
Portfolio weight of corporate bonds	0.0418	0.133**	0.0923**	-0.0414	-0.327***
	(0.033)	(0.061)	(0.047)	(0.029)	(0.071)
Log(Fund TNA)	1.230**	-0.885*	-0.552	0.343	0.838*
	(0.565)	(0.497)	(0.389)	(0.349)	(0.500)
Log(Fund family TNA)	-0.117	-0.278	-0.587	-0.440	0.191
	(0.430)	(0.567)	(0.437)	(0.373)	(0.555)
Fund age	0.190	-1.332***	-1.074***	0.227	1.212**
	(0.416)	(0.512)	(0.254)	(0.334)	(0.478)
Expense ratio	-4.315*	-6.654*	-2.316	4.289*	10.97***
	(2.247)	(3.627)	(2.782)	(2.289)	(3.528)
Turnover ratio	-0.00752	0.0129	0.0103	-0.00148	-0.0155
	(0.006)	(0.013)	(0.013)	(0.007)	(0.015)
Observations	6457	6457	6457	6457	6457
Adjusted R^2	0.183	0.760	0.800	0.734	0.877
Fund FE	Y	Y	Y	Y	Y
Time FE	Y	Y	Y	Y	Y

Table VII: Full-period performance of sample funds

This table shows the performance metrics of funds sorted by their time-series average foreign currency exposure. Group 1 has the lowest foreign currency exposure and Group 5 has the highest foreign currency exposure. The currency return is calculated as $Ret_{i,t}^{Currency} = \sum_{c \neq USD} Exposure_{i,t-1}^{c} * r_{i,t}^{c}$. The currency-adjusted return is the difference between the raw and the currency return. Model 1 is a four-factor model that includes the unhedged global market bond return, the emerging market bond return, the term factor, and the credit factor. Model 2 is a six-factor model that includes the U.S. dollar-hedged global market bond return, the emerging market bond return, the term factor, the credit factor, the dollar risk factor, and the currency carry factor. The last column shows whether the difference between Groups 1 and 5 is statistically different from zero. The p-value is calculated from the empirically distribution of 1,000 simulations where sample funds are randomly assigned into five groups.

Quintile portfolios sorted by funds' time-series average foreign currency exposure							
	1 (Low)	2	3	4	5 (High)	Low - High	P(Low-High)
Average foreign currency exposure	-0.01	0.05	0.29	0.57	0.97	-0.98	(0.00)
Average monthly excess return (%)	0.263	0.296	0.168	0.106	0.037	0.225	(0.00)
Average standard deviation (%)	1.18	1.70	1.68	1.76	2.58	-1.40	(0.00)
Average annualized Sharpe Ratio	0.79	0.62	0.36	0.26	0.09	0.70	(0.00)
Value-at-risk of monthly return (5th percentile)	-1.73	-2.72	-2.79	-2.96	-4.57	2.84	(0.00)
Currency return (%)	-0.039	-0.056	-0.135	-0.191	-0.252	0.213	(0.00)
Currency-adjusted return (%)	0.341	0.386	0.338	0.330	0.313	0.028	(0.18)
α_1 (%)	0.075	0.026	-0.026	-0.076	-0.239	0.315	(0.00)
α_2 (%)	0.035	0.040	0.018	-0.047	-0.108	0.144	(0.00)
α_1 of currency-adjusted return (%)	0.125	0.209	0.153	0.110	0.099	0.026	(0.19)
α_2 of currency-adjusted return (%)	0.084	0.156	0.145	0.071	0.052	0.031	(0.18)
β_{FX} from Model 2	0.03	0.11	0.31	0.62	1.10	-1.1	(0.00)

Table VIII: Panel regression of fund performance on its currency forward sales

This table shows the panel regressions of fund performance on funds' sale of foreign currency forwards, controlling for fund characteristics. All independent variables are lagged for one quarter. All specifications include style-by-time fixed effects and fund fixed effects. Standard errors are shown in parentheses and are clustered at the fund level. ***, **, and * represent result significant at 1%, 5%, and 10% level, respectively.

