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Benchmarking and Currency Risk

Massimo Massa, Yanbo Wang, and Hong Zhang*

Abstract

We show that the currency risk embedded in the benchmarks of international mutual funds negatively affects fund performance. More specifically, a high benchmark-implied currency risk induces funds to invest in markets with less volatile currencies, leading to a higher degree of currency concentration in portfolio holdings. This currency concentration, however, departs from the optimal equity allocation strategy across countries and reduces fund performance. We document that funds resorting to high currency concentrations underperform funds with low currency concentrations by as much as 1%–2% per year.

I. Introduction

One of the major trends in the global financial market during the 21st century is the dramatic growth in cross-border investments. This unprecedented wave of international investment has been accompanied by large swings in currency movements. Although the impact of currencies on asset prices is widely recognized in the literature and in the public media, little is known about how currency risk affects the investment decisions of portfolio managers in the global mutual fund industry. This ignorance is unfortunate because the common practice of "benchmarking," or the need to follow the investments of the indexes (i.e., benchmarks), may subject mutual funds to tremendous currency risk. More specifically, the base currency of a fund may differ from the base currencies of the stocks of its benchmark. This mismatch results in an embedded currency risk for international funds that invest in overseas assets according to their benchmarks.[1]

Perhaps the reason for the scarce attention devoted to this issue is that the embedded currency risk, if priced correctly, should not matter for *risk-adjusted*

*Massa, massimo.massa@insead.edu, INSEAD, Fontainebleau, 77305 Cedex, France; Wang, yanbo.wang@skku.edu, Sungkyunkwan University, Graduate School of Business, Seoul 110-745, Korea; and Zhang, zhangh@pbcsf.tsinghua.edu.cn, Tsinghua University, PBC School of Finance, Beijing 100083, China. The authors thank an anonymous referee, Yakov Amihud, Stephen Brown (the editor), William Goetzmann, Jennifer Huang, Sergei Sarkissian, and Matthew Spiegel for their helpful comments.

[1]For example, a "U.S." fund (i.e., a fund catering to U.S. investors and with the U.S. dollar as its base currency) tracking the Asian market is exposed to the fluctuations between the U.S. dollar and Asian currencies in proportion to the weights imposed by the Asian benchmark. This exposure posits a pure burden for the U.S. fund compared with an Asia-based fund tracking the same benchmark.

fund performance.[2] In this case, funds can stay with whichever embedded currency risk they face without any real performance impact. Alternatively, funds may use derivatives to financially hedge the risk. In either case, we may expect the embedded currency risk to limit itself to the currency component of the portfolio and to disappear after the relevant risk premium is netted out. The data, however, tell a very different story. The currency risk embedded in the benchmark of an international fund (i.e., the implied currency volatility risk (ICVR) that a fund will face when it strictly follows its benchmark in investing in foreign stocks) has a *negative* and significant effect on the fund performance in general and equity selection/performance in particular. Based on various models of risk adjustment, as we will specify shortly, we find that funds with high ICVR underperform funds with low ICVR by 88–120 basis points (bps) per year in general and by 80–94 bps in terms of equity performance in particular. The equity impact is especially puzzling because, in principle, equity selection should be orthogonal to embedded currency risk if the risk is fairly priced or easy to hedge.

To explore the possible economic grounds for this puzzling observation, we hypothesize that a high benchmark-implied *embedded currency risk* may induce funds to tilt their equity portfolio to reduce this risk. For example, to reduce exposure to currency volatility, a fund can withdraw investments from highly volatile currencies and revert to less volatile currencies, leading to excess currency concentration in the portfolio holdings. In the global mutual fund industry, this "operational hedge" (for the lack of a better term) provides an important substitute to derivative-based financial hedges due to regulatory reasons, for instance, because the use of derivatives by mutual funds is restricted in many countries. In addition, operational hedges also have the advantage of the "hedging" effect becoming permanent if the market conditions do not change. By contrast, derivative hedging requires positions to be rolled over periodically. Hence, we expect funds to be more concentrated when their implied currency risk is higher.

However, operational hedges, unlike derivative hedges, may affect equity selection and real performance. Because shifting currency weights may inevitably lead to changes in equity weights, tilting the currency composition imposes constraints on the equity selection component of fund management. For example, reverting to safer currencies induces funds to concentrate their equity portfolios in fewer countries and thus prevents them from achieving equity diversification or from exploiting the optimal equity combination. Consequently, their equity holdings would appear to be suboptimal if they are analyzed from the standard unconstrained mean-variance perspective. Our second hypothesis, therefore, states that currency concentration induced by the need to avoid volatile currencies reduces fund performance.

[2]For example, Solnik (1974), Adler and Dumas (1983), Harvey (1991), and Dumas and Solnik (1995), among others, provide asset pricing models that include currencies. Currency exposure may also enhance the ability of a fund to generate returns when it diversifies to reduce equity risk. Campbell, Medeiros, and Viceira (2010) show that in the last two decades, equity investors would have been better off investing in several currencies, including the U.S. dollar (USD), the euro (EUR), and the Swiss franc (CHF), that have negative correlations with the equity market. This benefit, of course, should also be priced in a perfect market.

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We test these hypotheses by focusing on a complete sample of international mutual funds over the period from 2001 to 2012. To test the first hypothesis, we link the policy of currency concentration in excess of the style benchmark to currency risk (ICVR). Consistent with our first hypothesis, we find that ICVR is positively related to the policy of currency concentration. More specifically, a 1-standard-deviation increase in ICVR can increase currency concentration by as much as 15% with respect to the standard deviation of currency concentration; this effect is not only statistically significant but also economically sizable.[3] The impact of ICVR is also larger than the impact of other exogenous fund characteristics that may affect currency concentration, such as style complexity, flow uncertainty, and the distance between the location of the stocks and the fund.

Of course, in addition to currency concentration, a fund can also revert to its base currency to reduce currency risk. However, the flexibility of allocations between local and foreign assets is rather limited for international funds. Even when they can revert to their base currency, the motivation to do so can be driven by local information in the equity market (e.g., Coval and Moskowitz (1999), (2001)) as opposed to currency concerns. In this regard, the reverting-to-base-currency approach is not an ideal currency policy to quantify the equity performance impact of embedded currency risk. Rather, we use this policy as a control in our performance tests to alleviate any suspicion of spurious correlation related to superior information and base currency weight.

We then move on to test the performance impact of the currency policy, as implied by our second hypothesis. To compute fund performance, we apply various risk adjustments to fund total returns, holding-implied fund returns, and its equity component, the last of which is computed by ripping off the return impact of exchange rates from the holding-implied returns. We mainly rely on three nested models for risk adjustment: i) the traditional international capital asset pricing model (ICAPM) (Solnik (1974), Adler and Dumas (1983)) based on the Morgan Stanley Capital International (MSCI) World total returns and the Fung and Hsieh (2004) currency factor (MX); ii) a 6-factor model, motivated by Griffin (2002) and Fama and French (2012), that adds the Fama–French (1992), (1993)–Carhart (1997) 4 factors in the domestic market to the ICAPM (MX4); and iii) a 7-factor model that further includes the Lustig, Roussanov, and Verdelhan (2011) carry-trade factor in addition to the MX4 factors (we call it MX4C). Together, these three models (MX, MX4, and MX4C) control for the most important common risk factors known to affect fund performance and currency returns.

Our empirical tests confirm that currency concentration has a negative impact on fund performance. A portfolio analysis shows that the economic impact of currency concentration is approximately 176, 154, and 116 bps per year for MX-, MX4-, and MX4C-adjusted fund total returns, respectively, and 202, 186, and 157 bps per year for MX-, MX4-, and MX4C-adjusted holding-based returns, respectively. This performance impact is further confirmed by a multivariate analysis that explicitly controls for possible confounding effects: a 1-standard-deviation

[3]In other words, the impact of $y = \beta \times x$ is computed as $\beta \times \sigma_x/\sigma_y$ here, where x and y are the independent and dependent variables, respectively, of the regression, and σ_x and σ_y are the standard deviations of the independent and dependent variables, respectively.

increase in currency concentration is related to a total return performance that is 137, 123, and 103 bps lower per year and a holding-based performance that is 155, 141, and 117 bps lower per year, respectively. The performance impact of the currency concentration policy is both statistically and economically significant.

Thus far, our tests confirm the two working hypotheses that the policy of currency concentration is enacted by funds to manage currency risk and that currency policy negatively affects portfolio performance. To further confirm these conclusions and to offer an economic explanation to understand the puzzling impact of currency risk on fund performance, we examine how much of the performance impact of currency risk is channeled through the currency concentration policy. Thus, we project currency concentration on ICVR and focus on the predicted component (i.e., ICVR-induced currency concentration) to investigate its impact on fund performance.

We find that a significant portion of the reduction in performance is related to the currency concentration induced by the currency risk. More specifically, a 1-standard-deviation increase in ICVR-induced currency concentration is related to a reduction in total return performance of 33, 28, and 22 bps and a reduction in holding-implied performance of 41, 32, and 29 bps for MX-, MX4-, and MX4C-adjusted returns, respectively. These results explain a significant proportion of the impact of ICVR on fund performance and suggest that currency policy indeed channels the influence of ICVR.

Finally, we show that the main impact of currency policies on fund performance is through the equity component of portfolio returns. We reach this conclusion by decomposing fund returns into currency and equity components and by showing that the impact of currency concentration or ICVR-induced currency concentration is mostly on equity performance. In the Internet Appendix (available at www.jfqa.org), we also show that our main results are robust when we control for family and style characteristics.

