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 over 90 percent of U.S. international fixed income funds use currency forwards to manage their foreign exchange exposure. Fund currency strategies differ substantially based on risk management demands related to the currency denominations, speculative demands such as currency momentum and carry trade, and incentives related to past performance and fund clienteles. Funds that hedge their currency risk exhibit lower return variability, but do not generate inferior risk-adjusted returns.

I. Introduction

Currency exchange rate fluctuations are an important contributor to the risk and return of international fixed income portfolios. Over the last three decades (1990 – 2019), the average USD 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] These differences in the risk-return profiles of currency-hedged and unhedged portfolios suggest that managing currency exposures is crucial for fixed-income portfolios. In this paper we investigate the determinants and the consequences of currency management strategies of international fixed income mutual funds.

Mutual funds that invest outside of the U.S. can manage their currency exposures by changing portfolio allocations or through the use of currency derivatives. In the first approach, a fund can choose between holding U.S. dollar denominated and holding local-currency denominated foreign securities. Maggiori, Neiman, and Schreger (2020) show that mutual funds prefer to hold securities denominated in home currencies, thus reducing their foreign currency exposure. Alternatively, funds may hold currency derivatives, which enable them to alter their currency exposures flexibly. However, there is a paucity of empirical evidence on mutual funds' use of currency derivatives, primarily due to data availability.[2]

Our paper fills this gap by documenting the prevalence of currency derivatives use and by analyzing the factors that determine funds' currency management policies. 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 port-

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

[2] Information on mutual funds' derivative positions is not available in commonly-used mutual fund holdings 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.

folio holdings. Our final sample contains 515,695 currency forward contracts used by 6,463 fund–quarters between 2010Q2 and 2018Q4. This novel dataset provides detailed snapshots of a fund's currency exposure and allows us to examine sample funds' currency management practices, especially through their use of currency forwards.

Currency forwards are the predominate 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 at least once.[3] 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 some 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. Whereas some funds use forwards to hedge their currency exposures from bond holdings, 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 exposure.

Theories suggest that bond funds' use of currency derivatives can be driven by risk management demands and speculative demands. For risk management, the key determinants of currency positions include 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.[4] For speculative currency demands, 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 currency forwards. By benchmarking the patterns in our data against these theoretical predictions, we are able to shed light

[3] A small fraction of sample funds also use currency options. We discuss this further in Section II.

[4] Solnik (1974) also shows that full currency hedging is optimal when currencies and equities are uncorrelated.

on the empirical relevance of international asset pricing theories.

Consistent with risk management demands, we find that funds' use of currency forwards is largely associated with 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. Furthermore, the use of currency forward hedges is positively associated with the concentration of foreign currencies, as measured by the Herfindahl–Hirschman index. This suggests that risk management is one of the primary drivers of funds' use of currency forwards.

In the time-series, the selling of foreign currency forwards intensifies when the economic uncertainty in foreign markets is heightened. As a case study, we examine how sample funds adjust their forward positions around the Brexit referendum. Compared with the hedging positions of other currencies within the same funds, funds' sales of British pound forwards increase significantly in the quarters before and after the referendum, when the uncertainty around future exchange rate risk is heightened.

With respect to the speculative demands of currency forwards, we posit that fund managers condition their forward positions on currency characteristics that have shown to predict future currency returns. For example, past currency returns have been shown to have momentum (e.g., Menkhoff, Sarno, Schmeling, and Schrimpf (2012b)) and to be related to the average interest differential between the foreign countries and the U.S. (Fama (1984) and Lustig, Roussanov, and Verdelhan (2014)).

Consistent with speculative demands, 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 dollar 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 hedge ratio across currencies but within a

fund. We find that funds tend to hedge more in currencies that have depreciated recently. Furthermore, the hedge ratio is negatively associated with country-specific interest rate. The results suggest that fund managers adjust their currency-specific hedging strategy to take advantage of the predictive power in past currency returns and interest rates.

We further examine two factors that might affect mutual fund managers' incentives of currency management. 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 affect 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.[5]

In the last part of our paper, we examine the performance implications of funds' currency management. Funds are sorted 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

[5]This argument derives from the Modigliani-Miller theorem that risk management is value-irrelevant in a frictionless environment as shareholders can hold well-diversified portfolios.

outperformance of low-currency-exposure funds is primarily driven by the currency returns. A calendar-time long-short portfolio that buys funds with the lowest currency exposures and sells funds with the highest currency exposures generates a six-factor monthly alpha of between 19.8 and 25.8 basis points, after taking into account global market bond returns, emerging market bond returns, the credit factor, the term factor, the dollar risk factor, and the carry factor. Our results suggest that currency-hedged funds provide at least a similar level of performance to unhedged funds while also substantially reducing portfolio risks.

This paper contributes to our understanding of 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 (e.g., Koski and Pontiff (1999), Deli and Varma (2002), Almazan, Brown, Carlson, and Chapman (2004), and Kaniel and Wang (2020)). 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 international fixed-income funds use currency forwards extensively to hedge or expand their exposure to certain currencies. Currency management has a significant impact on the funds' risk-adjusted performance. Our work is also related to Aragon, Li, and Qian (2019) and Jiang, Ou, and Zhu (2020), which 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.[6]

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 helps researchers to evaluate the empirical relevance of several international portfolio allocation theories that take into account currency trading. Consistent with Glen and Jorion (1993), we find that the inclusion of forward contracts improves the

[6]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.

performance of international bond portfolios.[7] Our findings complement the influential work of Maggiori et al. (2020), who focus on the currency denomination of international bond portfolios. Previously, most studies on international portfolio management assume that mutual funds do not hold a significant amount of 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 et al. (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. Theories 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)). 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)). The effect of hedging on firm value is inconclusive (Allayannis and Weston (2001), Jin and Jorion (2006)). 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.

[7] Perold and Schulman (1988) find that U.S. investors can fully hedge currency risks in their bond and equity portfolios in order to reduce volatility without sacrificing returns.

II. Data

We describe in this section the data sources, the sample selection, 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 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 quarterly SEC filings. 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: 89% of our sample funds employ currency forwards in at least one of their reporting quarters. Besides currency forward contracts, 14% of our sample funds also hold currency options. For those funds, the total notional amount of currency options is typically 20 to 30 percent of the total notional amount they hold from currency forwards. We therefore focus our data collection effort on currency forwards.[8]

Although the format of reporting for currency forward positions varies across funds, most funds include information on the following items for each of their currency forward contracts: (1) the currency purchased, (2) the purchase amount (typically denominated in the purchase currency), (3) the currency sold, (4) the sale amount (typically 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 a snapshot of this disclosure from JPMorgan Emerging Markets Debt

[8] In the Appendix, we further show that sample funds' returns have a similar beta on positive currency returns and negative currency returns, further suggesting that the impact of currency options is limited.

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.

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

[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 small fraction of our sample, 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).

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 of "TX" (Taxable Fixed Income Funds) and manually select funds that focus on international fixed income securities. The initial sample contains 457 distinct funds (identified by distinct *crsp_cl_grp*) 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 USD-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 USD-equivalent. 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 USD 8,711,028 (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 USD-equivalent notional amount of each non-USD 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 USD7,617,151 (28,121,000/3.6918), assuming that the USD/EUR spot rate is 0.8572 and the USD/PLN spot rate is 3.6918 at 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:

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

[12] As this example shows, the report-date USD-equivalent notional amount for the two legs of a forward contract can be slightly different due to foreign currency changes since the contracts were entered into.

