Foreign Currency Exposure within Country Exchange Traded Funds

S. Owen Williams, CFA, DBA

Grenoble Ecole de Management, 12 rue Pierre Sémard, 38000 Grenoble, France
Williams Market Analytics, Geneva, Switzerland

Abstract

This paper considers the implicit effect of the underlying foreign currency exposure on the performance characteristics of country exchange traded funds. The study shows that, while U.S.-domiciled country ETFs are more efficient than their European counterparts, volatility of the underlying foreign currency is the most significant source of tracking error for all funds relative to the local benchmark index. To better align ETF and index performance, the net currency variance is calculated for each sample fund to approximate the volatility impact from hedging the underlying currency exposure. As an essential element in risk reduction is to avoid incurring an offsetting drop in returns, the study finally calculates an optimal hedge ratio to give further insight to investors who use these products.

Keywords

Exchange Traded Funds; Currency Hedging; Portfolio Management; Risk Management

Introduction

The globalization of financial markets, coupled with portfolio diversification objectives, incite most investors and portfolio managers to actively maintain a considerable allocation in foreign equities. At the same time, many investors are reluctant to hold foreign currencies directly, as currency is perceived to be a high volatility, low average return investment. The use of country exchange-traded funds (ETFs hereafter), which offer an efficient, cost-effective method to gain international stock market exposure, help to meet investor demand for foreign equity. Although a country ETF may be denominated in dollars or euros, investors should be aware of the effective currency exposure these funds add to a portfolio. Just as the physical presence of foreign currencies impacts the valuation of a portfolio measured in the base currency, the inclusion of country funds add an inherent foreign exchange risk.

The purpose of this article is to investigate the benefits of hedging the underlying currency exposure while holding a country ETF. We expand on the recent work of Delcoure and Zhong (2007), Phengpis and Swanson (2009) and Shin and Soydemir (2010) by specifically examining the contribution of the underlying foreign currency to overall country ETF performance. In this aim, we first examine the capacity of a sample of thirty-seven trackers to reproduce the returns of their underlying local indexes. Then, we address the issue of currency hedging, which dates from Solnik's (1974) seminal work on the international asset-pricing model.

Prior research suggests that conditional currency hedging strategies significantly improve the performance of stock portfolios (Glen and Jorion, 1993). While researchers universally agree that foreign exchange risk premia are a significant component of equity rates of return (Dumas and Solnik, 1995), the optimal degree of currency hedging remains a subject of debate. Certain argue that, for risk-minimizing investors, the currency exposures of international equity portfolios should be fully hedged (Eun and Resnick, 1988; Campbell et al., 2010). Others, including Fischer Black (1990), purport that investors seek to hold foreign exchange risk as a function of their risk tolerances and should never fully hedge currency risk due to the potential gains stemming from Siegel's paradox. Whereas the majority of the existing research in this field attempts to explain and quantify the premiums or discounts of ETF prices, we evaluate net asset value (NAV hereafter) prices – as opposed to market prices – to concentrate on the fundamental drivers of country fund returns.

This study has several practical applications. First, the paper offers a decision rule based on the net currency variance to aid investors in making decisions whether to hedge the ETF's currency risk. The objective is twofold: minimizing the ETF tracking error relative to the underlying local index and improving the risk/return profile of a portfolio containing a country ETF. Second, our results suggest that investors in U.S.-listed country ETFs should

partially hedge the currency risk, while investors in European-listed country ETF are advised to fully hedge currency exposure.

The remainder of this article proceeds as follows. Section II studies the ETFs returns relative to the benchmark index. Section III measures the index fund performance using three alternative methods. Section IV proposes a decision rule to decide whether to hedge the ETF's currency risk, and Section V concludes.