Dependent variable	Net Return (%)	α^{Model1} (%)	α^{Model2} (%)	β^{FX}	Ret^{Cur}	Ret^{CurAdj}
	(1)	(2)	(3)	(4)	(5)	(6)
Net currency forward sales	0.212***	0.245***	0.0430*	-0.980***	0.184***	0.0272
	(0.032)	(0.031)	(0.025)	(0.050)	(0.037)	(0.037)
Assets denominated in foreign currencies	-0.291***	-0.261***	-0.0956***	0.977***	-0.368***	0.0769**
	(0.043)	(0.041)	(0.035)	(0.061)	(0.038)	(0.036)
Portfolio currency concentration	0.00802	0.0416	-0.0542	-0.0644	0.0783**	-0.0703*
	(0.046)	(0.040)	(0.034)	(0.060)	(0.037)	(0.040)
Portfolio weight of corporate bonds	0.00104**	0.000679*	0.000571	-0.0000296	0.00115***	-0.000116
	(0.001)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
Log(Fund TNA)	-0.000153	0.00150	0.00571	-0.000249	0.00266	-0.00282
	(0.005)	(0.005)	(0.005)	(0.006)	(0.005)	(0.005)
Log(Fund family TNA)	0.00864**	0.00672*	0.00493	0.00236	-0.00103	0.00968**
	(0.004)	(0.004)	(0.004)	(0.005)	(0.003)	(0.004)
Fund age	-0.00104	-0.00125	-0.00388***	0.00338**	0.000817	-0.00186
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Expense ratio	-0.0400	-0.0674**	-0.0513*	0.0796*	-0.0305	-0.00947
	(0.034)	(0.029)	(0.027)	(0.043)	(0.026)	(0.033)
Turnover ratio	0.00719	0.0140*	-0.00624	0.0107	0.000409	0.00678
	(0.008)	(0.007)	(0.009)	(0.011)	(0.007)	(0.008)
Institutional shares	-0.00702	-0.00750	-0.00353	0.00802	-0.00952	0.00250
	(0.021)	(0.021)	(0.021)	(0.030)	(0.019)	(0.021)
Observations	17853	16943	16943	17073	17853	17853
Adjusted R^2	0.730	0.275	0.193	0.704	0.452	0.609
Style-by-time fixed effects	Y	Y	Y	Y	Y	Y

Table IX: Calendar-time performance of portfolios sorted by foreign currency exposure

This table shows the calendar-time returns for portfolios sorted by a fund's foreign currency exposure. Each quarter, sample funds are sorted into five portfolios based on their total foreign currency exposure from the previous quarter-end. Funds in Portfolio 1 have the lowest currency exposure and funds in Portfolio 5 have the highest currency exposure. The currency return is calculated as $Ret_{i,t}^{Currency} = \sum_{c \neq USD} Exposure_{i,t-1}^{c} * r_{i,t}^{c}$. The currency-adjusted return is the difference between the raw and the currency return. Model 1 is a four-factor model that includes the unhedged global market bond return, the emerging market bond return, the term factor, and the credit factor. Model 2 is a six-factor model that includes the U.S. dollar-hedged global market bond return, the emerging market bond return, the term factor, the credit factor, the dollar risk factor, and the currency carry factor. Standard errors are shown in parentheses. ***, **, and * represent result significant at 1%, 5%, and 10% level, respectively.

Panel A: Value-weighted portfolios

	Portfolio 1	Portfolio 2	Portfolio 3	Portfolio 4	Portfolio 5	1-minus-5
	(1)	(2)	(3)	(4)	(5)	(6)
Raw return	0.353***	0.314**	0.235*	0.220	0.0880	0.265*
	(0.095)	(0.151)	(0.135)	(0.188)	(0.259)	(0.149)
Currency return	-0.00978	-0.0471	-0.137	-0.112	-0.230	0.220
	(0.016)	(0.032)	(0.091)	(0.154)	(0.220)	(0.221)
Currency-adjusted return	0.362***	0.361***	0.371***	0.331***	0.318***	0.0437
	(0.099)	(0.135)	(0.082)	(0.067)	(0.078)	(0.078)
α_1	0.112***	-0.00655	-0.0201	-0.0742	-0.294***	0.407***
	(0.030)	(0.049)	(0.066)	(0.086)	(0.095)	(0.093)
α_2	0.0698**	-0.00358	0.00645	-0.101	-0.188***	0.258***
	(0.029)	(0.048)	(0.059)	(0.075)	(0.069)	(0.067)
α_1 of currency-adj return	0.122***	0.213***	0.178***	0.203***	0.647	0.0571
	(0.029)	(0.042)	(0.048)	(0.051)	(0.047)	(0.046)
α_2 of currency-adj return	0.0961***	0.152***	0.148***	0.126*	0.0505	0.0456
	(0.029)	(0.044)	(0.052)	(0.053)	(0.050)	(0.051)