The $Forward$ is normalized by the fund's total net assets (TNA). This measure is positive if a fund sells foreign currency 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-USD 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-USD denominated holdings. This measure is defined as the ratio between a fund's net foreign currency forwards and its portfolio weight denominated in non-USD 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:

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

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 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 515,695 currency forward contracts used in 6,463 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, 44.8% of forward contracts purchase USD and sell a foreign currency, while 40.0% sell USD and purchase a foreign currency. The rest (15.1%) involve two non-USD foreign currencies. The average (median) notional amount of a currency forward is $10.7 million ($1.23 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 67.2 (46) days. This relative short average maturity of forward contracts used by sample funds may reflect the fact that currency forwards are more liquid at the short-end. It suggests that mutual funds need to frequently roll-over their forward contracts if they want to maintain a stable currency hedge.[14]

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 75.9 (42). 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%) relative to fund TNAs.

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 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

[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.

scaled by total assets. The distribution is roughly centered around zero and there is a similar number of fund-quarters with positive and negative foreign currency forward sales. It is somewhat surprising that a nontrivial set of fund-quarters purchase foreign currency forwards and thereby increase their foreign currency exposure. This suggests that some funds' purposes of utilizing forward contracts is not to hedge 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 3a displays a scatter plot of sample funds' portfolio weight in foreign currency-denominated assets against their net portfolio exposure to foreign currencies. Consistent with industry conventions, we further categorize sample funds into four groups: (i) "International Funds" that hold mainly ex-U.S. assets, (ii) "Global Funds" that hold a wider global portfolios including U.S.-issued bonds, (iii) "Emerging Markets Funds" that hold mainly bonds issued by emerging market countries, and (iv) all other funds.[16]

The scatter plot in Panel (a) shows that 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. At the same time, there are also a large number of funds that do not hedge their foreign currency exposures on average. These funds locate on the 45-degree line, where a fund's portfolio weight of foreign-denominated assets equals its

[16]We categorize sample funds using their Lipper Objective Code: Funds with a code of "GLI", "GB", or "GUS" are categorized as global funds (118 funds); Funds with a code of "INI" are categorized as international funds (51 funds); Funds with a code of "EMD" or "EML" are categorized as emerging markets funds (113 funds). All other funds are categorized as "other funds" (20 funds). The median fund in each of the first three categories holds 8.9%, 39.2% and 5.2% of its portfolio in assets issued by US-domiciled issuers.

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.

The relatively wide distribution of funds' net foreign currency exposures given the level of their portfolio weights of foreign-denominated assets suggests that it is important to consider funds' use of currency forwards when we investigate their currency strategies. In fact, based on the R-squared from a simple regression of a fund's time-series average foreign currency exposure on its average portfolio weight of foreign currency-denominated assets, only 59% of the variation in net currency exposure is explained by asset currency denominations.

Figure 3b shows the pattern with funds' euro-denominated assets and net euro exposures. Almost all sample funds have lower exposures to euros relative to their portfolio weights of euro-denominated assets, indicating that they on average sell euros on the currency forward market. Moreover, a significant subset of funds have negative net exposure to the euro, suggesting that they use euro forwards to bet against the euro or to use euros to hedge other highly-correlated currencies.

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.

B. Persistence in forward contracts

The use of currency forwards for a given fund are fairly persistent over time. In a panel regression at the fund-quarter level (Panel A of Table III), fund fixed effects explain 72.8% of the variation in funds' total foreign currency forward positions (scaled by contemporaneous fund TNA). 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 very 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 III 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.

C. Examples

To examine the accuracy of our data and 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 Global Bond Portfolio. Based on its disclosures, the DFA Global Bond Portfolio explicitly commits to fully-hedged currency strategies.[17] Examining our measure of currency forwards and currency exposure for this fund provides a sanity check for the validity of our empirical measures. Figure 5a displays (i) the portfolio weight of securities denominated in foreign currencies, (ii) the net sale amount of currency forwards scaled by TNA, and (iii) the total foreign currency exposure of this fund. The figure shows that our data capture the currency hedging strategy of the DFA Global Bond 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, which is our second example. Figure 5b shows that, while the fraction

[17] Its annual report states: "The Global Bond 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."

of non-USD denominated 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 during our sample period. This is consistent with the fund's "active" management of foreign currency exposure, as stated in its prospectus.[18]

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 have speculative demands for currency forwards if fund managers have certain expectations about future currency returns. 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)), carry trades (e.g., Menkhoff, Sarno, Schmeling, and Schrimpf (2012a) and Lustig et al. (2014)), 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 et al. (1996).

[18] From its prospectus, the Oppenheimer International Bond Fund 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."

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.

In the remainder of this section we discuss both the cross-sectional and time-series determinants of the use of currency forward contracts by international bond funds.

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 deployment, 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 IV shows that funds with more assets denominated in non-U.S. dollar currencies (either 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.

Turning our attention from the extensive margin of hedging to the intensive margin, 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), Table IV displays the determinants of fund net forward sales. For each dollar increase in the portfolio assets denominated in G10 currencies, a fund sells 26.9 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. For funds that have a diversified portfolio currency denomination, currency hedging is less of a concern.

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 typically able to access currency derivatives themselves.

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

"speculation" purposes. For each dollar of portfolio assets denominated in G10 (developed markets) currencies, an average fund sells 35.0 cents of forwards in those currencies and purchases 9.1 cents of forwards. For each dollar of assets in non-G10 currencies, however, the amounts of currency sales and purchases are similar. 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.[19]

Column (5) examines funds' use of currency forwards using the the hedge ratio. The portfolio weight of foreign currency-denominated assets is uncorrelated with funds' hedge ratio, as the hedge ratio is already normalized by the currency denomination of the portfolio. A higher asset concentration of foreign currencies, however, is associated with a higher hedge ratio. 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, although this result is only marginally significant.

B. Fund past performance and the use of currency forwards

We further relate funds' use of currency forwards with 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 et al. (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 funds with more illiquid holdings suffer more outflows from low performance (Chen, Goldstein, and Jiang (2010)). This suggests that

[19]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..."

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:

$$Flow_{i;t} = \alpha_i + \alpha_t + \beta_1 \min(Perf_{i;t\ \ 1}, 0) + \beta_2 \max(Perf_{i;t\ \ 1}, 0) + \sum_j \beta_j X^j_{i;t\ \ 1} + \epsilon_{i;t} \quad (11)$$

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 V 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 et al. (2017), who document the fragility of corporate bond funds. Given that international fixed-income funds may similarly suffer from holding illiquid securities as domestic corporate bond funds, it is reasonable to expect that investors 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:

$$Y_{i;t} = \alpha_i + \alpha_t + \beta_1 \min(Perf_{i;t\ \ 1}, 0) + \beta_2 \max(Perf_{i;t\ \ 1}, 0) + \sum_j \beta_j X^j_{i;t\ \ 1} + \epsilon_{i;t} \quad (12)$$

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 mitigate reverse-causality

concerns. Because a fund's forward positions are fairly persistent, a purely cross-sectional analysis may mistakenly interpret the performance impact of currency forwards as strategic adjustments to forward positions made by mutual funds. In estimating a model with fund-fixed effects, we effectively capture the *deviation* of a fund's currency forward strategy in response to its recent performance.

In Column (2) of Table V, 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)).

In Column (5) of Table V, we examine the overall foreign currency exposure of funds in relation to their past performance, mainly to confirm that funds' adjustments to their forward positions are not offset by changes in their underlying currency denominations. Consistent with the previous results, we find that the negative performance segment is positively associated with the funds' foreign currency exposures: poorly-performing funds tend to lower their exposures to foreign currencies. On the other hand, positive performance is not correlated with changes in funds' overall currency exposures.

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.

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

Mutual funds' use of currency forwards also varies 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 follows a currency momentum strategy, they should sell less currency forwards after periods of high foreign currency returns (relative to the USD). The second strategy is the "dollar carry trade" in Lustig et al. (2014). Under the strategy, funds should hedge more of their foreign currency exposures when the average short-term foreign interest rate is lower than the US 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. Standard errors are double-clustered at the fund level and at the time level.