Overall, we demonstrate that international mutual funds deviate from their benchmarks by enhancing currency concentration when their benchmark implies higher currency risk. This active concentration, however, leads to lower rather than higher performance. If we interpret lower equity performance as the cost of an operational hedge, then this cost is higher than the typical cost in the currency forward market.[4] Meanwhile, although we conclude that operational hedges are a major source of performance reduction for international mutual funds, our tests do not refute the existence of derivative hedges; the lack of data on derivative-related currency-hedging activities makes it impossible for us to draw any conclusions on the latter.[5] However, our results illustrate that the *residual* impact of currency risk,

[4]Discussions with fund managers suggest that forward market hedges could cost approximately 20–40 bps year, which is less than the direct impact of ICVR on equity performance. However, we must interpret this cost with caution. If the total cost of currency hedges is only approximately 20–40 bps per year, large corporations should not be affected significantly by their currency exposure. However, this ideal situation is not what we observe in the market. For instance, an article in *Financial Times* (Gangahar (2009)) states, "The list of companies that have reported the pinch of currency risk in recent weeks is long and distinguished," including Procter & Gamble, Mattel, Starbucks, McDonald's, Kimberly–Clark, Walmart, and so forth.

[5]The survey of Levich, Hayt, and Ripston (1999) shows that currency derivative hedging is rare among portfolio managers. However, we must interpret this result with caution because the survey was conducted some time ago.

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after netting out all potential derivative hedges and desired currency exposures, is economically significant. This finding confirms that in the global mutual fund industry, the impact of currency risk is not limited to the currency market. Rather, risk exposure in one asset class (i.e., currency) can affect investment decisions and efficiency in a totally different asset class (i.e., equity). Our results, therefore, provide new ground to elucidate the incentives and performance of international mutual funds.

Our results shed new light on delegated portfolio management. For example, the literature illustrates that superior performance can be delivered by closely related managers (Coval and Moskowitz (1999), (2001), Chen, Hong, Jiang, and Kubik (2013), Kang and Stulz (1997), Grinblatt and Keloharju (2001), and Froot, O'Connell, and Seasholes (2001)) as well as by the policy of portfolio concentration (e.g., Kacperczyk, Sialm, and Zheng (2005), Brands, Brown, and Gallagher (2005)) as a result of better information. The negative relationship between currency concentration and performance is exactly the opposite of the positive relationship between equity concentration and performance found in the literature. This interesting difference suggests that the currency concentration policy is motivated by hedging purposes rather than by superior information.

Our findings also contribute to the literature on the limits of arbitrage (e.g., Shleifer and Vishny (1997)) because we show how exogenous constraints negatively affect equity choices, effectively preventing funds from achieving optimal trading in the equity market. In other words, the mismatch between the base currency and the currency of investment may tilt investors' equity portfolios in a way that prevents the exploitation of mispricings at the equity level. This mechanism may reduce the efficiency of the equity market by introducing a currency-based limit of arbitrage.

II. Data and Variables Construction

Data on equity mutual funds come from Morningstar International and FactSet/LionShares. Morningstar International has complete coverage of open-end mutual funds worldwide starting from the early 1990s. The database is free of survivorship bias because it includes data on both active and defunct funds. The initial sample includes 199,542 primary equity funds and share classes (both active and dead funds).[6] We consolidate multiple share classes into portfolios by adding share class net assets together and by value weighting the share class returns, fees, and turnover ratios based on the share class total net assets (TNAs). The ensuing sample contains 100,238 equity funds (both active and dead funds).

The data set on holdings is the FactSet/LionShares database (2001–2012). This database contains holdings at the stock level for over 35,019 institutions in 144 countries, with positions totaling US$16.31 trillion as of the end of 2012. FactSet/LionShares compiles institutional ownership data from public filings by investors (such as 13-F filings in the United States), company annual reports,

[6]The primary fund is typically the class with the highest TNAs. In general, the primary fund represents more than 80% of the total assets across all share classes.

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stock exchanges, and regulatory agencies from around the world. Institutions are defined as professional money managers, including mutual fund companies, pension funds, bank trusts, and insurance companies. Overall, institutional ownership represents over 40% of the total world stock market capitalization in our sample period. We consider all types of stock holdings (common shares, American depositary receipts (ADRs), global depositary receipts (GDRs), and dual listings). We handle the issue of different reporting frequencies by institutions from different countries by using the latest available holdings update at each quarter end.

We further exclude offshore funds (e.g., a large number of the funds domiciled in Luxembourg), closed-end funds, index-tracking funds, exchange-traded funds, and funds-of-funds based on the fund class specification provided by FactSet/LionShares. We exclude offshore funds because their client location is not well defined (i.e., we do not know their base currency). Next, we hand-match the data set to the Morningstar database and require the mutual funds to have data on TNAs, age, fees, flows, and returns in the Morningstar database. We also require funds to have a valid benchmark (i.e., a benchmark that is followed by at least 10 funds) and at least 2 years of reported returns because we need to estimate fund factor loadings. The benchmarks are from Morningstar ("Prospectus Primary Benchmark"). Finally, we require the funds to be fully invested in equity; that is, the total amount invested in equity should not be lower than 95% of the TNA value.

The final sample includes 5,795 funds in 28 countries (3,543 active funds and 2,252 dead funds as of 2012). Panel A of Table 1 presents the number and TNAs of the sample of mutual funds by country from 2001 to 2012. A total of 3,543 equity funds that manage approximately US$3.65 trillion as of 2012 are included in the sample. Among them, U.S. funds represent 90% of the sample in terms of TNAs but only 66% of the number of funds. Panel B further details the number of funds with valid benchmarks by country and year. We find that the percentage of U.S. funds drops from 79% in 2001 to 59% in 2012, suggesting that the importance of funds domiciled in other countries increased over our sample period. Later sections demonstrate that our results are robust to both U.S. funds and funds from other countries.

The descriptive statistics reported in Panel A of Table 1 further illustrate two prominent patterns related to foreign assets/currencies. First, the mutual funds in our sample hold a significant proportion of their portfolios abroad. In 2008, for example, more than 1,614 funds have at least half of their assets invested in foreign assets. Second, most of the funds have at least one foreign currency in their holding portfolios. Indeed, by the end of the year 2008, one-fourth of the funds hold assets denominated in more than eight foreign currencies. These two observations jointly illustrate the importance of currencies in terms of portfolio management in the global mutual fund industry. To capture the impact of foreign currencies, our final sample focuses on international equity mutual funds that invested 20% or more of their net asset value in foreign assets. Our results are robust to this threshold.

We now describe the main variables that we use in the analysis. We report their summary statistics in Table 2 and provide their detailed definitions in the Appendix. We start with the main currency policy for operational hedges: the

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TABLE 1

Summary Statistics of International Mutual Funds

Table 1 presents the summary statistics on how mutual funds invest in foreign assets and currencies. Columns 1 and 2 of Panel A report the number of fund domicile countries and mutual funds by year; column 3 summarizes the TNAs of these funds in trillions of U.S. dollars. Only funds with a valid benchmark are included. Columns 4–6 show the number of mutual funds with foreign equity less than 20%, between 20% and 50%, or larger than 50% of their overall equity holdings (in terms of U.S. dollar value). Columns 7–9 report the number of funds that hold 1, between 2 and 8, and more than 8 foreign currencies of stocks in their holdings portfolios. Foreign equity is defined as stocks that are not listed in a fund's domicile country. Foreign currencies are defined as currencies that are not the base currency of a fund. Panel B reports the number of funds by country and year.

Panel A. International Mutual Funds

				No. of Benchmarked Funds with Specified Foreign Holdings			No. of Benchmarked Funds with Specified Foreign Currencies		
Year	No. of Countries	No. of Funds with Valid Benchmark	Total TNA (US$trillions)	<20%	20%–50%	50%–100%	1	(1, 8]	>8
	1	2	3	4	5	6	7	8	9
2001	19	2,598	2.48949	1,874	127	597	368	1,628	305
2002	20	3,339	2.36954	2,230	228	881	478	2,015	376
2003	27	3,960	1.93271	2,504	294	1,162	611	2,215	405
2004	27	4,385	2.81036	2,725	361	1,299	642	2,434	569
2005	27	4,614	3.15467	2,878	366	1,370	609	2,513	630
2006	27	5,007	3.86576	3,025	446	1,536	667	2,637	788
2007	28	5,140	4.49250	3,099	456	1,585	641	2,728	852
2008	30	5,164	4.28128	3,072	478	1,614	573	2,763	968
2009	30	4,943	2.44582	2,989	464	1,490	566	2,615	879
2010	30	4,462	3.46004	2,677	432	1,353	470	2,355	856
2011	28	4,282	4.16560	2,504	417	1,361	419	2,318	857
2012	26	3,543	3.64726	2,227	320	996	359	1,950	694

Panel B. Mutual Funds with Valid Benchmark by Country and Year

	Year											
Country	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
United States	2,065	2,217	2,277	2,368	2,458	2,598	2,669	2,656	2,537	2,355	2,223	2,096
United Kingdom	165	219	298	351	375	444	449	466	441	405	418	242
Luxembourg	99	249	335	406	432	480	493	514	468	408	361	209
France	10	63	133	204	233	265	283	316	323	269	239	202
Germany	56	152	206	208	210	217	214	208	181	166	155	142
India	0	0	1	62	87	141	141	135	147	144	141	112
Spain	7	67	102	111	118	120	125	120	114	100	89	83
Sweden	24	54	87	91	87	97	98	97	96	18	83	79
Switzerland	38	35	56	61	64	67	81	72	71	67	84	78
Belgium	43	66	80	88	88	94	92	81	76	69	55	47
Norway	20	30	42	48	52	51	52	53	49	47	46	46
Denmark	15	42	82	85	93	93	96	107	100	98	90	42
Austria	13	29	38	42	42	46	45	45	43	40	42	40
Ireland	16	44	82	91	100	101	94	106	112	98	95	40
Finland	6	15	28	32	37	41	47	47	41	42	40	23
Netherlands	10	18	35	37	38	39	36	32	31	29	27	23
Liechtenstein	0	0	20	27	28	29	33	31	31	31	28	11
Guernsey	7	10	10	9	10	10	9	8	8	7	7	7
Italy	1	22	29	32	32	34	32	13	15	14	10	6
Cayman Islands	0	0	1	5	4	4	6	4	4	4	4	4
Jersey	0	2	3	3	3	3	3	6	6	6	7	3
Portugal	0	3	4	4	4	4	4	4	4	3	3	3
British Virgin Islands	2	2	2	3	1	2	3	2	2	2	2	2
Channel Islands	0	0	0	0	0	0	0	1	1	1	0	1
Malaysia	0	0	1	8	10	19	24	30	29	31	26	1
Taiwan	0	0	0	0	0	0	0	0	0	1	1	1
Andorra	0	0	0	0	0	3	3	0	6	0	0	0
Bermuda	1	0	2	3	2	2	2	2	2	2	2	0
Greece	0	0	4	4	4	0	3	3	1	1	0	0
Hong Kong	0	0	0	0	0	0	0	1	1	1	1	0
Isle of Man	0	0	2	2	2	3	3	3	3	3	3	0
Singapore	0	0	0	0	0	0	0	1	0	0	0	0
Total	2,598	3,339	3,960	4,385	4,614	5,007	5,140	5,164	4,943	4,462	4,282	3,543

TABLE 2

Summary Statistics of the Key Variables

Table 2 reports the summary statistics for our main variables. The definitions for the variables are provided in the Appendix. Column 1 reports the number of observations for each variable in our final sample. Columns 2–6 report the mean, median, standard deviation, skewness, and kurtosis of the distribution for each variable.