Panel B: Equal-weighted portfolios

	Portfolio 1	Portfolio 2	Portfolio 3	Portfolio 4	Portfolio 5	1-minus-5
	(1)	(2)	(3)	(4)	(5)	(6)
Raw return	0.342***	0.352**	0.267*	0.200	0.110	0.232*
	(0.111)	(0.148)	(0.147)	(0.166)	(0.244)	(0.138)
Currency return	-0.0143	-0.0319*	-0.0996	-0.124	-0.206	0.192
	(0.015)	(0.017)	(0.072)	(0.131)	(0.213)	(0.204)
Currency-adjusted return	0.357***	0.384***	0.366***	0.324***	0.316***	0.0411
	(0.115)	(0.136)	(0.093)	(0.070)	(0.074)	(0.072)
α_1	0.0727**	0.0261	-0.0300	-0.0799*	-0.248***	0.321***
	(0.030)	(0.036)	(0.046)	(0.044)	(0.088)	(0.085)
α_2	0.0394	0.0181	-0.00610	-0.0601	-0.158**	0.198***
	(0.030)	(0.037)	(0.041)	(0.038)	(0.063)	(0.062)
α_1 of currency-adj return	0.0570**	0.182***	0.0953***	0.109***	0.0426	0.0144
	(0.029)	(0.040)	(0.028)	(0.033)	(0.032)	(0.024)
α_2 of currency-adj return	0.0673**	0.145***	0.107***	0.0679**	0.0555	0.0118
	(0.029)	(0.039)	(0.030)	(0.030)	(0.034)	(0.027)

Internet Appendix

A. Persistence in forward contracts

The use of currency forwards for a given fund is fairly persistent over time. In a panel regression at the fund-quarter level (Panel A of Table A1), fund fixed effects explain 72.8% of the variation in funds' total foreign currency forward positions. When we examine individual funds' forward positions with respect to individual foreign currencies, fund fixed effects explain between 36.0% (Australian dollar) to 68.9% (Euro) of the variation. In contrast, quarter fixed effects explain relatively little variation in the use of currency forwards.

Similarly, a fund's lagged forward position in a given currency is a strong predictor for its use of currency forwards in the current quarter. Panel B of Table A1 shows that the coefficients on the lagged forward positions range between 0.74 (Mexican peso) to 0.91 (Japanese yen) across major currencies. The lagged forward position explains 80.0% of a fund's total foreign currency forward position. It shows that a fund's strategy involving currency forwards is highly persistent over time.

B. Funds use of currency forwards around Brexit

We assemble a sample of funds that hold at least two percent of their assets issued by UK-domiciled entities as of 2015Q2, four quarters before the Brexit vote. Within this set of funds, we conduct analyses at the fund–quarter–currency level that include all fund–currency pairs where one of the G10 currencies is held by the fund. We then employ fund-by-quarter fixed effects and fund-by-currency fixed effects to isolate the changes in a funds' pound hedging around the Brexit referendum as compared to the funds' general hedging policies.

The regression specification is as follows:

$$Y_{i,c,t} = \alpha_{i,t} + \delta_{i,c} + \beta_1 \mathbb{1}_{c=GBP} Brexit(t-2) + \beta_2 \mathbb{1}_{c=GBP} Brexit(t-1) + \beta_3 \mathbb{1}_{c=GBP} Brexit(t)$$
$$+ \beta_4 \mathbb{1}_{c=GBP} Brexit(t+1) + \beta_5 \mathbb{1}_{c=GBP} Brexit(t+2) + \beta_6 \mathbb{1}_{c=GBP} Brexit(t \geq 3) + \epsilon, \quad (20)$$

where i denotes funds, c denotes currencies, and t denotes quarters. The outcome variable $Y_{i,c,t}$ is either a fund's hedge ratio with respect to currency c, a fund's sale of currency c forwards ($forward^c$), or a fund's exposure to currency c.

Table A2 shows that funds' sales of British pound forwards increase significantly one quarter before the Brexit referendum. This heightened level of GBP forward sales persists until one quarter after the Brexit referendum (column (2)). Accordingly, when we use the currency-specific hedge ratio as the outcome variable, we similarly observe a spike in the GBP-specific hedge ratio for both the quarter of the Brexit referendum and the quarter after. Finally, the increase in GBP forward sales is not offset by changes in the portfolio asset denominations, as fund exposures to GBP are significantly lower from one quarter before the referendum to one quarter after (column (3)).