Table VI shows that funds reduce their hedge ratios when the average excess return of foreign currencies is higher in the previous quarter. A 2.9 percentage points increase in foreign currency excess returns (equivalent to one standard deviation in sample) is associated with a 2.2 percentage points decrease in funds' average hedge ratio. Similarly, Column (2) of Table VI shows that a higher foreign currency return in the previous quarter is associated with a smaller amount of 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 appreciate against the U.S. dollar.

The hedging decisions 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 VI shows that mutual funds' hedge ratios are lower during periods when the average interest rate differential between G10 countries and the US are higher.

Hedging 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.[20] Table VI 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 2.1 percentage points increase in the hedge ratio, and a 0.5 percentage point increase in funds' sales of foreign currency forwards (Column (2)).

In Columns (3) and (4) of Table VI, we examine the impact of recent currency returns, foreign-US 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 funds' asset currency denominations do not seem to respond significantly to past currency returns, interest differentials, or the World Uncertainty Index. Instead, the adjustment of fund currency exposure in response to aggregate market conditions seems to be entirely driven by changes in funds' currency 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.

D. Within-fund differences in currency management

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

[20] In our test, we capture the global level of uncertainty using the simple average across all countries.

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 3-month forward contracts. For currency c held by fund i at quarter t, the regression specification is as follows:

$$\begin{aligned} Hedge\_ratio^{c}_{i;t} = \alpha_{i;t} + \beta_1 CurrencyRet^{c}_{t\ 1;t} + \beta_2 CurrencyVol^{c}_{t\ 1;t} + \beta_3 IntDiff^{c}_{t\ 1} \\ + \beta_4 WUI^{c}_{t} + \beta_5 BAspread^{c}_{t} + \gamma\omega^{c}_{t} + \epsilon^{c}_{i;t} \end{aligned} \tag{13}$$

Table VII 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, Column (1)). This is suggestive that fund managers take advantages 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 (-0.616*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. 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.

E. 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 compare mutual funds' currency forwards of other currencies against their utilization of British pound forwards. The analyses are at the fund–quarter–currency level and the sample includes 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:

$$Y_{i;c;t} = \alpha_{i;t} + \delta_{i;c} + \beta_1 \mathbb{1}_{c=GBP} Brexit(t-2) + \beta_2 \mathbb{1}_{c=GBP} Brexit(t-1) + \beta_3 \mathbb{1}_{c=GBP} Brexit(t)$$
$$+ \beta_4 \mathbb{1}_{c=GBP} Brexit(t+1) + \beta_5 \mathbb{1}_{c=GBP} Brexit(t+2) + \beta_6 \mathbb{1}_{c=GBP} Brexit(t \geq 3) + \epsilon, \qquad (14)$$

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. β_1 to β_5 can be interpreted as funds' change in GBP hedging relative to three quarters before the Brexit referendum or earlier.

We report regression coefficients in the Appendix 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, the increased amount of GBP forward sales reported at the end of that quarter suggests that funds entered into those contracts before 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.

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 $r^c_{i,t}$ is the return 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:

$$Ret^{CurAdj}_{i;t} = Ret^{Fund}_{i;t} - Ret^{Currency}_{i;t}. \tag{16}$$

The average monthly $Ret^{Currency}$ and Ret^{CurAdj} are -0.13% and 0.34%, respectively, and the standard deviations of the two components are similar. In univariate regressions of the fund return on $Ret^{Currency}$ (or Ret^{CurAdj}), each component explains around 55% of the variation in fund returns.

We further employ factor-based models to examine sample funds' systematic risk exposures and abnormal performance. Two models are used. 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:[21]

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

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

[21]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.

currency investments.

In Model 2, we replace the unhedged global bond market returns with the U.S. dollar-hedged global bond market returns.[22] 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.[23]

Table VIII 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 currency exposure is 97%). Average portfolio returns and standard deviations vary across the five groups sorted by their foreign currency exposures. The group with the highest currency

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

[23] 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 $\sqrt{12}$.

exposure (Group 5) has the lowest average monthly access 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 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 between the currency exposure-sorted groups. Funds in the lowest exposure group, on average, have a annualized Sharpe ratio of 0.79, whereas funds in the highest exposure group have a Sharpe ratio of 0.09.

We also calculate the difference of average returns, standard deviations, and Sharpe ratios between low-exposure funds (Group 1) and high-exposure funds (Group 5). To test whether these differences are statistically different from zero, we simulate the empirical distribution of between-group differences by randomly assigning funds into quintiles.[24] 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 VIII 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

[24] 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 VIII 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 have 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, have an average α^{Model1} of -0.239% per month, and an α^{Model2} of -0.108%. The difference of alphas between low- and high-exposure groups are also significant at a 1% level based on our simulated empirical distribution.

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.

These results should be interpreted with caution because funds enter the sample for different time periods and because funds may follow similar investment strategies. To address these concerns we study next calendar-time portfolio returns.

C. 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.

Figure 7 depicts the cumulative returns of the portfolios with the lowest and highest foreign currency exposures (Portfolios 1 and 5). Within each quintile portfolio, fund returns

are weighted by the lagged TNA. As shown in the figure, the portfolio of funds with the lowest foreign currency exposure significantly outperforms the portfolio of funds with the highest foreign currency exposure during our sample period. The performance of funds with the highest foreign currency exposure are highly correlated with the dollar risk factor from Lustig et al. (2011), which is defined as the average excess return of foreign currencies relative to the USD.

We also consider a long-short portfolio that buys funds with the lowest foreign currency exposure and sells funds with the highest foreign exposure. 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.[25]

Panel A shows that the portfolio of funds with the lowest exposures to foreign currencies tends 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 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.

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.[26]

[25] We present the factor loadings of each portfolio in the Appendix.

[26] As discussed in the appendix, the outperformance of low-currency-exposure funds is robust to excluding global bond funds – the subset of funds with a significant amount of assets invested in US-issued securities.

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 currency risk management strategies depend on fund characteristics, such as age, size, turnover, and expenses. Furthermore, mutual funds also increase their hedging using forward contracts after experiencing poor performance. The currency hedging also varies over time 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 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 Figure shows histograms of sample funds' (a) fractions of assets issued by foreign domiciled issuers, (b) fractions of assets denominated in non-USD currencies, (c) net sales of foreign currency forwards scaled by TNA, and (d) net exposures to non-USD currencies.