TABLE1. SAMPLE ETFS

Fund Name	Ticker	Inception	Funds currency	Underlying currency	Benchmark index
Group A. Funds listed on New York exchange					
iShares MSCI South Africa Index Fund	EZA	Feb. 2003	USD	ZAR	MSCI South Africa
iShares MSCI Australia Index Fund	EWA	Mar. 1996	USD	AUD	MSCI Australia
iShares MSCI Brazil Index Fund	EWZ	July 2000	USD	BRL	MSCI Brazil
iShares MSCI Canada Index Fund	EWC	Mar. 1996	USD	CAD	MSCI Canada
iShares MSCI Chile Index Fund	ECH	Nov. 2007	USD	CLP	MSCI Chili
iShares MSCI France Index Fund	EWQ	Mar. 1996	USD	EUR	MSCI France
iShares MSCI Germany Index Fund	EWG	Mar. 1996	USD	EUR	MSCI Germany
iShares MSCI Israel Index Fund	EIS	Mar. 2008	USD	ILS	MSCI Israel
iShares MSCI Japan Index Fund	EWJ	Mar. 1996	USD	JPY	MSCI Japan
iShares MSCI Korea Index Fund	EWY	May 2000	USD	KRW	MSCI Korea
iShares MSCI Mexico Index Fund	EWW	Mar. 1996	USD	MXN	MSCI Mexico
iShares MSCI Singapore Index Fund	EWS	Mar. 1996	USD	SGD	MSCI Singapore
iShares MSCI Sweden Index Fund	EWD	Mar. 1996	USD	SEK	MSCI Sweden
iShares MSCI Switzerland Index Fund	EWL	Mar. 1996	USD	CHF	MSCI Swiss 25-50
iShares MSCI Taiwan Index Fund	EWT	June 2000	USD	TWD	MSCI Taiwan
iShares MSCI Thailand Index Fund	THD	Mar. 2008	USD	THD	MSCI Thailand
Shares MSCI Turkey Index Fund	TUR	Mar. 2008	USD	TRY	MSCI Turkey
iShares MSCI United Kingdom Fund	EWU	Mar. 1996	USD	GBP	MSCI U.K.
Group B. Funds listed on European exchanges					
Lyxor South Africa ETF	AFS FP	June 2007	EUR	ZAR	JSE Top 40
Lyxor Brazil ETF	RIO FP	Jan 2007	EUR	BRL	Ibovespa
iShares MSCI Brazil Index Fund	IBZL NA	Nov. 2005	EUR	BRL	MSCI Brazil
Lyxor India ETF	INR FP	Nov. 2006	EUR	INR	MSCI India
Lyxor Japan ETF	JPN FP	Nov. 2005	EUR	JPY	TOPIX
iShares MSCI Japan Index Fund	IJPN NA	Feb. 2005	EUR	JPY	MSCI Japan
Lyxor MSCI Korea ETF	KRW FP	Sept. 2006	EUR	KRW	MSCI Korea
iShares MSCI Korea Index Fund	IKOR IM	Mar. 2006	EUR	KRW	MSCI Korea
Lyxor Russia ETF	RUS FP	June 2006	EUR	RUB	DJ Russia Titans
iShares SMI Fund	SMIEX GY	April 2001	EUR	CHF	Swiss Mkt Index
Lyxor MSCI Taiwan ETF	TWN FP	Mar. 2008	EUR	TWD	MSCI Taiwan
iShares MSCI Taiwan Index Fund	ITWN IM	Mar. 2006	EUR	TWD	MSCI Taiwan
Lyxor Turkey ETF	TUR FP	Aug. 2006	EUR	TRY	DJ Turkey Titans
iShares MSCI Turkey Index Fund	ITKY NA	Oct. 2006	EUR	TRY	MSCI Turkey
iShares FTSE 100 Fund	UKXEX GY	Jan. 2002	EUR	GBP	FTSE 100
Lyxor ETF MSCI USA	USA FP	Mar. 2006	EUR	USD	MSCI USA
Lyxor ETF NASDAQ-100	UST FP	Feb. 2001	EUR	USD	Nasdaq 100
iShares NASDAQ-100	NDXEX GY	April 2006	EUR	USD	Nasdaq 100
iShares S&P500 Index Fund	IUSA GY	April 2003	EUR	USD	S&P 500

ETF Return Relative to the Benchmark Index

Sample Selection and Data

The study sample is derived from a selection of New York or European-listed country funds from the two leading ETF issuers, iShares and Lyxor. By retaining ETFs from only two fund sponsors, the sample limits the variability of fund performance due to differing management styles. The conditions for inclusion of an ETF in the subset for the study are:

- A fund base currency in U.S. dollars or in euros, allowing an examination of the volatility of bilateral exchange rates for American and European investors.

- A fund creation date prior to the first quarter of 2008 in order to provide a minimum of six years of historical data and to permit an analysis of at least one bull and one bear market in equities.
- A single underlying currency among fund holdings[1].
- A foreign currency which has floated freely against the fund currency for the period of the study. Country funds investing in China, Hong Kong, and Malaysia are therefore eliminated from the research.