Variable	No. of Obs. 1	Mean 2	Median 3	Std. Dev. 4	Skewness 5	Kurtosis 6
Panel A. Currency and Alternate Policies						
CURRENCY_CONCENTRATION (main)	72,051	0.482	0.433	0.266	0.581	2.366
BMK_CURRENCY_NUM	70,716	1.151	1.234	0.28	−2.76	13.322
BMK_CURRENCY_CONCENTRATION	72,051	0.455	0.36	0.274	0.509	1.962
INDUSTRY_CONCENTRATION	72,041	0.28	0.169	0.24	1.901	5.372
STOCK_NUM	72,051	99.269	60	158.676	6.468	68.498
STOCK_CONCENTRATION_DOM	72,051	0.003	0	0.016	32.382	1,666.091
STOCK_CONCENTRATION_FORE	72,043	0.081	0.021	0.183	3.559	15.955
LOCAL_CURRENCY_WEIGHT	72,051	0.207	0.005	0.29	1.011	2.335
Panel B. Determinants of Currency Policy						
ICVR (main)	72,051	0.019	0.017	0.014	0.821	3.616
ECONOMIC_DISTANCE	72,051	0.136	0.151	0.114	0.554	3.54
INDUSTRY_DISTANCE	72,051	0.634	0.679	0.169	−0.42	1.986
GEOGRAPHIC_DISTANCE	72,051	−0.355	−0.409	0.27	0.1	1.685
CULTURAL_DISTANCE	72,051	0.122	0.061	0.156	1.886	8.163
FUND_NEG_OUTFLOW	72,051	−0.01	0.00	0.03	4.46	23.04
FUND_CORR_FLOW_FX	72,051	0.01	0.00	0.30	0.01	4.47
Panel C. Other Fund Characteristics						
FUND_FEE	72,051	1.518	1.478	0.558	0.496	4.87
FUND_TURNOVER	72,051	128.573	93.79	1,396.106	86.642	10,000.00
FUND_AGE	71,551	12.369	10	9.613	1.913	8.563
FUND_TNA (in US$10^8)	72,051	5.50	0.77	26.00	0.00	0.00
Panel D. Fund Performance (%)						
FUND_TOTAL_RETURNS						
MX	70,416	0.028	−0.033	3.057	0.21	4.921
MX4	70,408	0.007	−0.038	2.599	0.159	4.37
MX4C	70,408	0.037	0.043	2.975	0.037	4.38
HOLDING_IMPLIED_RETURNS						
MX	70,029	0.032	−0.058	3.66	0.163	4.902
MX4	70,021	0.031	−0.026	3.119	0.119	4.382
MX4C	70,021	0.056	0.04	3.56	0.063	4.306
EQUITY_COMPONENT_OF_FUND_RETURNS						
MX	70,029	0.02	−0.061	3.644	0.161	4.922
MX4	70,021	0.016	−0.036	3.11	0.114	4.404
MX4C	70,021	0.049	0.028	3.541	0.068	4.298

choice of the degree of currency concentration in the portfolio (CURRENCY_CONCENTRATION). For any given portfolio, its currency concentration is defined as the sum of the squared currency investment weights (i.e., $\sum_{i=1}^{N} w_i^2$), where w_i is the weight of currency i in the portfolio. We then compute the currency concentration of a fund in excess of what would have been required by the benchmark. Note that, for our purposes, currency concentration is defined in excess of the style benchmark. Because the difference between the real holdings of a fund and its benchmark can be considered an active long–short portfolio in the spirit of Cremers and Petajisto (2009), the net of benchmark currency policies captures managers' real actions in response to currency risk, that is, their actions to avoid volatile currencies that should otherwise be invested in according to their benchmarks. The degree of currency concentration varies drastically across international funds.

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We control for three types of variables that may affect a fund's currency concentration owing to reasons unrelated to operational currency hedging. The first type concerns the complexity of the benchmark's exogenous currency portfolio, which may lead funds to deviate from their benchmarks. Specifically, we use the natural logarithm of the number of currencies in the benchmark portfolio (BMK_CURRENCY_NUM) and the existing degree of currency concentration in the benchmark portfolio (BMK_CURRENCY_CONCENTRATION). The average fund style invests in 28 currencies, with a currency concentration of 0.455.

The second type of control concerns the degree of concentration of the fund's equity portfolio, including industry concentration and stock concentration (Kacperczyk et al. (2005), Brands et al. (2005)). Note that we control for concentrations in domestic and foreign equity separately (STOCK_CONCENTRATION_DOM and STOCK_CONCENTRATION_FORE, respectively) because concentrations in domestic stocks could be related to information. Stock concentration is defined in a manner similar to currency concentration. For instance, STOCK_CONCENTRATION_DOM $= \sum_{i \in \text{DOMESTIC_STOCK}} w_i^2$, where w_i is the investment weight of security i in a given portfolio. Industry concentration is defined based on Kacperczyk et al. (2005). In addition, we also control for the natural logarithm of the number of stocks in each fund's portfolio (STOCK_NUM). The average fund holds 99 stocks in its portfolio and has an overall concentration of 0.084 and a domestic (foreign) concentration of 0.003 (0.081).

The third type concerns the choice of the proportion of the asset value that is invested in the base currency (LOCAL_CURRENCY_WEIGHT). More specifically, we define local currency weight as the proportion of the fund portfolio invested in the base currency of the fund in excess of what its benchmark requires. As mentioned previously, a reverting-to-base-currency policy could provide limited flexibility for international funds, and such a policy could be motivated by both local equity information and currency risk management. Interestingly, the performance impacts of these two motivations are exactly the opposite of each other: The use of local information leads to better performance, whereas the management of currency risk generates worse performance. Overall, currency concentration, rather than the local currency weight, is the main policy to test the impact of currency risk on equity performance.

Next, we construct the proxy for currency risk: ICVR. This variable measures the currency volatility of the fund due to its style affiliation. ICVR is constructed as the standard deviation of the *benchmark currency portfolio* return according to the historical foreign exchange (FX) rates and their covariance matrix in the previous 36 months. More specifically, the benchmark currency portfolio of a fund is constructed by replacing the equity investments of the benchmark with cash investments in the corresponding currency of the stock. The currency return—with respect to the base currency of the fund—that could have been generated by these cash holdings in the previous 36 months is then used to compute its standard deviation, which we define as the fund's ICVR. The median ICVR is 1.7%, and ICVR can reach as high as 3.7% at its 90th percentile. Such a variation implies that some mutual funds are indeed exposed to currency risk owing to the mismatch between the currencies of the benchmark portfolios and their own base currencies. All the independent variables are further adjusted in the regressions by their benchmark averages.

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Although ICVR is the main independent variable that affects currency concentration and fund performance, other variables, such as flow uncertainty and the distance between the location of the stocks and the fund, may also affect currency concentration for very different economic reasons, such as fire-sale pressure and superior information (Coval and Stafford (2007)). We therefore construct and explicitly control for these variables. More specifically, we build on the literature to construct proxies for geographic distance (Sarkissian and Schill (2004)), cultural distance (Grinblatt and Keloharju (2001)), industry distance (Sarkissian and Schill (2004)), and economic distance (Kang and Stulz (1997), Dahlquist and Robertsson (2001)). For each distance measure, we compute the distance between a fund and its benchmark holdings as the benchmark holdings' value-weighted average of the distance between the benchmark stocks and the domicile country of the mutual fund. In general, a higher value for "distance" indicates that the fund and its benchmark holdings are less connected or further away from each other. Distance defined based on benchmark weights is exogenous to fund choices.

The proxies for flow uncertainty are negative fund outflows (FUND_NEG_OUTFLOW) and the correlations between fund flows and FX returns (FUND_CORR_FLOW_FX). The negative fund outflows variable at time t is constructed as the ratio between the dollar outflows at time t divided by the TNAs of the fund at time $t-1$. We keep the negative signs. The correlation between the fund flows and the FX returns is the correlation between a fund's monthly flow/TNA ratio and the return of the currencies in which the fund invests, weighed according to the benchmark investment weights. For each month, the correlation is constructed by using the prior 12 months of available data.[7] A positive correlation means that outflows or fire sales occur when the foreign currencies in which the fund should invest have negative returns on average; that is, they depreciated against the base currency of the fund. Both the negative fund outflows and the correlation between the fund flows and the FX returns are defined in excess of the benchmark.