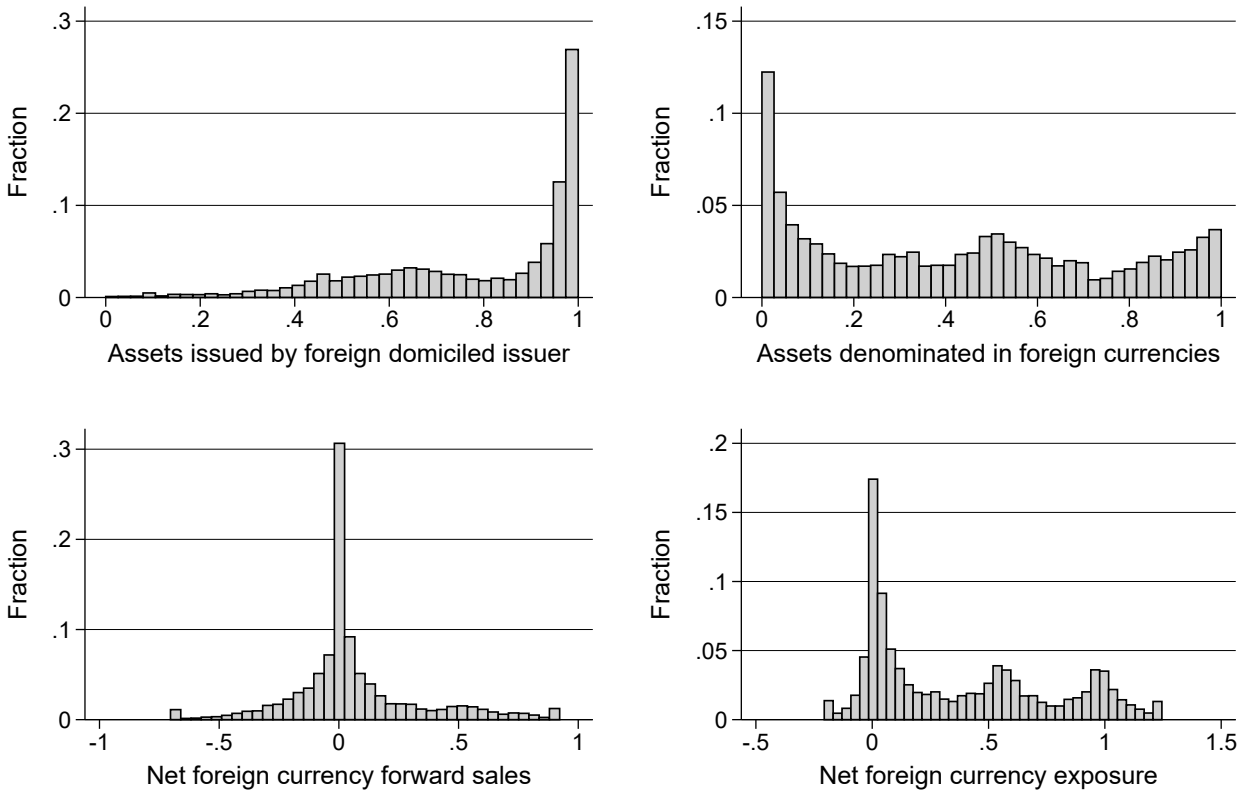
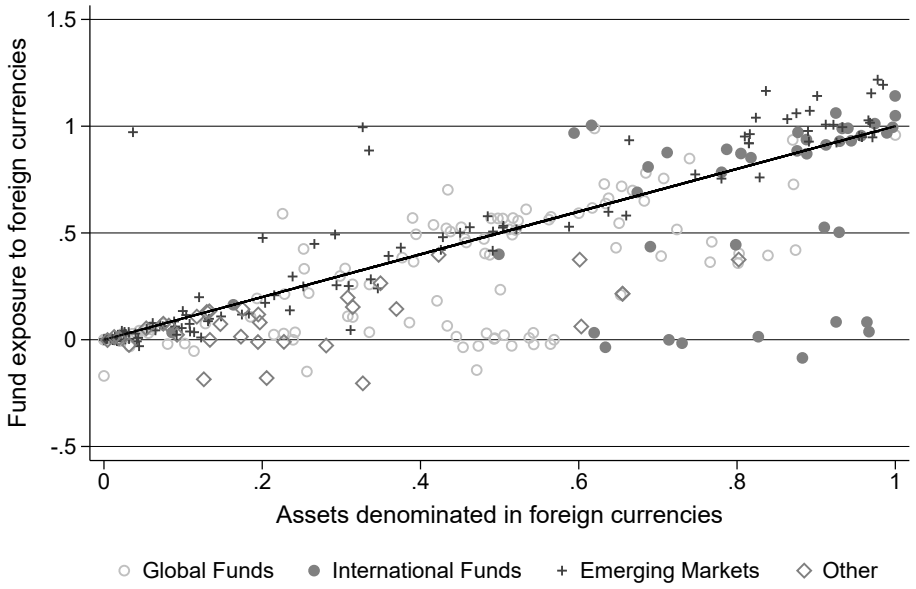
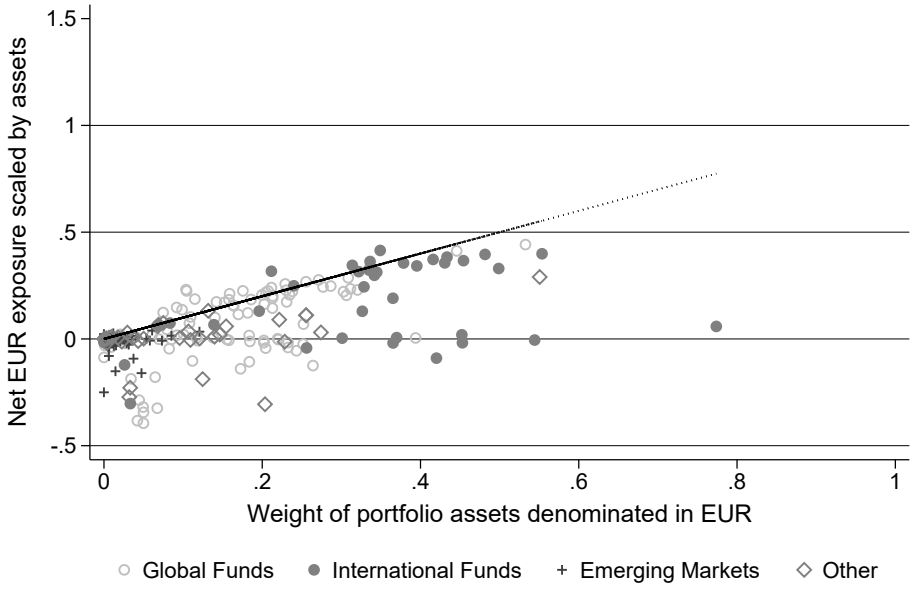


Figure 3: Portfolio asset currency denominations and net currency exposures

This Figure shows scatter plots of sample funds' portfolio weights based on currency denominations and the portfolio currency net exposures taking into account currency forwards. Each circle represents a fund. Sample funds are further categorized into (i) global funds, (ii) international funds, and (iii) emerging markets funds. For a given fund, the portfolio weight of assets denominated in foreign currencies (or EUR) and net 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 the said currency.



(a) Assets denominated in foreign currencies vs. Net exposure to foreign currencies



(b) Assets denominated in EUR vs. Portfolio EUR exposure

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.