The resulting sample of country funds is presented in Table 1. While trading volume is not among our selection criteria, the question of liquidity is essential when dealing with ETFs, as noted by Calamia et al. (2013). These authors point out that ETF market prices and spreads relative to the underlying benchmark index may be significantly affected by thin trading volume. Moreover, for Europe-listed ETFs, a large portion of trading occurs OTC. To minimize the impact of the liquidity issue, the study uses weekly fund NAVs, rather than market prices, in both the fund currency and hedged into the local currency. Note that for all country ETFs, the daily closing price corresponds to the last trade of the fund on the listing exchange while the daily NAV is calculated based on closing prices of the underlying stocks on the foreign exchange. An additional motivation for using NAVs is to better isolate the two fundamental factors which drive country fund valuation, namely the price movements of the underlying stocks and the variations in the bilateral exchange rate. Indeed, country ETF prices also reflect non-fundamental factors such as market noise, liquidity on the exchanges, and time zone differences between the local and home markets. Moreover, for a portfolio oriented towards a long-term horizon, conclusions drawn using NAV data remain relevant for investors. Gastineau (2001) and Engle and Sarkar (2006), among others, demonstrate that divergences between a tracker's price and the tracker's NAV over the long-term are effectively eliminated by the creation/redemption process on the primary market. Data is collected from March 13, 2003 (or the date of fund inception) through June 30, 2014. Net asset value data is taken from iShares (retrieved from: www.ishares.com) and Lyxor (retrieved from: www.lyxoretf.fr) whereas index and exchange rate values are provided by Bloomberg LP.

Cumulative Weekly Returns

To begin the analysis, we calculate the weekly returns for all time series as the first difference of log prices, assuming continuous compounding:

$$r_{NAV_{i,t}} = \log\left(\mathrm{NAV_{i,t}} + \mathrm{DIV_{i,t}}\right) - \log\left(\mathrm{NAV_{i,t-1}}\right) + \left(\frac{\mathrm{EXP}_{i,t}}{52}\right) \quad (1)$$

For the fund NAV data, dividends (DIV) are reinvested into the price series before transformation in order to correspond with the total return versions of the benchmark indexes. In addition, for each fund, the annual expense ratio (EXP) is added back on a pro rata basis to correct for tracking error due management or administration fees, which vary by fund. Variations in the underlying total return benchmark indexes (r_{Index}) and the returns of the foreign currency (r_{FX}) are both calculated in a similar manner. As the research also evaluates the country funds returns in the local money, the currency-hedged NAV returns (r_{LC}) are computed as the difference between log returns of the tracker and the bilateral exchange rate (FX) expressed in direct quotations:

$$r_{LC_{i,t}} = \left\{\log\left(\mathrm{NAV_{i,t}} + \mathrm{DIV_{i,t}}\right) - \log\left(\mathrm{NAV_{i,t-1}}\right) + \left(\frac{\mathrm{EXP}_{i,t}}{52}\right)\right\} - \left\{\log\left(\mathrm{FX_{i,t}}\right) - \log\left(\mathrm{FX_{i,t-1}}\right)\right\} \quad (2)$$

Direct quotes indicate the number of dollars (or euros) per unit of foreign currency. In this way a numerical increase corresponds with an appreciation of the foreign currency. Using the above return series, the study initially examines a graphical overview of historical return behavior for the ETFs, in both the base and foreign currencies, as well as for the local benchmarks. We first plot the cumulative weekly returns, R_{cum}, for the three series associated with each ETF:

$$R_{cum} = \prod_{t-1}^{T} (1 + r_t) - 1 \quad (3)$$

As expected, the plots of the cumulative tracker NAV returns in the foreign currency and the local index are visually almost indistinguishable, offering an initial estimation of fund tracking efficiency. At the same time, the series of cumulative returns in the listing currency reveal the excess volatility attributable to the bilateral exchange rates. If one considers the iShares Canada Index Fund **(**Figure 1, left), for example, the graph shows the excess swings of the NAV in the base currency (dashed line) relative to the index and hedged NAV returns[2]. The Canadian dollar is therefore pro-cyclical versus the U.S. dollar. In comparison, the graph of the iShares Japan Fund (Figure 1, right), reveals smaller swings of the NAV series in the base currency, suggesting the Japanese yen / U.S.

dollar cross is rather counter-cyclical. Again, one observes a tight fit between hedged cumulative returns for iShares Japan and for the MSCI Japan Index.