Finally, we also control for general fund characteristics, including the annual expense ratio (FUND_FEE), the annual turnover ratio (FUND_TURNOVER), the age of the fund (FUND_AGE), and fund size (FUND_TNA). The last two variables are the natural logarithm of the years of operation since inception and the TNAs in U.S. dollars. All the fund characteristics are lagged by one quarter. The average annual expense ratio and turnover ratio are 1.52% and 128.6%, respectively. Huang, Sialm, and Zhang (2011) report an average annual expense ratio and turnover ratio of 1.28% and 90%, respectively, for actively managed domestic U.S. equity funds, suggesting that international funds are typically more expensive and active than U.S. funds (the two ratios are 1.27% and 94%, respectively, for active U.S. equity funds in our sample). The average age and TNAs by the end of 2006 are 17.54 years and US$1.38 billion, respectively, in the study by Huang et al. (2011) compared with 12 years and US$0.56 billion, respectively, in our sample in the same year. Our main tests exclude small funds with TNAs below $2

[7]We compute the correlation only if at least six data points are available; otherwise, we set it as a missing value. In a robustness check, we also attempt to replace the correlation between flows and currency returns with the volatility of the flows or the correlation between outflows/TNA ratios and currency returns. In another robustness check, we include the average flow-based variables as defined at the style level. These alternative measures do not have significant impacts of their own, and their inclusion does not significantly affect our results.

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million. As mentioned previously, all the independent variables are adjusted by their benchmark averages.

We now describe the alternative measures of performance that we use. First, we compute fund total returns, holding-based returns, and the equity and currency components of the holding-based returns for each fund on the basis of its most updated holdings information. Fund total returns are the monthly fund returns reported by Morningstar; we compound the monthly returns into quarterly returns to match the frequency of the holdings data for our main analyses. When a portfolio has multiple share classes, we compute its total return as the TNA-weighted return of all share classes of the portfolio, where the TNA values are 1-period lagged.

Following the convention in the literature (e.g., Kacperczyk and Seru (2007)), monthly holding-based returns are computed from the most updated holdings information as the value-weighted returns of the stocks in the portfolio denominated in the base currency: $\sum_n \xi_{n,t-1}^{\text{FUND}} \times (1 + \text{r}_{n,t}) \times (1 + \delta_{\text{FC_}n,t})$, where $\xi_{n,t-1}^{\text{FUND}}$ is the investment weight of the fund and its benchmark in stock n, $\text{r}_{n,t}$ is the return of the stock in the base currency of the stock, FC_n is the foreign currency of stock n, and $\delta_{\text{FC_}n,t}$ is the return (appreciation) of the base currency of the stock compared with the base currency of the fund. The equity component of the portfolio return is defined as $\sum_n \xi_{n,t-1}^{\text{FUND}} \times (1 + \text{r}_{n,t})$, which represents the stock return that the portfolio would have had if the currency returns were removed (i.e., completely hedged) from the holding-based returns. The difference between the holding-implied return and its equity component then represents the impact of currency risk.

Next, we consider various adjustments for risk. We rely on three nested models for risk adjustment. The first model (MX) is the traditional ICAPM, which is based on the MSCI World total returns and the Fung and Hsieh (2004) currency factors. The inclusion of currency risk factors is consistent with the "international" asset pricing models (e.g., Solnik (1974), Adler and Dumas (1983)). The second model (MX4) adds the Fama–French (1992), (1993)–Carhart (1997) 4 factors in the domestic market to the previous model because domestic factors are known to affect asset returns in the global market (e.g., Griffin (2002), Fama and French (2012)). Finally, given the importance of carry trades in the currency market, the third model (MX4C) further includes the Lustig et al. (2011) carry-trade factor on top of the MX4 factors.[8]

We then apply these models to compute the fund performance from the three measures of fund returns (i.e., fund total returns, funds' holding-implied returns, and the equity component of holding-implied returns). More specifically, we compute fund performance as the difference between the fund returns and the realized risk premium, which is estimated as the realized factor return multiplied by the risk exposure of the funds estimated over the full sample period. The methodology of using the full sample factor loadings for cross-sectional, risk-adjusted

[8]In the spirit of Cremers and Petajisto (2009), we also use benchmark-adjusted returns to compute fund performance. Our results are robust to this measure. In addition, our results are robust to other models of risk adjustment, such as the Fung and Hsieh (2004) 7-factor model and the international Fama–French (1992), (1993)–Carhart (1997) factors. However, we focus on the three nested models (MX, MX4, and MX4C) because they systematically control for the most important common risk factors in the global market.

return tests follows that of Black, Jensen, and Scholes (1972), Fama and French (1992), and Lettau and Ludvigson (2001) and allows us to obtain better estimates of the risk coefficients. We find that the performances of international mutual funds are widely distributed, which motivates us to explore the factors that may affect fund performance in later sections.

III. The Impact of Currency Risk on Fund Performance

We start by reporting the seemingly puzzling relationship between fund performance and lagged currency risk (ICVR) in Table 3. To do so, we rank the funds in each quarter according to their lagged currency risk and sort them into terciles. Then, we trace the average returns of all the funds in these terciles and report the out-of-sample, long-run performance that these funds can achieve.

TABLE 3

Performance Impacts of Currency Risks

Table 3 reports the out-of-sample performance of funds sorted by their ICVRs. In each quarter, funds are sorted into three terciles according to their ICVRs in the previous quarter. We then trace the average return of all the funds in these terciles over our entire sample period and report the out-of-sample, long-run performance that these funds can achieve. Columns 1–3 present the results for total returns from Morningstar, columns 4–6 report the results for the holding-implied returns, and columns 7–9 report the results for the equity component of returns. In each block, MX adjusts fund performance by the traditional ICAPM, MX4 adds the Fama–French (1992), (1993)–Carhart (1997) 4 factors in the domestic market to the ICAPM, and MX4C includes the Lustig et al. (2011) carry-trade factor on top of the MX4 adjustment. The lines labeled "High," "Medium," and "Low" report the out-of-sample quarterly performance (in %) of funds with high, medium, and low ICVRs, respectively. The final line, "High − Low," displays the risk-adjusted return difference between the high and low tercile of funds. *t*-statistics are reported below in parentheses. * and ** indicate significance at the 5% and 1% levels, respectively.

	FUND_TOTAL_RETURNS			HOLDING_IMPLIED_RETURNS			EQUITY_COMPONENT_OF_RETURNS		
	MX	MX4	MX4C	MX	MX4	MX4C	MX	MX4	MX4C
	1	2	3	4	5	6	7	8	9
Low	0.174*	0.164**	0.138**	0.16	0.174**	0.163**	0.14	0.141*	0.137*
	(2.55)	(4.18)	(3.41)	(1.82)	(3.22)	(3.04)	(1.57)	(2.51)	(2.48)
Medium	0.02	−0.01	0.045*	0.03	0.01	0.06	0.02	0.00	0.068*
	(0.78)	(−0.72)	(2.21)	(0.94)	(0.35)	(1.96)	(0.73)	(0.04)	(2.28)
High	−0.086*	−0.138**	−0.091**	−0.089**	−0.091**	−0.056*	−0.091**	−0.094**	−0.063*
	(−2.44)	(−4.50)	(−2.92)	(−2.94)	(−3.39)	(−2.03)	(−3.09)	(−3.64)	(−2.46)
High − Low	−0.260**	−0.301**	−0.229**	−0.247*	−0.266**	−0.219**	−0.227*	−0.235**	−0.200**
	(−3.20)	(−5.71)	(−4.29)	(−2.52)	(−4.38)	(−3.70)	(−2.35)	(−3.91)	(−3.46)

Columns 1–3 of Table 3 present the results for total returns from Morningstar, columns 4–6 report the results for the holding-implied returns, and columns 7–9 report the results for the equity component of holding-implied returns. For each type of fund return, we further make risk adjustments based on the three nested models (MX, MX4, and MX4C). The lines labeled "High," "Medium," and "Low" report the long-term performance of funds with high, medium, and low ICVR, respectively. The final line, "High − Low," displays the risk-adjusted return difference between the high and low terciles of funds.

The results show a strong and statistically significant negative relationship between currency risk and fund performance. More specifically, the long-term performance difference between funds with high and low currency risk can be as high as 104, 120, and 92 bps per year for MX-, MX4-, and MX4C-adjusted fund

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total returns, respectively, and 99, 106, and 88 bps per year for MX-, MX4-, and MX4C-adjusted holding-based performance, respectively; within the results for holding-based performance, 91, 94, and 80 bps per year can be directed to the equity component for MX-, MX4-, and MX4C-adjusted holding-implied returns, respectively.[9] We also verify that this negative relationship is robust in multivariate regressions (the Internet Appendix tabulates the results).

The most striking observation is that the impact of ICVR is not only robust and significant but also concentrated in the equity component of fund performance. As we argued, the impact of currency risk on equity returns is unexpected when traditional asset pricing models are used. However, this result may be explained by our two hypotheses through the intermediary channel of operational hedges. Hence, we move on to explicitly test the channel and our two hypotheses.

IV. Operational Hedging

A. Hedging Policy

We now focus on the main operational hedging policy (i.e., currency concentration) and study its relationship with currency risk. We therefore regress currency concentration on ICVR and a set of control variables:

$$\begin{aligned}(1)\quad &\text{CURRENCY_CONCENTRATION}_{f,t+1}\\ &= \alpha + \beta_1 \text{ICVR}_{f,t} + \beta_2 \text{DIST}_{f,t} + \beta_3 \text{FLOW_UNC}_{f,t} + \beta_4 X_{f,t} + \epsilon_{f,t},\end{aligned}$$

where $\text{CURRENCY_CONCENTRATION}_{f,t+1}$ is the currency concentration of fund f in quarter $t + 1$, ICVR is the measure of currency volatility risk, DIST is one of the four proxies for distance between the fund and its benchmark stocks, and FLOW_UNC is the proxy for flow uncertainty. The vector X stacks all the control variables, including the fund's fees, age, TNA, turnover, industry concentration, and degree of concentration in domestic stocks and foreign stocks, as well as the number of stocks in its portfolio, the number of currencies in its style benchmark, and the degree of currency concentration of its style benchmark.

We report the results in Table 4. Models 1–4 perform Fama–MacBeth (1973) analyses, and models 5–8 tabulate pooled panel regressions with fixed fund and year effects and estimation errors clustered at the fund level. A strong positive relationship is found between currency risk and currency concentration. In the full-fledged models (models 4 and 8), a 1-standard-deviation increase in ICVR increases currency concentration by 15% (14%) in the case of the Fama–MacBeth (pooled) specification. This result suggests that funds are averse to currency volatility and that they try to avoid the troublemakers (i.e., currencies that contribute the most to benchmark-implied currency volatility). Currency risk management is implemented by tilting the equity portfolio to meet currency hedging goals (i.e., operational hedging).