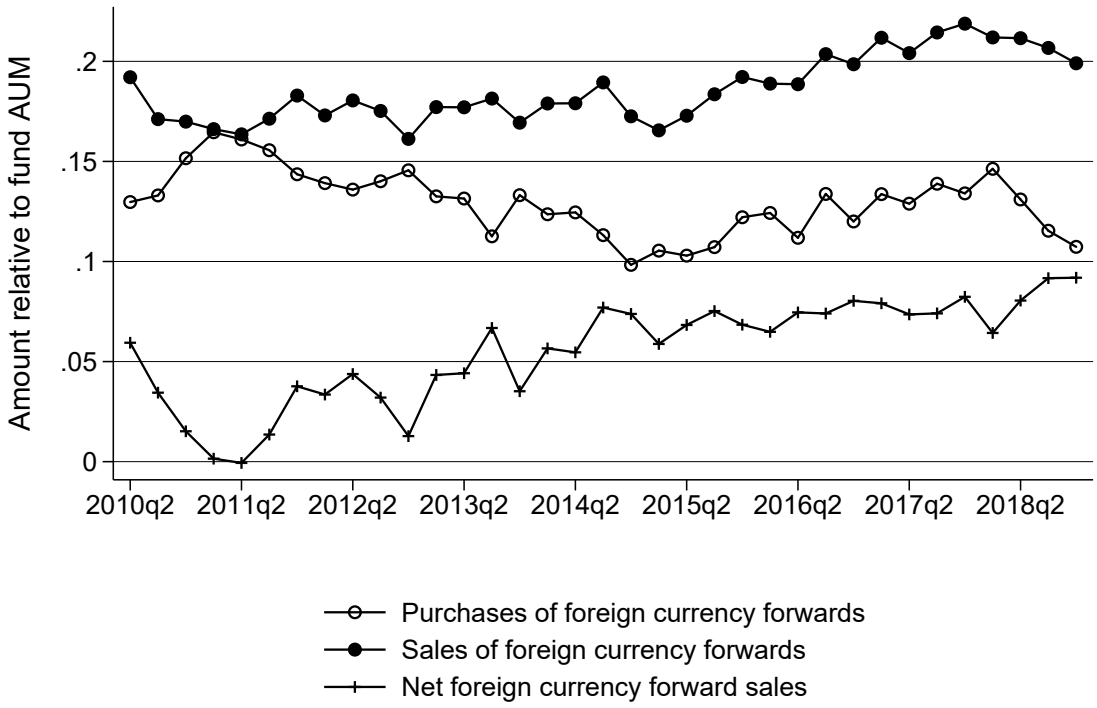
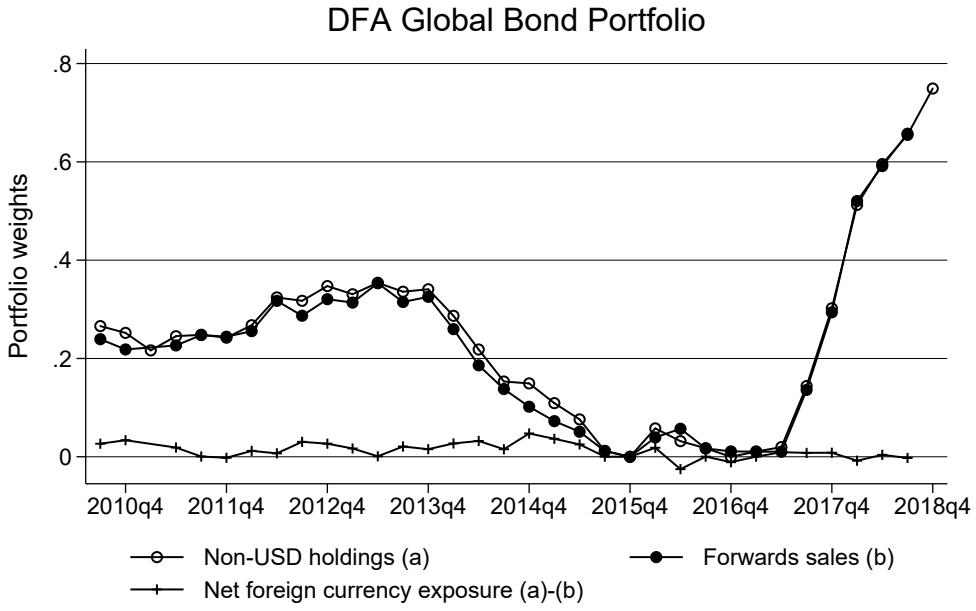
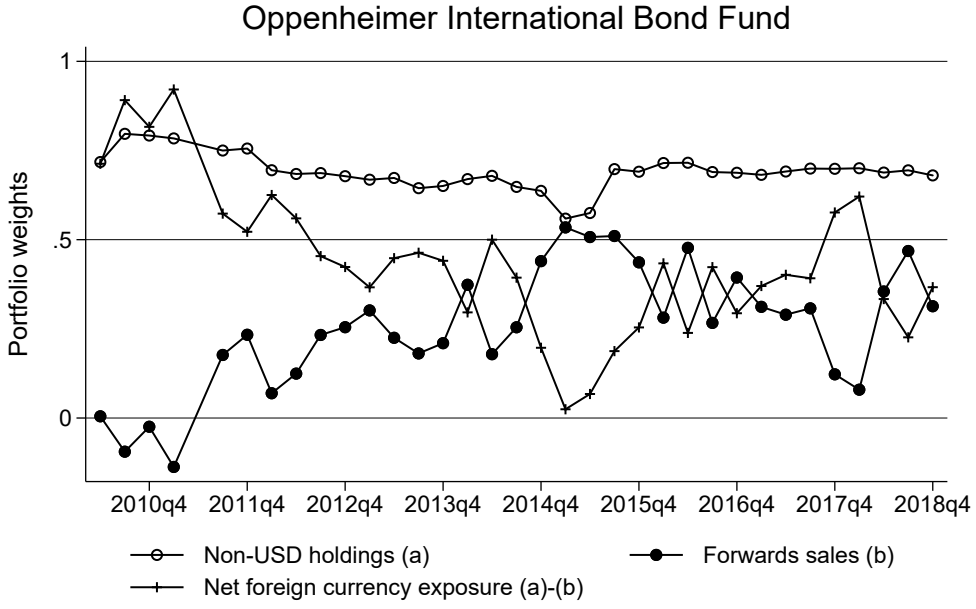


Figure 5: Examples of fund currency forward positions

This Figure shows the fractions of assets denominated in foreign currencies, the net currency forward sales, and the net exposures to foreign currencies of the DFA Global Bond Portfolio in Panel (a) and the Oppenheimer International Bond Fund in Panel (b).



(a)



(b)

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

This Figure shows 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.

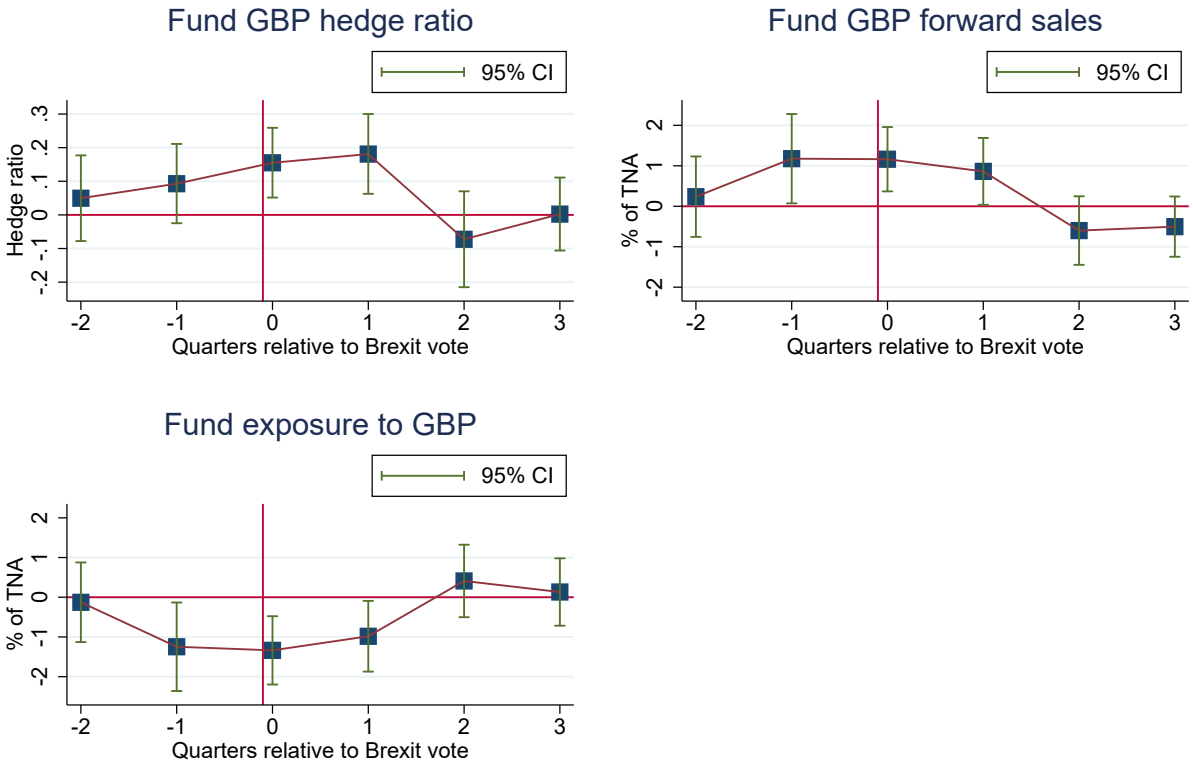


Figure 7: Cumulative raw return of funds sorted by USD exposure

This Figure shows the cumulative raw returns of quintile portfolios of funds sorted by their exposures to foreign currencies as well as the cumulative returns of the dollar risk factor, defined as the average excess return of foreign currencies relative to the USD (Lustig et al. (2011).