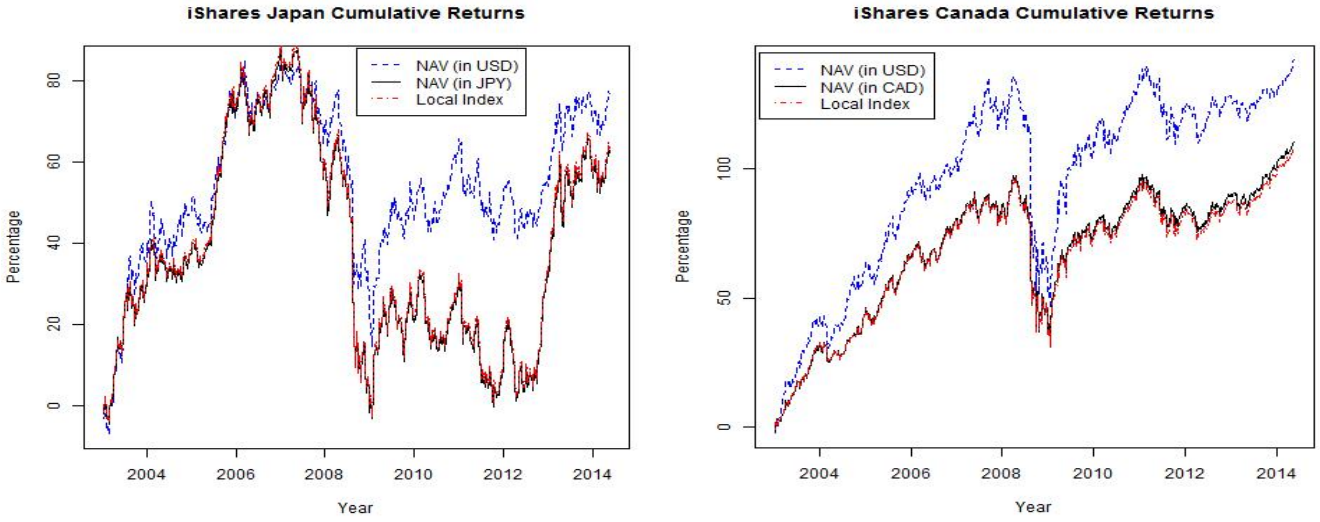

FIGURE1. CUMULATIVE WEEKLY RETURNS OF TWO NEW YORK-LISTED ETFS

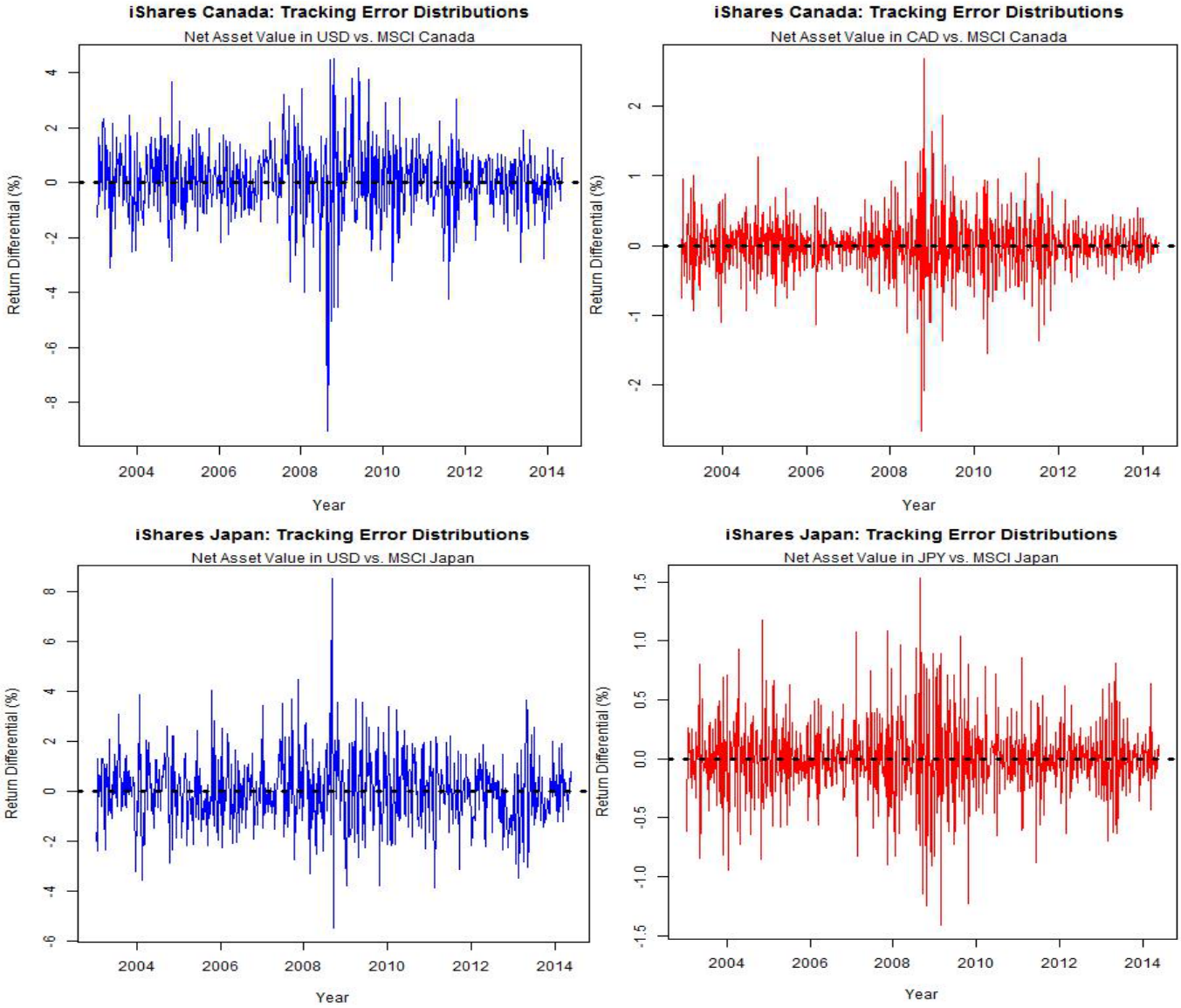

FIGURE2. TRACKING ERROR DISTRIBUTIONS

The following preliminary generalizations may be drawn from the cumulative return graphs. First, the unhedged cumulative returns for most emerging country funds show the greatest volatility relative to the index and hedged returns. Second, among the Group A funds (U.S.-listed), only the unhedged cumulative returns for iShares Japan and for iShares Taiwan present a volatility inferior to the benchmark index, attesting to the otherwise safe haven status of the U.S. dollar[3]. Third, for the Group B funds (European-listed), the unhedged cumulative returns for the developed country funds show relatively less fluctuations, suggesting that the yen, sterling, franc, and dollar are counter-cyclical versus the euro. Finally, the hedged cumulative fund returns for all funds generally track with a high precision the returns of their local benchmark index.

Tracking Error Distributions

A similar measure of ETF return behavior relative to the benchmark foreign index is given by plotting the weekly distributions of tracking errors for each NAV series versus the index. This second group of plots reaffirm that the exchange rate effect is the principal cause of deviations of country fund returns from local index returns. Taking again the example of iShares Canada, the graph on the top left of Figure 2 shows the NAV yields in the quotation currency (r_{NAV}) less the returns on the MSCI Canada Index (r_{Index}). Return divergences rarely exceed +2.5% or -2.5%, except during the Financial Crisis. The graph on the top right substitutes the returns on the currency-hedged NAV series for iShares Canada (r_{LC}). Outside the period of crisis, performance deviation between the fund and the index are limited to less than +1% to -1%. The existence of tracking error between the index and NAV series in a common