[9]The annual performance impact is computed as four times the quarterly performance difference reported in the "High − Low" line. For instance, the performance difference measured by MX (first column) based on the total return from Morningstar is −0.26% per quarter, which translates into $-0.26\% \times 4 = 104$ bps of annualized performance impact.

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TABLE 4

The Formation of Currency Policies (first-stage regressions)

Table 4 presents the results of the first-stage regressions between currency policies and proxies for information, flow uncertainty, and currency risk. $\text{CURRENCY_CONCENTRATION}_{f,t+1} = \alpha + \beta_1 \text{ICVR}_{f,t} + \beta_2 \text{DIST}_{f,t} + \beta_3 \text{FLOW_UNC}_{f,t} + \beta_4 X_{f,t} + \epsilon_{f,t}$, where $\text{CURRENCY_CONCENTRATION}_{f,t+1}$ is the currency concentration of fund f in quarter $t+1$, ICVR is the measure of currency volatility risk, DIST is one of the four proxies for distance between the fund and its benchmark stocks, and FLOW_UNC is the proxy for flow uncertainty. The vector X stacks all the control variables, including the fund's fees, age, TNA, turnover, industry concentration, and degree of concentration in domestic and foreign stocks, as well as the number of stocks in each fund's portfolio. We also include the benchmarked currency number (BMK_CURRENCY_NUM) and currency concentration (BMK_CURRENCY_CONCENTRATION). *t*-statistics are reported below in parentheses. * and ** indicate significance at the 5% and 1% levels, respectively.

	Regression Model							
	Fama–MacBeth				Pooled Panel			
	1	2	3	4	5	6	7	8
Panel A. Implied Currency Risk								
ICVR	3.895**	2.373**	4.115**	3.105**	3.786**	2.292**	3.880**	2.861**
	(15.49)	(11.74)	(15.76)	(12.44)	(15.80)	(8.41)	(17.73)	(10.81)
Panel B. Fund Distance								
ECONOMIC_DISTANCE		0.085**		–0.006		0.101**		0.013
		(5.30)		(–0.31)		(2.80)		(0.39)
INDUSTRY_DISTANCE		0.088**		0.057**		0.086**		0.060*
		(7.99)		(10.58)		(3.17)		(2.36)
GEOGRAPHIC_DISTANCE		0.082**		0.029**		0.080**		0.031*
		(19.03)		(8.02)		(5.49)		(2.25)
CULTURAL_DISTANCE		0.222**		0.168**		0.220**		0.171**
		(12.43)		(11.94)		(6.64)		(5.51)
Panel C. Fund Flow Uncertainty								
FUND_NEG_OUTFLOW			–0.003	–0.002			0.000	0.000
			(–0.79)	(–0.48)			(0.53)	(0.19)
FUND_CORR_FLOW_FX			–0.011**	–0.009**			–0.013**	–0.011**
			(–3.68)	(–3.21)			(–4.53)	(–3.75)
Panel D. Currency Control Variables								
BMK_CURRENCY_NUM			–0.001**	–0.000**			–0.001**	–0.000*
			(–8.96)	(–5.10)			(–4.13)	(–2.13)
BMK_CURRENCY_ CONCENTRATION			–0.202**	–0.179**			–0.199**	–0.173**
			(–36.49)	(–28.66)			(–18.77)	(–15.97)
Panel E. Fund Characteristics Control Variables								
FUND_FEE	–0.005	0.000	0.002	0.005	–0.006	0.000	0.001	0.005
	(–1.94)	(–0.12)	(0.74)	(1.92)	(–1.18)	(–0.08)	(0.20)	(0.95)
FUND_TURNOVER	0.002	0.003	0.002	0.003	0.001	0.002	0.002	0.002
	(0.96)	(1.75)	(1.62)	(1.80)	(0.39)	(1.04)	(0.89)	(1.05)
FUND_AGE	0.005**	0.005**	0.008**	0.007**	0.006	0.005	0.008*	0.006*
	(4.18)	(3.72)	(7.60)	(6.45)	(1.67)	(1.44)	(2.37)	(2.06)
FUND_TNA	–0.003*	–0.002	–0.004**	–0.003**	–0.004**	–0.003*	–0.005**	–0.004**
	(–2.59)	(–1.95)	(–5.04)	(–4.38)	(–2.58)	(–1.97)	(–3.32)	(–2.59)
Panel F. Fund Equity Management Control Variables								
INDUSTRY_ CONCENTRATION	–0.221**	–0.196**	–0.166**	–0.154**	–0.202**	–0.180**	–0.155**	–0.145**
	(–9.96)	(–8.92)	(–9.38)	(–8.56)	(–6.15)	(–5.82)	(–5.73)	(–5.45)
STOCK_NUM	0.019**	0.019**	0.015**	0.016**	0.020**	0.022**	0.017**	0.018**
	(10.37)	(9.59)	(7.18)	(7.37)	(5.21)	(5.64)	(4.75)	(5.08)
STOCK_ CONCENTRATION_DOM	2.283**	2.122**	1.237**	1.325**	1.803**	1.725**	1.085**	1.197**
	(8.95)	(9.63)	(9.07)	(9.86)	(7.41)	(7.42)	(6.36)	(6.52)
STOCK_ CONCENTRATION_FORE	0.861**	0.845**	0.816**	0.810**	0.845**	0.834**	0.808**	0.805**
	(25.30)	(25.25)	(26.53)	(26.73)	(27.21)	(27.53)	(29.37)	(29.06)
Constant	–0.111**	–0.018*	–0.005	0.041**	–0.113**	–0.019	–0.004	0.043**
	(–23.06)	(–2.59)	(–0.85)	(6.67)	(–20.51)	(–1.33)	(–0.41)	(2.89)
No. of obs.	69,931	69,931	69,931	69,931	69,931	69,931	69,931	69,931
R^2	0.319	0.366	0.411	0.429	0.305	0.354	0.396	0.415

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Among the control variables, we also find a significant positive correlation between cultural distance and currency concentration. A 1-standard-deviation increase in distance is related to a 10% (10%) higher currency concentration in the case of the Fama–MacBeth (1973) (pooled) specification. Additionally, a strong negative correlation is found between the (signed) outflows and the correlation of flows and FX and currency concentration. An increase of 1 standard deviation in the expected monthly outflows, that is, outflows become more negative (correlation of flows and FX), is related to a 1.0% (1.1%) higher currency concentration. In addition, equity concentration, both in domestic and foreign stocks, is also positively related to currency concentration. This result is expected because concentration in a limited number of stocks has a direct impact on currency choice. A 1-standard-deviation increase in the domestic stock concentration, for instance, leads to a 0.74% (0.67%) increase in currency concentration in the case of the Fama–MacBeth (pooled) specification. Industry concentration, by contrast, is negatively correlated with currency concentration, suggesting that from a manager's perspective, cross-industry and cross-country (currency) investment may be regarded as substitutes in achieving diversification.

Although it is not surprising that the policy of currency concentration can also be affected by these benchmark currency characteristics and equity policies, we notice that currency risk is by far the most important driving force of the policy. Hence, these results are largely consistent with our working hypothesis: Operational hedging is affected by the degree of currency uncertainty induced by the funds' style affiliation.

B. Portfolio Analysis

We now test our second hypothesis by directly linking operational hedging policies to fund performance. As we have argued, if currency concentration represents a way to hedge currency risk, it should constrain stock selection and thus reduce equity performance. To verify this hypothesis, we perform both an out-of-sample portfolio analysis and a multivariate analysis that controls for alternative policies and fund characteristics, as defined in the previous section.

We start with the portfolio analysis. In each quarter, we rank the funds according to their currency policies and sort them into terciles. Then, we compute the average return of all the funds in these terciles and use various models to adjust the risk. Finally, we report the long-term performance of the 3 terciles of funds in Table 5. The layout is similar to that of Table 3, in that columns 1–3, 4–6, and 7–9 present the results for total returns from Morningstar, holding-implied returns, and the equity component of holding-implied returns, respectively. The lines labeled "High," "Medium," and "Low" report the long-term performance of funds with high, medium, and low currency concentrations, respectively. The line "High − Low" displays the risk-adjusted return difference between the high and low terciles of funds.

The results show a strong and statistically significant negative relationship between currency concentration and fund performance. The economic impact of the currency concentration policy (computed in the same way as in Table 3) is approximately 176, 154, and 116 bps per year for total returns and 202, 186, and

TABLE 5

Single-Sorted Performance Impacts of Currency Concentration

Table 5 reports the performance of funds sorted by currency concentrations. In each quarter, the funds are sorted into 3 terciles according to their currency concentrations in the previous quarter. We then trace the average return of all the funds in these terciles over our entire sample period and report the out-of-sample, long-run performance that these funds can achieve. Columns 1–3 present the results for total returns from Morningstar, columns 4–6 report the results for the holding-implied returns, and columns 7–9 report the results for the equity component of returns. The lines labeled "High," "Medium," and "Low" report the out-of-sample quarterly performance (in %) of funds with high, medium, and low currency concentrations, respectively. The final line, "High − Low," displays the risk-adjusted return difference between the high and low terciles of funds. *t*-statistics are reported below in parentheses. * and ** indicate significance at the 5% and 1% levels, respectively.