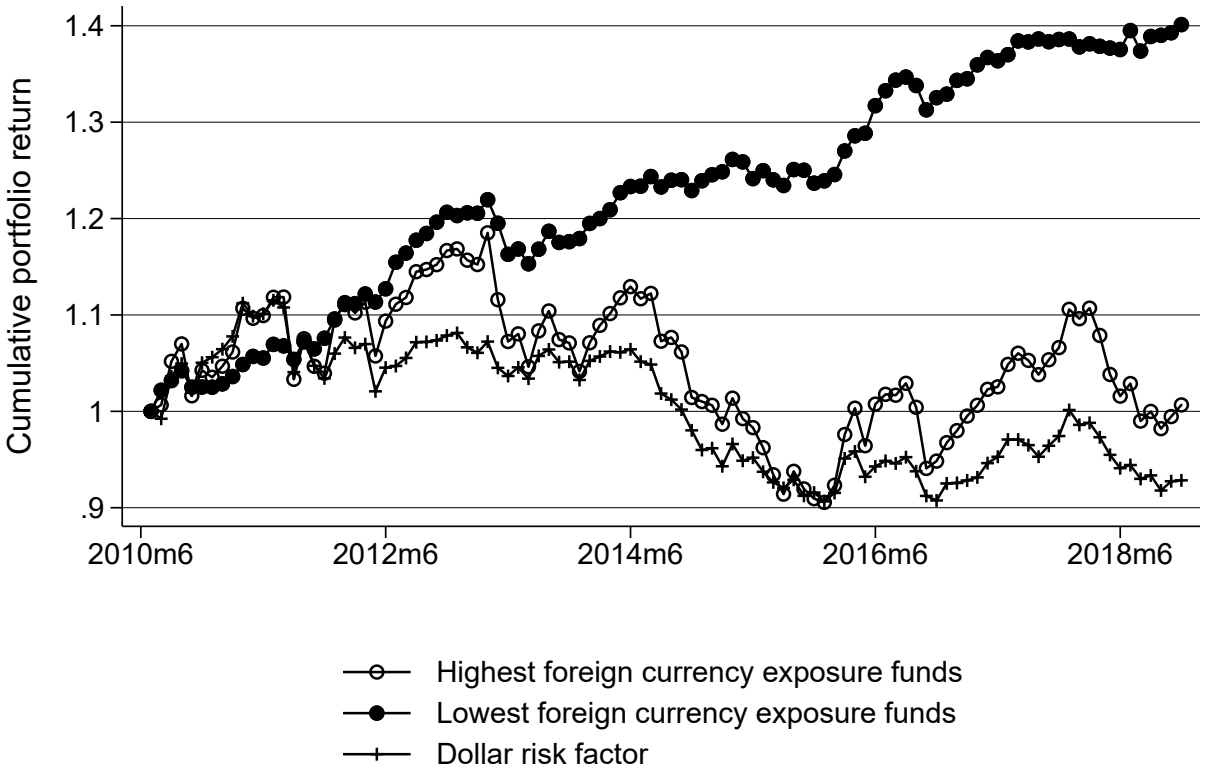


Table I: Sample of US-based global fixed income funds

This table shows the number of sample funds, their total asset under management (AUM), 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
$\mathbb{1}_{\text{USD as purchase currency}}$	515,695	0.448	0.497	0	0	1
$\mathbb{1}_{\text{USD as sale currency}}$	515,695	0.400	0.490	0	0	1
$\mathbb{1}_{\text{Involve two non-USD currencies}}$	515,695	0.151	0.358	0	0	1
Notional amount (in million USD)	515,695	10.7	30.8	0.341	1.23	5.16
Days to settlement (as of reporting date)	515,695	67.2	76.8	17	46	80

Panel B: Fund-quarter-level statistics

	Obs.	Mean	Stdev	25th	50th	75th
$\mathbb{1}_{\text{Have currency forwards}}$	6,463	0.868	0.338	1	1	1
Number of forward contracts	5,614	75.9	92.6	12	42	109
Number of counterparties	5,614	7.78	5.23	3	7	11
Percentage of assets issued by foreign-domiciled entities (%)	6,463	78.3	22.7	62.1	88.6	97.6
Percentage of assets denominated in foreign currencies (%)	6,463	42.8	32.4	10.5	42.6	68.4
Percentage of assets denominated in G10 currencies (%)	6,463	21.7	26.4	0.24	6.7	41.5
Percentage of assets denominated in other foreign currencies (%)	6,463	21.1	28.2	2.1	8.0	26.4
Net foreign currency forward sales scaled by assets (%)	6,463	6.83	30.0	-0.43	0.25	11.6
Gross foreign currency forward purchases scaled by assets (%)	6,463	13.1	16.9	0	5.23	21.4
Gross foreign currency forward sales scaled by assets (%)	6,463	19.9	24.7	2.00	9.85	27.3
Net foreign currency exposure scaled by assets (%)	6,463	37.1	39.3	1.9	23.9	66.1
Fund hedge ratio ($Hedge\_ratio$) (%)	6,463	18.0	84.1	-9.76	2.35	69.8
Portfolio foreign currency concentration (HHI)	6,463	0.286	0.230	0.121	0.232	0.360
Fund characteristics						
Total Net Assets (in million USD)	6,463	1,237	4,343	47.3	232	800
Fund family TNA (in million USD)	6,463	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)	6,463	10.3	8.6	3	7	18
Expense ratio (%)	6,463	0.90	0.31	0.76	0.94	1.11
Turnover ratio (%)	6,463	105.6	84.5	52	90	122
Portfolio weight of corporate bonds (%)	6,463	46.8	21.7	32.6	44.1	70.7
Weighted average maturity (# of years)	6,463	8.61	3.54	6.78	8.98	10.86
Fraction of assets in institutional shares	6,463	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 - US 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: 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 IV: 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	0.0261	0.269	0.350	0.0911	0.256
	(0.010)	(0.071)	(0.055)	(0.032)	(0.168)
Assets denominated in other foreign currencies	0.0241	0.0441	0.259	0.221	-0.0255
	(0.010)	(0.059)	(0.056)	(0.031)	(0.144)
Portfolio currency concentration	0.0346	7.165	4.854	-2.162	38.23
	(0.500)	(3.477)	(2.629)	(2.275)	(23.031)
Portfolio weight of corporate bonds	-0.00945	0.0449	-0.0325	-0.0736	0.313
	(0.007)	(0.050)	(0.041)	(0.028)	(0.187)
Log(Fund TNA)	-0.0501	0.587	0.134	-0.434	0.980
	(0.085)	(0.899)	(0.678)	(0.512)	(2.221)
Log(Fund family TNA)	0.189	0.570	0.652	0.103	2.955
	(0.065)	(0.751)	(0.563)	(0.433)	(1.757)
Fund age	0.0570	0.174	0.337	0.160	0.131
	(0.024)	(0.232)	(0.163)	(0.131)	(0.713)
Expense ratio	-0.413	-10.73	-8.376	1.952	-30.06
	(0.550)	(4.837)	(4.439)	(2.028)	(10.942)
Turnover ratio	0.00541	0.00394	0.0251	0.0211	-0.00980
	(0.002)	(0.018)	(0.012)	(0.011)	(0.052)
Fraction of assets in institutional shares	0.316	-6.956	-2.913	3.659	-18.11
	(0.354)	(3.327)	(2.555)	(1.988)	(9.666)
Observations	6463	6463	6463	6463	6192
Adjusted R^2	0.175	0.124	0.261	0.213	0.076
Time FE	Y	Y	Y	Y	Y