C. The sensitivity of fund returns to currency appreciation and depreciation

While only around 18% of sample funds deploy currency options, one might be concerned that those option positions significant affect sample funds' return sensitivity with respect to exchange rates. To ensure that we are not ignoring a significant aspect of funds' currency management strategies, we examine whether fund returns are symmetrically sensitive to currency appreciation and depreciation. To this end, we run the following factor regression on each fund's return series:

$$\begin{aligned} Return_{i,t} - rf_t = \alpha_i^{Model2} &+ \beta^{GlobalHedged}(GlobalMarket_t^{Hedged} - rf_t) \\ &+ \beta^{Emerging}(EmeMarket_t - rf_t) + \beta^{term}Term_t + \beta^{credit}Credit_t + \\ &+ \beta^{FX+}\max(RXMean_t, 0) + \beta^{FX-}\min(RXMean_t, 0) + \beta^{Carry}HML_t^{FX} + \epsilon_{i,t}. \end{aligned}$$

The key component is that we separately include foreign currency appreciation ($\max(RXMean_t, 0)$) and depreciation ($\min(RXMean_t, 0)$) as two factors. If currency options are an important component of fund currency management, one would expect that the coefficients β^{FX+} and β^{FX-} to be different from each other.

Table A3 shows that the sensitivities of fund returns are roughly the same for currency appreciation and depreciation. Across fund groups with different level of currency exposure, only 6 to 14% of funds have β^{FX+} and β^{FX-} that are significantly different from each other.

D. Calendar-time return of portfolios sorted by currency exposure

In Table A4, we examine the calendar-time factor risk-adjusted returns for portfolios double-sorted by a fund's foreign currency exposure and currency forward sales. Each quarter, sample funds are

first sorted into three portfolios based on their total foreign currency exposure from the previous quarter-end. Within each portfolio, funds are further sorted into three groups based on their sales of foreign currency forwards.The risk-adjusted return is α_i^{Model2} from the following model:

$$\begin{aligned} Return_{i,t} - rf_t = \alpha_i^{Model2} &+ \beta^{GlobalHedged}(GlobalMarket_t^{Hedged} - rf_t) \\ &+ \beta^{Emerging}(EmeMarket_t - rf_t) + \beta^{term}Term_t + \beta^{credit}Credit_t + \\ &+ \beta^{FX}RXMean_t + \beta^{Carry}HML_t^{FX} + \epsilon_{i,t}. \end{aligned} \tag{21}$$

The double-sorted portfolio results presented in Table A4 suggest that, controlling for a foreign currency exposure of a fund, whether a fund achieves such currency exposure through underlying asset denominations or currency forward positions does not affect fund risk-adjusted return significantly. This indicates that the trading costs associated with these currency forward positions are relatively small.

Table A1: Persistence of fund-level currency forward positions

This table shows the adjusted R-squared of panel regressions. In Panel A, the forwards of currency c sold by fund i at quarter t ($Forward^c_{i,t}$) is regressed on fund fixed-effects, time fixed-effects, or both. In Panel B, $Forward^c_{i,t}$ is regressed on its owned lagged variable, $Forward^c_{i,t-1}$.

Panel A: regress currency forward positions (scaled by TNA) on fixed effects			
	Adjusted R-squared with:		
Currency:	Fund fixed-effects only	Quarter fixed-effects only	Fund + quarter fixed-effects
All currencies	72.8%	0.21%	73.6%
EUR	68.9%	0.07%	69.3%
JPY	68.6%	1.52%	69.9%
GBP	66.3%	0.19%	66.9%
AUD	36.0%	0.26%	37.1%
CAD	46.4%	-0.08%	46.6%
MXN	37.7%	0.24%	38.4%

Panel B: regress currency forward positions on lagged forward positions (scaled by TNA)			
Currency :	Coefficient on lagged position	t-stat	Adjusted R-squared
All currencies	0.89	(63.37)	80.0%
EUR	0.89	(67.25)	78.3%
JPY	0.91	(54.60)	82.0%
GBP	0.82	(20.59)	68.3%
AUD	0.77	(24.40)	58.1%
CAD	0.74	(20.48)	55.8%
MXN	0.74	(27.05)	53.4%

Table A2: Use of GBP currency forwards around the Brexit referendum

This table examines sample funds' hedging activities regarding GBP around the Brexit referendum. The observations are at the fund–quarter–currency level. GBP is an indicator for positions involving GBP. All specifications include fund-by-quarter fixed-effects and fund-by-currency fixed-effects. Standard errors are clustered at the fund level, and standard errors are shown in parentheses. ***, **, and * represent result significant at 1%, 5%, and 10% level, respectively.