	FUND_TOTAL_RETURNS			HOLDING_IMPLIED_RETURNS			EQUITY_COMPONENT_OF_FUND_RETURNS		
	MX	MX4	MX4C	MX	MX4	MX4C	MX	MX4	MX4C
	1	2	3	4	5	6	7	8	9
Low	0.284*	0.223**	0.191**	0.354**	0.316**	0.311**	0.314*	0.274**	0.283**
	(2.62)	(3.81)	(3.17)	(2.82)	(4.05)	(3.93)	(2.49)	(3.45)	(3.54)
Medium	−0.01	−0.03	0.01	−0.07	−0.05	−0.03	−0.07	−0.05	−0.04
	(−0.79)	(−1.84)	(0.52)	(−1.91)	(−1.63)	(−0.93)	(−1.88)	(−1.71)	(−1.09)
High	−0.155**	−0.164**	−0.099**	−0.152*	−0.148**	−0.08	−0.146*	−0.151**	−0.07
	(−4.20)	(−5.42)	(−3.13)	(−2.14)	(−2.85)	(−1.63)	(−2.09)	(−3.07)	(−1.35)
High − Low	−0.439**	−0.386**	−0.290**	−0.506**	−0.464**	−0.393**	−0.460*	−0.425**	−0.350**
	(−3.25)	(−4.90)	(−3.67)	(−2.73)	(−3.91)	(−3.27)	(−2.48)	(−3.64)	(−2.92)

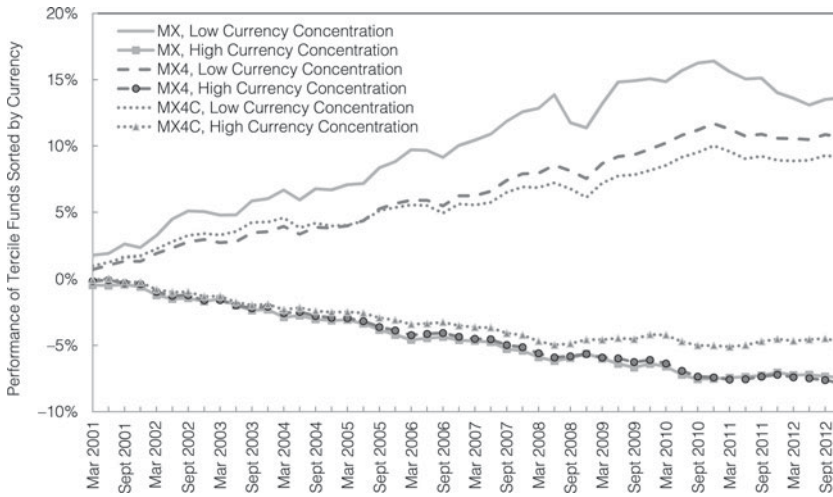
157 bps per year for holding-based performance in the case of the MX-, MX4-, and MX4C-adjusted returns, respectively.

Figure 1 visualizes the return and alpha time series that are generated by funds with high and low currency concentrations. In particular, each quarter, the funds are sorted into three terciles according to their currency concentrations. We then plot the accumulated fund performance for high- and low-tercile funds.

FIGURE 1

Performance of Tercile Funds Sorted by Currency Concentration

In each quarter, funds are sorted into 3 terciles according to their lagged currency concentration. We then plot the out-of-sample accumulated fund performance (MX-, MX4-, and MX4C-adjusted total returns) for the funds in the terciles with high and low currency concentrations.



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To save space, we depict only the total return-based performance (MX, MX4, and MX4C) here; for the holding-based performance plots, see the Internet Appendix. If low-currency-concentration funds outperform high-currency-concentration funds, as reported in Table 5, we would expect the performance gap between the two types of funds to increase (and become wider) over time. The figure clearly shows such a pattern, which further confirms the underperformance of high-concentration funds.

C. Multivariate Analysis

We now consider a multivariate analysis. We relate out-of-sample fund performance to funds' currency policies and a set of fund-level control variables in quarterly Fama–MacBeth (1973) regressions and report the results in Table 6.

In Panel A of Table 6, the dependent variable is quarterly fund total returns (in percentage) adjusted by the three nested models. The difference between

TABLE 6

Performance Impacts of Currency Concentration in Fama–MacBeth Regressions

Table 6 reports the performance impact of currency concentration according to Fama–MacBeth (1973) regressions. In Panel A, we regress MX-, MX4-, and MX4C-adjusted quarterly Morningstar total returns (in %) of the funds on the lagged currency concentration and the lagged control variables and tabulate the time-series averages of the cross-sectional parameters as well as their Newey–West (1987) *t*-statistics (reported below in parentheses) with 5 lags. Panel B reports the result of the holding-implied returns. Panels C and D report the results of similar tests using the U.S. and non-U.S. subsamples for the Morningstar total returns and holding-implied returns, respectively. * and ** indicate significance at the 5% and 1% levels, respectively.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	MX	MX4	MX4C	MX	MX4	MX4C
	1	2	3	4	5	6
Panel A. Total Returns from Morningstar						
CURRENCY_CONCENTRATION	−1.169**	−1.061**	−0.802**	−1.292**	−1.156**	−0.968**
	(−3.26)	(−5.44)	(−3.25)	(−3.30)	(−6.02)	(−4.29)
LOCAL_CURRENCY_WEIGHT	0.097	0.107	−0.086	−0.027	0.016	−0.167
	(1.39)	(1.32)	(−0.88)	(−0.32)	(0.17)	(−1.62)
FUND_FEE	−0.100	−0.136*	−0.242**	−0.133*	−0.158**	−0.262**
	(−1.61)	(−2.50)	(−3.39)	(−2.50)	(−3.28)	(−4.31)
FUND_TURNOVER	−0.048	−0.057*	−0.126**	−0.045	−0.054*	−0.118**
	(−1.71)	(−2.52)	(−7.02)	(−1.67)	(−2.41)	(−6.72)
FUND_AGE	0.067	0.047*	0.059	0.054	0.040	0.048
	(1.91)	(2.10)	(2.00)	(1.85)	(1.94)	(1.91)
FUND_TNA	−0.023	−0.003	−0.018	−0.001	0.011	−0.001
	(−0.81)	(−0.17)	(−1.21)	(−0.05)	(0.66)	(−0.06)
BMK_CURRENCY_CONCENTRATION	0.031	0.126	0.029	−0.064	0.044	−0.077
	(0.47)	(1.59)	(0.43)	(−0.92)	(0.52)	(−1.01)
STOCK_NUM				0.829	0.864*	1.111**
				(1.97)	(2.60)	(2.90)
INDUSTRY_CONCENTRATION				−0.056**	−0.018	0.013
				(−2.98)	(−1.27)	(0.69)
STOCK_CONCENTRATION_DOM				4.287	2.759	2.388*
				(1.76)	(1.36)	(2.21)
STOCK_CONCENTRATION_FORE				0.375	0.348	0.766*
				(0.73)	(1.21)	(2.03)
Constant	−0.027	−0.095**	−0.027	0.000	−0.074*	−0.001
	(−1.02)	(−3.11)	(−1.01)	(−0.02)	(−2.47)	(−0.03)
No. of obs.	69,923	69,915	69,915	69,908	69,900	69,900
R^2	0.033	0.024	0.019	0.052	0.04	0.034
F-statistics	3.23	7.28	11.11	3.70	6.28	9.75

(continued on next page)

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TABLE 6 (continued)

Performance Impacts of Currency Concentration in Fama–MacBeth Regressions

	Model 1 MX 1	Model 2 MX4 2	Model 3 MX4C 3	Model 4 MX 4	Model 5 MX4 5	Model 6 MX4C 6
Panel B. Holding-Implied Returns						
CURRENCY_CONCENTRATION	−1.334* (−2.65)	−1.181** (−4.07)	−1.028* (−2.63)	−1.455** (−3.01)	−1.324** (−5.01)	−1.100** (−3.16)
LOCAL_CURRENCY_WEIGHT	0.058 (0.94)	0.005 (0.06)	0.025 (0.21)	−0.078 (−0.88)	−0.100 (−1.16)	0.001 (0.01)
Control for fund characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Control for equity policies	No	No	No	Yes	Yes	Yes
No. of obs.	69,538	69,530	69,530	69,537	69,529	69,529
R^2	0.034	0.024	0.02	0.063	0.05	0.042
F-statistics	2.21	4.22	10.52	2.41	4.35	7.31
	U.S. Funds			Non-U.S. Funds		
	Model 4 MX 1	Model 5 MX4 2	Model 6 MX4C 3	Model 4 MX 4	Model 5 MX4 5	Model 6 MX4C 6
Panel C. Subsamples for Total Returns from Morningstar						
CURRENCY_CONCENTRATION	−2.819** (−3.04)	−2.389** (−3.76)	−2.193** (−2.74)	−1.066** (−2.72)	−0.831** (−3.17)	−0.741** (−2.80)
LOCAL_CURRENCY_WEIGHT	0.358 (1.53)	0.216 (1.15)	−0.070 (−0.19)	0.131 (1.56)	0.192** (2.69)	0.141 (1.90)
Control for fund characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Control for equity policies	No	No	No	Yes	Yes	Yes
No. of obs.	16,365	16,365	16,365	40,160	40,152	40,152
R^2	0.085	0.069	0.061	0.024	0.021	0.024
F-statistics	3.56	3.64	7.21	3.06	6.37	15.80
Panel D. Subsample for Holding-Implied Returns						
CURRENCY_CONCENTRATION	−2.027** (−3.08)	−1.999** (−4.16)	−1.400** (−2.69)	−1.033* (−2.54)	−0.855** (−3.14)	−0.633* (−2.28)
LOCAL_CURRENCY_WEIGHT	0.022 (0.08)	0.111 (0.36)	0.304 (0.75)	0.109 (1.63)	0.097* (2.06)	0.142* (2.12)
Control for fund characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Control for equity policies	No	No	No	Yes	Yes	Yes
No. of obs.	15,053	14,917	14,957	36,704	36,154	35,921
R^2	0.067	0.047	0.035	0.033	0.022	0.021
F-statistics	2.70	4.21	6.02	2.19	3.90	9.44

models 1–3 and models 4–6 is that models 1–3 control for local currency weight and fund characteristics, including fees, turnover, age, and TNA, whereas models 4–6 further control for the characteristics of the equity holdings of funds, including the number of stocks, the industry concentration, and the degree of concentration in domestic and foreign stocks. For each model, Panel A tabulates the time-series averages of the cross-sectional parameters and their Newey–West (1987) *t*-statistics with 5 lags (to control for the potential seasonality in quarterly regressions; our results are robust to the choice of lags). In Panel B, we report similar statistics for the risk-adjusted, holding-implied returns. To save space, however, we tabulate only the coefficients for the main variables in Panel B (and in later tables). The full specifications of the regression parameters can be found in the Internet Appendix.