Table V: 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 VI: 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 USD, (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	-0.746	-0.277	0.0278	0.266
	(0.355)	(0.111)	(0.058)	(0.115)
Average G10-US interest rate differential	-5.934	-1.355	0.0396	1.258
	(2.609)	(0.897)	(0.588)	(1.039)
World Uncertainty Index	0.475	0.119	-0.0510	-0.155
	(0.200)	(0.063)	(0.040)	(0.072)
Assets denominated in G10 currencies	0.637	0.390		
	(0.194)	(0.097)		
Assets denominated in other foreign currencies	0.487	0.472		
	(0.218)	(0.130)		
Portfolio currency concentration	32.04	6.158		
	(9.164)	(1.974)		
Portfolio weight of corporate bonds	0.258	0.135	-0.334	-0.328
	(0.149)	(0.061)	(0.051)	(0.073)
Log(Fund TNA)	-0.638	-0.940	0.0608	0.946
	(1.051)	(0.507)	(0.332)	(0.522)
Log(Fund family TNA)	-0.343	-0.187	-0.152	0.174
	(1.138)	(0.571)	(0.390)	(0.533)
Fund age	3.492	1.064	-0.565	-1.412
	(1.062)	(0.385)	(0.237)	(0.443)
Expense ratio	-10.99	-6.805	7.449	10.82
	(7.267)	(3.525)	(2.100)	(3.483)
Turnover ratio	0.0226	0.0137	-0.00555	-0.0153
	(0.031)	(0.014)	(0.008)	(0.015)
Observations	6185	6457	6457	6457
Adjusted R^2	0.648	0.755	0.934	0.874
Fund FE	Y	Y	Y	Y

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

This table examines the determinants of a fund's hedge 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). 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 VIII: 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 raw return and currency return. Model 1 is a four-factor model that includes unhedged global market bond return, emerging market bond return, the term factor, and the credit factor. Model 2 is a six-factor model that includes USD-hedged global market bond return, 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)
Skewness of monthly return	-0.298	-0.156	-0.251	-0.400	-0.404	0.106	(0.19)
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)
Alpha from Model 1 (%)	0.075	0.026	-0.026	-0.076	-0.239	0.315	(0.00)
Alpha from Model 2 (%)	0.035	0.040	0.018	-0.047	-0.108	0.144	(0.00)
β_{FX} from Model 2	0.03	0.11	0.31	0.62	1.10	-1.1	(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)

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. Currency return is calculated as $Ret_{i,t}^{Currency} = \sum_{c \neq USD} Exposure_{i,t-1}^{c} * r_{i,t}^{c}$. Currency-adjusted return is the difference between raw return and currency return. Model 1 is a four-factor model that includes unhedged global market bond return, emerging market bond return, the term factor, and the credit factor. Model 2 is a six-factor model that includes USD-hedged global market bond return, 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 from Model 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 from Model 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 from Model 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 from Model 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)

Appendix

A. Cross-currency differences in funds' use of currency forwards

Funds' use of forward contracts varies across different currencies. At the fund–quarter level, we regress a fund's forward position (scaled by TNA) of a certain currency on the fund's portfolio weight denominated in that currency (ω^c):

$$Forwards^c_{i;t}/TNA_{i;t} = \alpha + \beta\omega^c_{i;t} + \epsilon_{i;t} \tag{19}$$

The coefficient β indicates the average tendency for funds to hedge currency c using forwards. Full hedging corresponds to $\beta = 1$, while no hedging corresponds to $\beta = 0$.

Table A1 shows regression results. All G-10 currencies exhibit a positive relation between the hedging and currency exposures (i.e., β) although the coefficients are not statistically significant for the Swedish, Norwegian, and Swiss currencies. When we pool the G-10 currencies together in a regression, the β estimate is 0.368, indicating that more than one-third of sample funds' exposure to G10 currencies are hedged using forwards. For the ten emerging market currencies that are most popular (in terms of assets' denominations) in our sample, only three of them have reliably positive β estimates. For the pooled sample of emerging market currencies, the coefficient is close to zero.

B. Funds use of currency forwards around Brexit

We illustrate mutual funds' utilization of currency forwards amid 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 compare mutual funds' utilization of currency forwards of other currencies against their utilization of British pound forwards. 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. β_1 to β_5 can be interpreted as funds' change in GBP hedging relative to three quarters before the Brexit referendum or earlier.

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. Panel regressions on fund performance

We conduct panel regressions of fund performance on funds' currency forward sales, taking into account a host of fund characteristics. To this end, we first calculate monthly α^{Model1} and α^{Model2} for each fund–quarter. More specifically, factor loadings of each fund–quarter are calculated based on the past 36 months' returns on a rolling basis, and a fund's alpha is defined as its monthly excess net return minus the product between the estimated factor loadings and contemporaneous realized factor returns.

We regress fund performance (measured by monthly raw returns, α^{Model1}, or α^{Model2}) on the sale amount of foreign currency forwards (relative to TNA) and various fund characteristics, controlling for style–by–time fixed effects:

$$Performance_{i;t} = \alpha + \beta Forward^{net}_{i;t\ 1} + \gamma FundCharacteristics_{i;t\ 1} + \epsilon. \quad (21)$$

Table A4 displays the results. Columns (1) to (3) show that, controlling for fund characteristics including the currency denominations of portfolio assets, a fund's currency forward sales are positively and consistently associated with its performance. A one standard deviation increase in the amount of a fund's currency forward sales (0.3) is associated with a 6.2 basis point increase in monthly raw return, a 6.9 basis point increase in monthly α^{Model1}, and a 1.7 basis point increase in monthly α^{Model2}. All these relationships are statistically significant at 1% when the standard errors are clustered at the fund level.

When we decompose sample funds' monthly returns into a component driven by exchange rate movements and a component that is not currency-driven, we find that the relationship is mainly driven by the currency return (Column (5)) rather than currency-adjusted return (Column (6)).

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

Table A5 shows the monthly alpha and factor loadings for portfolios sorted by their previous-quarter exposure to foreign currencies. The regression model is:

$$\begin{aligned} Return_{i;t} - rf_t = \alpha_i^{Model2} &+ \beta^{GlobalHedged}(GlobalMarket_t^{Hedged} - rf_t) \\ &+ \beta^{Emerging}(EmeMarket_t - rf_t) + \beta^{term}Term_t + \beta^{credit}Credit_t + \\ &+ \beta^{FX}RXMean_t + \beta^{Carry}HML_t^{FX} + \epsilon_{i;t}. \end{aligned} \tag{22}$$

where the factors include U.S. dollar-hedged global bond market returns, emerging market bond returns, the term factor, the credit factor, the dollar risk factor (average excess return of foreign currencies), and the currency carry factor.

In Table A6, we repeat the calendar-time analysis, but exclude from our sample funds with "global fund" investment style. Such global funds invest a significant amount of assets (on average 40%) in securities issued by US-domiciled entities.

Table A1: Average hedging tendency across currencies

This table shows the estimated β coefficient from the regression on fund–quarter–currency pairs:

$$Forward^{c}_{i,t} = \alpha + \beta\omega^{c}_{i,t} + \epsilon_{i,c,t},$$

where fund i holds nonzero assets denominated in currency c during quarter t.