Dependent variable	$Hedge\_ratio$	$Forward^c$	$Exposure^c$
	(1)	(2)	(3)
GBP * Two quarters before Brexit	0.0496	0.237	-0.127
	(0.064)	(0.499)	(0.503)
GBP * One quarter before Brexit	0.0930	1.176**	-1.246**
	(0.059)	(0.554)	(0.559)
GBP * Quarter of Brexit	0.155***	1.163***	-1.337***
	(0.052)	(0.398)	(0.432)
GBP * One quarter after Brexit	0.181***	0.862**	-0.983**
	(0.059)	(0.414)	(0.446)
GBP * Two quarters after Brexit	-0.0726	-0.601	0.411
	(0.072)	(0.425)	(0.458)
GBP * Three quarters (and more) after Brexit	0.00242	-0.504	0.132
	(0.055)	(0.373)	(0.426)
Assets denominated in given foreign currency	0.0291***	0.699***	
	(0.005)	(0.065)	
Observations	13286	13286	13286
Adjusted R^2	0.576	0.770	0.828
Fund-by-Quarter FE	Y	Y	Y
Fund-by-Currency FE	Y	Y	Y

Table A3: The sensitivity of fund returns to currency appreciation vs. depreciation

This table shows the sensitivity of fund returns with respect to the appreciation of foreign currencies and the depreciation of foreign currencies. We estimate the equation

$$\begin{aligned} Return_{i,t} - rf_t = \alpha_i^{Model2} &+ \beta^{GlobalHedged}(GlobalMarket_t^{Hedged} - rf_t) \\ &+ \beta^{Emerging}(EmeMarket_t - rf_t) + \beta^{term} Term_t + \beta^{credit} Credit_t + \\ &+ \beta^{FX+} \max(RXMean_t, 0) + \beta^{FX-} \min(RXMean_t, 0) + \beta^{Carry} HML_t^{FX} + \epsilon_{i,t}. \end{aligned}$$

and report β^{FX+} and β^{FX-} for funds sorted into quintiles by their foreign currency exposure, as well as the full sample.

Quintile portfolios sorted by funds' time-series average foreign currency exposure						
	1 (Low)	2	3	4	5 (High)	Full sample
Average β^{FX+}	-0.00	0.15	0.34	0.63	1.09	0.44
Average β^{FX-}	-0.04	0.05	0.28	0.61	1.10	0.40
Average $\beta^{FX+} - \beta^{FX-}$	0.04	0.09	0.06	0.02	0.02	0.04
Fraction where $\beta^{FX+} - \beta^{FX-}$ is significant at 10% level	0.14	0.08	0.16	0.08	0.06	0.10

Table A4: Calendar-time portfolios sequentially sorted by foreign currency exposure and foreign currency forward sales

This table shows the calendar-time factor risk-adjusted returns for portfolios sorted by a fund's foreign currency exposure and currency forward sales. Each quarter, sample funds are first sorted into three portfolios based on their total foreign currency exposure from the previous quarter-end. Within each portfolio, funds are further sorted into three groups based on their sales of foreign currency forwards. t-statistics are shown in parentheses. ***, **, and * represent result significant at 1%, 5%, and 10% level, respectively.

Panel A: Equal-weighted returns

		Sorted on sale of foreign currency forwards			
		1 (Low)	2	3 (High)	High-minus-Low
Sorted by	1 (Low)	0.042	0.031	0.024	-0.018
by foreign		(1.09)	(0.705)	(0.845)	(0.436)
currency	2	-0.04	0.016	0.015	0.055
exposure		(-0.861)	(0.368)	(0.304)	(-0.906)
	3 (High)	-0.094	-0.167	-0.111	-0.017
		(-1.577)	(-3.051)	(-2.338)	(0.318)
	Low-minus-High	0.136	0.198	0.135	
		(2.054)	(2.762)	(2.925)	

Panel B: Value-weighted returns

		Sorted on sale of foreign currency forwards			
		1 (Low)	2	3 (High)	Low-minus-High
Sorted by	1 (Low)	0.001	-0.039	0.026	0.026
by foreign		(0.007)	(0.8)	(0.593)	(0.402)
currency	2	-0.044	-0.023	0.038	0.082
exposure		(0.829)	(0.417)	(0.432)	(0.818)
	3 (High)	-0.14	-0.143	-0.092	0.048
		(1.783)	(2.593)	(1.628)	(0.559)
	Low-minus-High	0.14	0.104	0.119	
		(1.477)	(1.526)	(1.694)	