The results are consistent with the previous portfolio analyses and show a strong and significant correlation between currency policies and fund returns.

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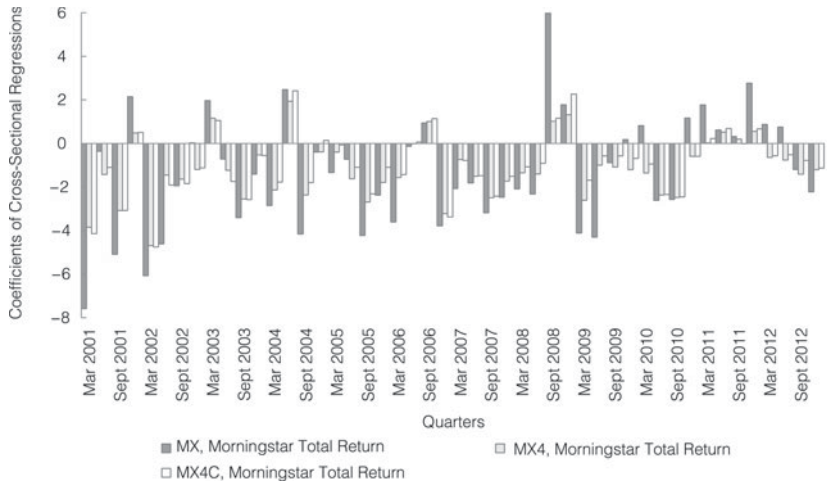
In models 4–6, a 1-standard-deviation increase in currency concentration is related to a total return performance that is 137, 123, and 103 bps lower and a holding-based performance that is 155, 141, and 117 bps lower for MX-, MX4-, and MX4C-adjusted returns, respectively.[10] Hence, the negative performance impact of currency concentration is not only statistically significant but also economically relevant.

Furthermore, we conduct a series of additional analyses related to the negative performance impact of currency concentration. We first plot, in Figure 2, the time-series variation of the quarterly Fama–MacBeth (1973) regression coefficients of currency concentration from models 4–6 of Panel A. The plots show that the performance impact of currency concentration is generally negative. One notable exception occurs in the third and fourth quarters of 2008, during which concerns regarding the global financial crisis may dominate currency considerations. Nonetheless, the overall impact of currency concentration is clearly negative in most quarters across all the performance measures.

FIGURE 2

Impact of Currency Risk over Time

Figure 2 plots the quarterly cross-sectional regression coefficients of currency concentration based on models 4 (MX), 5 (MX4), and 6 (MX4C) in Panel A of Table 6.



Next, because the majority of the funds are U.S. domiciled, we also conduct robustness checks to explore whether the impact of currency policy arises from U.S. funds only. Panels C and D of Table 6, therefore, apply the previous analyses of Panels A and B to the subsamples of U.S. and non-U.S. funds, respectively. To save space, we tabulate side by side only the subsample regression coefficients corresponding to those from models 4–6 of Panels A and B: columns 1–3 for U.S. funds and columns 4–6 for non-U.S. funds. Subsample regressions based on models 1–3 of Panels A and B yield similar conclusions. The results show that the

[10]The quarterly economic magnitude is estimated as the 1-standard-deviation change in currency concentration times the regression coefficient. We further annualize this impact by multiplying its value by 4.

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performance impact of currency concentration prevails in both U.S. and non-U.S. funds, although the magnitude of the performance impact is greater for U.S. funds.

Finally, Table 7 explores the general impact of currency concentration on equity performance. The layout is similar to that of Panel B of Table 6, except that we focus on the equity component of holding-implied returns rather than the holding-implied returns. The results are consistent with the previous results and show that a strong negative relationship exists between equity performance and currency concentration. A 1-standard-deviation increase in currency concentration is related to a reduction in MX-, MX4-, and MX4C-adjusted equity performance of 131, 120, and 108 bps, respectively. The magnitude of the impact is on par with that reported in Table 6, confirming that the performance impact of ICVR is mainly achieved through the equity channel.

TABLE 7

Equity Component of Fund Performance

Table 7 reports the impact of currency policies on the equity component of fund performance. Specifically, similarly to Table 6, MX-, MX4-, and MX4C-adjusted equity returns (quarterly performance, in %) are regressed period by period on currency concentration and a set of control variables. We report the time-series averages of the cross-sectional regression parameters and their Newey–West (1987) adjusted *t*-statistics (reported below in parentheses) for the main policies. * and ** indicate significance at the 5% and 1% levels, respectively.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	MX	MX	MX4	MX4	MX4C	MX4C
CURRENCY_CONCENTRATION	−1.159*	−0.998**	−0.951*	−1.232*	−1.127**	−1.011*
	(−2.24)	(−3.18)	(−2.20)	(−2.44)	(−3.58)	(−2.49)
LOCAL_CURRENCY_WEIGHT	0.058	0.062	0.076	−0.084	−0.059	0.014
	(0.74)	(0.86)	(0.67)	(−0.78)	(−0.72)	(0.16)
Control for fund characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Control for equity policies	No	Yes	No	Yes	No	Yes
No. of obs.	69,538	69,530	69,530	69,537	69,529	69,529
R^2	0.033	0.022	0.019	0.061	0.047	0.04
F-statistics	1.82	3.56	8.27	1.98	3.40	5.66

In addition to these analyses, we also find that the negative correlation between performance and currency policies is robust when we use panel specifications and when we control for family or style affiliations. The Internet Appendix provides the details of these analyses.

V. Currency Risk, Hedging Policies, and Performance

We can now combine the different pieces of the analyses and provide an integrated view. We have shown that currency risk affects portfolio performance (Section III). We have identified one main operational hedging policy (i.e., currency concentration) that has been used to manage such risk, and we have demonstrated that this policy reduces fund performance in general and equity performance in particular (Section IV). We can now determine whether this policy provides an important channel through which currency risk negatively affects fund performance.

More specifically, using a 2-stage specification, we can project currency concentration on ICVR and focus on the predicted component to examine the extent to which the impact of currency risk on performance is specifically channeled

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through currency concentration. As a "placebo" test, we also perform the same projection based on cultural distance (the proxy that has the second largest explanatory power (after ICVR) in Table 3). Hence, we project currency concentration on ICVR and cultural distance to decompose currency concentration into components due to ICVR, cultural distance, and other factors (the residual). Then, we investigate which components have the explanatory power for fund performance.

We report the out-of-sample performance impact of various components of currency policies in Table 8. Panel A focuses on total returns, whereas Panel B focuses on holding-based returns. In each panel, the fund performance is again adjusted by using MX in models 1 and 4, MX4 in models 2 and 5, and MX4C in models 3 and 6. In the case of total returns, our main finding is that a 1-standard-deviation increase in ICVR-induced concentration can reduce fund total return performance by 33, 28, and 22 bps per year and holding-implied return performance by 41, 32, and 29 bps per year for MX-, MX4-, and MX4C-adjusted returns, respectively. These results not only are statistically significant but also explain a significant proportion of the total impact of ICVR on fund performance, as documented in Table 3. By contrast, the "placebo" test suggests that distance does not affect fund performance through the channel of currency concentration. This result is logical because distance, if it is related to superior equity information, should mostly affect performance through equity policies, not currency policies.

In addition to ICVR, the residual also absorbs a quite significant proportion of negative fund performance through the channel of currency concentration. This result is not surprising for two reasons. First, we projected only a linear impact of ICVR on currency concentration. Any nonlinear effect could be captured by the residual. Hence, we do not expect the linearly projected currency policy to fully explain the return impact of ICVR. Second, ICVR, although important, is only one type of currency risk that may incentivize operational hedging. Other types of currency risk, such as catastrophic risk (e.g., Burnside, Eichenbaum, Kleshchelski, and Rebelo (2011)), and exogenous characteristics may also constrain currency concentration. The overall results, however, clearly demonstrate that the policy adopted to address currency risk is highly responsible for the impact of currency risk on performance.

Finally, we also decompose the equity performance impact of currency concentration into the impact related to currency risk and the other possible explanations and report the results in Panel C of Table 8. The results show that the ICVR-related component of currency concentration is strongly related to the equity component of performance. In particular, a 1-standard-deviation change is related to a reduction in MX-, MX4- and MX4C-adjusted equity performance of 37, 27, and 24 bps, respectively. Again, the economic magnitude is on par with that reported in the previous two panels, confirming that currency risk mainly affects equity returns through the policy of currency concentration. In addition, the "placebo" test on cultural distance fails to detect a significant impact through this channel.

Overall, these results show that the need to concentrate on a limited number of currencies directly affects fund performance. This effect is sizable and is mainly achieved through the equity portion of the portfolio. That is, the currency policy conditions the choice of stocks in a suboptimal manner and reduces fund performance.