G-10 currencies			Selected Emerging markets		
Currency	Weight	β	Currency	Weight	β
EUR	10.4%	0.337	MXN	3.2%	-0.027
JPY	3.9%	0.225	BRL	2.4%	0.137
GBP	3.2%	0.620	IDR	1.7%	-0.019
CAD	1.4%	0.391	ZAR	1.5%	0.089
AUD	1.1%	0.475	MYR	1.4%	-0.235
SEK	<1%	0.078	TRY	1.1%	0.017
NZD	<1%	0.532	RUB	1.1%	0.112
NOK	<1%	0.137	COP	<1%	0.047
DKK	<1%	0.929	HUF	<1%	0.015
CHF	<1%	0.062	THB	<1%	-0.121
Pooled	22.2%	0.368	Pooled	14.5%	0.015

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: 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. Standard errors are shown in parentheses. ***, **, 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	0.209	0.231	0.0573	-0.979	0.156	0.0619
	(0.031)	(0.030)	(0.025)	(0.047)	(0.031)	(0.034)
Assets denominated in G10 currencies	-0.242	-0.122	-0.202	1.024	-0.146	-0.122
	(0.047)	(0.040)	(0.039)	(0.078)	(0.047)	(0.046)
Assets denominated in other foreign currencies	-0.328	-0.350	-0.0660	0.993	-0.519	0.166
	(0.044)	(0.043)	(0.033)	(0.066)	(0.042)	(0.034)
Portfolio currency concentration	-0.000983	0.0114	-0.0220	-0.0869	0.0329	-0.0214
	(0.051)	(0.046)	(0.034)	(0.069)	(0.044)	(0.044)
Portfolio weight of corporate bonds	0.117	0.0246	0.0348	0.104	0.0259	0.0501
	(0.048)	(0.042)	(0.040)	(0.058)	(0.033)	(0.046)
Log(Fund TNA)	0.000365	0.00303	0.00414	0.00116	0.00505	-0.00968
	(0.005)	(0.004)	(0.004)	(0.006)	(0.004)	(0.005)
Log(Fund family TNA)	0.00830	0.00618	0.00538	0.00173	-0.00174	0.0146
	(0.004)	(0.004)	(0.003)	(0.005)	(0.003)	(0.004)
Fund age	-0.00114	-0.00205	-0.00354	0.00353	-0.000454	-0.000116
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Expense ratio	-0.0303	-0.0485	-0.0449	0.0710	-0.000546	0.00486
	(0.031)	(0.027)	(0.024)	(0.040)	(0.022)	(0.028)
Turnover ratio	0.00616	0.00857	-0.00523	0.0119	-0.00762	0.00959
	(0.009)	(0.007)	(0.009)	(0.011)	(0.007)	(0.008)
Variable annuity fund	0.0166	-0.0109	-0.0282	0.00634	-0.00518	0.0158
	(0.021)	(0.020)	(0.019)	(0.024)	(0.013)	(0.022)
Observations	17853	16943	16943	17073	17853	17853
Adjusted R^2	0.730	0.276	0.194	0.706	0.454	0.466
Style-by-time fixed effects	Y	Y	Y	Y	Y	Y

Table A5: Calendar-time net returns of portfolios sorted by foreign currency exposure

This table shows the calendar-time factor loadings and risk-adjusted 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. Standard errors are shown in parentheses. ***, **, and * represent result significant at 1%, 5%, and 10% level, respectively.

	Panel A: Value-weighted returns					
	Portfolio 1	Portfolio 2	Portfolio 3	Portfolio 4	Portfolio 5	1-minus-5
	(1)	(2)	(3)	(4)	(5)	(6)
Alpha	0.0698	-0.00358	0.00645	-0.101	-0.188	0.258
	(0.029)	(0.048)	(0.059)	(0.075)	(0.069)	(0.067)
Global bond market excess return (USD hedged)	0.347	0.151	0.184	0.969	0.433	-0.0863
	(0.093)	(0.158)	(0.194)	(0.245)	(0.225)	(0.219)
Emerging markets bond market excess return	0.324	0.533	0.212	0.250	0.347	-0.0232
	(0.026)	(0.044)	(0.054)	(0.069)	(0.063)	(0.061)
Credit factor	0.150	0.193	0.266	-0.0111	-0.0608	0.211
	(0.042)	(0.070)	(0.086)	(0.109)	(0.100)	(0.098)
Term factor	-0.0252	-0.100	-0.0255	-0.281	0.0372	-0.0624
	(0.038)	(0.064)	(0.079)	(0.100)	(0.092)	(0.089)
Dollar risk factor	-0.00345	0.117	0.293	0.613	1.069	-1.072
	(0.022)	(0.037)	(0.046)	(0.058)	(0.054)	(0.052)
Currency carry factor	0.0470	0.0899	0.143	0.137	0.114	-0.0675
	(0.015)	(0.025)	(0.030)	(0.038)	(0.035)	(0.034)
Observations	102	102	102	102	102	102
Adjusted R^2	0.930	0.921	0.851	0.876	0.945	0.905
	Panel B: Equal-weighted returns					
	Portfolio 1	Portfolio 2	Portfolio 3	Portfolio 4	Portfolio 5	1-minus-5
	(1)	(2)	(3)	(4)	(5)	(6)
Alpha	0.0394	0.0181	-0.00610	-0.0601	-0.158	0.198
	(0.030)	(0.037)	(0.041)	(0.038)	(0.063)	(0.062)
Global bond market excess return (USD hedged)	0.282	0.198	0.179	0.593	0.534	-0.251
	(0.099)	(0.121)	(0.134)	(0.123)	(0.205)	(0.204)
Emerging markets bond market excess return	0.362	0.533	0.313	0.200	0.236	0.126
	(0.028)	(0.034)	(0.038)	(0.034)	(0.058)	(0.057)
Credit factor	0.321	0.299	0.324	0.0529	0.0182	0.303
	(0.044)	(0.054)	(0.060)	(0.055)	(0.092)	(0.091)
Term factor	-0.0819	-0.136	-0.0235	-0.0116	0.0264	-0.108
	(0.040)	(0.049)	(0.055)	(0.050)	(0.084)	(0.083)
Dollar risk factor	0.00315	0.0945	0.300	0.661	1.052	-1.049
	(0.023)	(0.029)	(0.032)	(0.029)	(0.049)	(0.049)
Currency carry factor	0.0416	0.0348	0.0911	0.0281	0.113	-0.0714
	(0.015)	(0.019)	(0.021)	(0.019)	(0.032)	(0.032)
Observations	102	102	102	102	102	102
Adjusted R^2	0.942	0.952	0.939	0.960	0.948	0.890

Table A6: Calendar-time portfolio sorted by foreign currency exposure: Excluding global funds

Value-weighted						
	1 (Low)	Portfolio 2	Portfolio 3	Portfolio 4	5 (High)	5-minus-1
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	0.0811	0.0390	-0.0752	-0.0373	-0.182	0.264
	(0.041)	(0.045)	(0.087)	(0.102)	(0.078)	(0.079)
Global bond market excess return (USD hedged)	0.290	0.108	0.734	0.468	0.365	-0.0750
	(0.135)	(0.148)	(0.285)	(0.333)	(0.254)	(0.258)
Emerging markets bond market excess return	0.501	0.670	0.315	0.302	0.397	0.104
	(0.038)	(0.041)	(0.080)	(0.093)	(0.071)	(0.072)
Credit factor	0.209	0.235	0.112	0.000635	-0.145	0.354
	(0.060)	(0.066)	(0.127)	(0.148)	(0.113)	(0.115)
Term factor	-0.0893	-0.123	-0.346	-0.0524	0.0147	-0.104
	(0.055)	(0.060)	(0.116)	(0.136)	(0.104)	(0.105)
Dollar risk factor	-0.0171	0.112	0.409	0.592	1.111	-1.128
	(0.032)	(0.035)	(0.068)	(0.079)	(0.060)	(0.061)
Currency carry factor	0.0750	0.0967	0.202	0.129	0.161	-0.0861
	(0.021)	(0.023)	(0.044)	(0.052)	(0.040)	(0.040)
Observations	102	102	102	102	102	102
Adjusted R^2	0.924	0.950	0.826	0.785	0.937	0.857