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TABLE 8

Performance Impacts of Currency Policies (2-stage regressions)

Table 8 reports the out-of-sample performance impact due to various components of currency policies. Specifically, in Panel A, we project currency concentration on ICVR and cultural distance to decompose currency concentration into components due to ICVR, cultural distance, and other factors. Similarly to Table 6, we then regress, in a panel specification, MX-, MX4-, and MX4C-adjusted quarterly Morningstar total returns on various components of currency concentration and lagged control variables. We control for the time fixed effect and estimate the error clustered at the fund level. We report the regression parameters as well as the *t*-statistics (reported below in parentheses) for different components of currency concentration and tabulate the parameters for other control variables in the Internet Appendix. Panels B and C report the results for holding-implied returns and the equity component of returns, respectively. * and ** indicate significance at the 5% and 1% levels, respectively.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	MX	MX4	MX4C	MX	MX4	MX4C
Panel A. Total Returns from Morningstar						
Fitted to ICVR	−2.587**	−2.178**	−1.745	−2.251**	−1.878**	−1.511
	(−4.10)	(−3.76)	(−1.74)	(−3.66)	(−3.32)	(−1.51)
Fitted to CULTURAL_DISTANCE	0.14	−1.184**	(1.12)	(0.16)	−1.450**	(1.32)
	(0.29)	(−2.61)	(−1.11)	(−0.31)	(−3.18)	(−1.31)
Residual of CURRENCY_CONCENTRATION				−1.043**	−0.931**	−0.726**
				(−6.26)	(−6.19)	(−2.91)
LOCAL_CURRENCY_WEIGHT	−0.136	−0.086	−0.253	−0.043	−0.003	−0.189
	(−1.38)	(−0.94)	(−1.51)	(−0.45)	(−0.03)	(−1.13)
Control for fund characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Control for equity policies	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	69,908	69,900	69,900	69,908	69,900	69,900
R^2	0.009	0.011	0.012	0.011	0.013	0.013
F-statistics	9.53	13.83	5.27	10.93	15.06	5.20
Panel B. Holding-Implied Returns						
Fitted to ICVR	−3.185**	−2.570**	−2.213*	−2.764**	−2.195**	−1.927
	(−5.56)	(−4.75)	(−2.13)	(−4.99)	(−4.13)	(−1.85)
Fitted to CULTURAL_DISTANCE	0.95	(0.52)	(0.13)	0.57	(0.85)	(0.39)
	(1.81)	(−1.08)	(−0.12)	(1.02)	(−1.72)	(−0.35)
Residual of CURRENCY_CONCENTRATION				−1.305**	−1.163**	−0.887**
				(−7.40)	(−7.34)	(−2.97)
LOCAL_CURRENCY_WEIGHT	−0.210*	−0.213*	−0.116	−0.095	−0.110	−0.037
	(−2.29)	(−2.45)	(−0.63)	(−1.09)	(−1.33)	(−0.20)
Control for fund characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Control for equity policies	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	69,537	69,529	69,529	69,537	69,529	69,529
R^2	0.008	0.008	0.008	0.01	0.01	0.009
F-statistics	8.28	9.05	3.46	11.20	11.97	3.73
Panel C. Equity Component of Fund Performance						
Fitted to ICVR	−2.862**	−2.145**	−1.866**	−2.513**	−1.836**	−1.612**
	(−4.97)	(−3.94)	(−4.21)	(−4.47)	(−3.41)	(−3.63)
Fitted to CULTURAL_DISTANCE	1.131*	−0.242	0.219	0.819	−0.519	−0.008
	(2.09)	(−0.49)	(0.52)	(1.42)	(−1.02)	(−0.02)
Residual of CURRENCY_CONCENTRATION				−1.084**	−0.960**	−0.787**
				(−5.93)	(−5.85)	(−7.41)
LOCAL_CURRENCY_WEIGHT	−0.178*	−0.139	−0.077	−0.081	−0.054	−0.007
	(−1.97)	(−1.63)	(−1.11)	(−0.94)	(−0.65)	(−0.10)
Control for fund characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Control for equity policies	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	69,537	69,537	69,529	69,529	69,529	69,529
R^2	0.007	0.009	0.008	0.009	0.008	0.009
F-statistics	7.499	9.111	7.893	9.438	31.66	33.47

VI. Conclusion

We study the determinants of currency management in international equity funds and their implications for fund performance. To rationalize the surprising

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finding that currency risk reduces equity performance, we hypothesize that the combination of base currency and style affiliation creates constraints for international funds. To be more specific, funds with highly embedded currency risk from their benchmarks tend to invest in markets with less volatile currencies, leading to a currency concentration in portfolio holdings. However, this currency concentration departs from the optimal equity allocation strategy across countries and may reduce fund performance.

We test this hypothesis by using a worldwide sample of mutual funds. We show that higher embedded currency risk (ICVR) leads to higher currency concentration and that higher currency concentration is typically related to lower fund performance. Furthermore, we confirm that currency risk can lead to lower equity performance through the channel of currency concentration.

Overall, we document that the effect of currency risk and a management policy of currency concentration is not limited to the currency market. Rather, it extends to the equity market and affects the equity choice/performance of international funds. These results shed initial light on the complicated determinants of currency management for international mutual funds and their implications for fund performance.

Appendix. Variable Definitions

1. Implied Currency Risk

Implied Currency Volatility Risk (ICVR): The standard deviation of the *benchmark currency portfolio* return of a fund. The benchmark currency portfolio of a fund is constructed by replacing the equity investments of a fund's benchmark with cash investments in the corresponding currency of the stock. The currency return (with respect to the base currency of the fund) that could have been generated by these cash holdings in the previous 36 months is then used to compute its standard deviation, which we define as the fund's ICVR.

2. Distance between a Fund and Its Benchmark Portfolio (DIST; further details in the Internet Appendix)

GEOGRAPHIC_DISTANCE: The benchmark holdings' value-weighted average of the geographic distances (defined in Sarkissian and Schill (2004)) between the benchmark's stocks and the mutual fund's domicile country.

INDUSTRY_DISTANCE: The benchmark holdings' value-weighted average of the industry distances between the benchmark's stocks and the mutual fund's domicile country.

CULTURAL_DISTANCE: The benchmark holdings' value-weighted average of the cultural distances between the benchmark's stocks and the mutual fund's domicile country. CULTURAL_DISTANCE = 0 if either of the languages of the two countries (i.e., the stock listing country and the fund's domicile country) are the same or the two countries had a colony relationship, and 1 otherwise.

ECONOMIC_DISTANCE: We first define economic proximity as the percentage of the stock listing country's exports going to the fund's domicile country and economic distance as the negative of economic proximity. Finally, we compute fund economic distance as the benchmark holdings' value-weighted average of the economic distances between the benchmark's stocks and the mutual fund's domicile country.

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3. Fund Flows Uncertainty (FLOW_UNC)

FUND_NEG_OUTFLOW: The sum of all the monthly outflows of a fund in the prior 12 months, scaled by the average TNAs of the prior 12 months. We keep the negative signs for outflows and outflows/TNA ratios.

FUND_CORR_FLOW_FX: The correlation between the monthly flows/TNA ratio of a fund and the return of the currencies in which the fund should invest if it were following its benchmark's investment weights in the prior 12 months. The correlation is between the monthly flow ratio and the currency returns. In contrast to the outflow ratio, the flow ratio is (flows in that month)/(TNA in that month).

4. Other Currency Control Variables

BMK_CURRENCY_NUM: The natural logarithm of the number of currencies in the benchmark portfolio.

BMK_CURRENCY_CONCENTRATION: The sum of the squared currency investment weights according to the benchmark portfolio followed by a fund (i.e., $\sum_{i=1}^{N} w_i^2$, where w_i is the weight of currency i in the benchmark portfolio).

5. Fund Characteristics

FUND_FEE: The lagged annual expense ratio. *Source:* Morningstar.

FUND_TURNOVER: The lagged annual turnover ratio. *Source:* Morningstar.

FUND_AGE: The natural log of the number of operational years since inception; 1-period lagged.

FUND_TNA: The natural log of portfolio TNAs in U.S. dollars; 1-period lagged.

6. Fund Equity Management

STOCK_NUM: The natural logarithm of the number of stocks in a portfolio.

STOCK_CONCENTRATION_DOM: STOCK_CONCENTRATION_DOM $= \sum_{i \in \text{Domestic Stock}} w_i^2$, where w_i is the investment weight of domestic security i in a given portfolio based on the most updated holdings information for a portfolio.

STOCK_CONCENTRATION_FORE: STOCK_CONCENTRATION_FORE $= \sum_{i \in \text{Foreign Stock}} w_i^2$, where w_i is the investment weight of foreign security i in a given portfolio based on the most updated holdings information for a portfolio.

INDUSTRY_CONCENTRATION: INDUSTRY_CONCENTRATION $= \sum w_i^2 - \sum \bar{w}_i^2$, where w_i is the investment of the fund in sector i and $\bar{w}_i$ is the investment weight of the benchmark portfolio in sector i.

7. Performance Measures and Factors

FUND_TOTAL_RETURNS: Fund return as reported by Morningstar. For multiple share classes, fund total return is computed as the TNA-weighted return of all share classes of the portfolio, where TNA values are 1-month lagged.

HOLDING_IMPLIED_RETURNS: Monthly portfolio return computed based on the most updated quarterly holdings information.

EQUITY_COMPONENT_OF_FUND_RETURNS: The equity component of fund returns is the hypothetical equity return that the portfolio would have had if the FX returns were removed (i.e., $\sum_n \xi_{n,t-1}^{\text{Fund}}(1 + \mathrm{r}_{n,t})$, where $\xi_{n,t-1}^{\text{Fund}}$ is the investment weights of the fund in stock n, and $\mathrm{r}_{n,t}$ is the return of the stock in its local currency).

MX: Risk-adjusted fund performance based on the MSCI World total returns and the Fung–Hsieh (2004) currency factors.

MX4: MX performance further adjusted by the Fama–French (1992), (1993)–Carhart (1997) 4 factors.

MX4C: MX4 performance further adjusted by the Lustig et al. (2011) carry-trade factor.

For all of the previous measures (i.e., MX, MX4, and MX4C), risk-adjusted returns for funds are defined as fund returns less the productions between its factor betas multiplied

by the realized factor values in a given month; that is, $\alpha_{f,t} = r_{f,t} - \beta \times X_t$, where $r_{f,t}$ is the return of fund f in month t, X_t is the realized factor return in the sample month, and β is the factor loading of the fund estimated over the whole sample period.

8. Currency Policies (defined relative to their benchmarks)

LOCAL_CURRENCY_WEIGHT: Benchmark-adjusted, base-currency investment weight. It is computed as the base-currency investment weight of a fund less the corresponding weight of its benchmark.

CURRENCY_CONCENTRATION: Benchmark-adjusted currency concentration. It is computed as the sum of the squared currency weights less the sum implied by its benchmark.

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