currency is attributable to the construction and management style of the fund (replication strategy, timing of fund rebalancing, cash drag). For purposes of comparison, the iShares Japan Index Fund, with a counter-cyclical underlying exchange rate is also shown. The graph on the bottom left contains the returns of the iShares Japan NAV series in dollars (r_{NAV}) less the MSCI Japan Index (r_{Index}). Weekly divergences remain largely within +2% and -2%. The plot of currency-hedged NAV yields for iShares Japan (r_{LC}), on the bottom right, shows that deviations of fund returns from index returns are limited to approximately +0.5% to -0.5%. The reduction in tracking error distribution when considering the NAV series in the local currency is observed for all funds in the study.

Measuring Index Fund Performance

ETF Tracking Error

The sole objective of index funds is to reproduce as closely as possible the performance of the underlying index. As such, the ETF's tracking error relative to its benchmark index is the principal metric of the fund's efficiency. To quantitatively test the tracking errors for each ETF series, three separate estimations are calculated, following the methodology applied by Milonas and Rompotis (2006) and by Shin and Soydemir (2010). The first tracking error calculation is given by the absolute value of differences between the ETF and index returns:

$$TE = \frac{\sum_{t-1}^{n} \left| r_{NAV_{i,t}} - r_{index_{i,t}} \right|}{n-1} \tag{4}$$

In taking the absolute value of the differences, this measure corrects for the underestimation produced by a simple calculation where misses resulting from greater ETF returns for the period annul downside misses. The second metric for fund tracking error uses the residual term from a regression of ETF returns on those of its underlying index:

$$r_{NAV_{i,t}} = \alpha_i + \beta_i r_{index_{i,t}} \tag{5}$$

The alpha (α_i) indicates the excess return an ETF earns above the benchmark return. Given the passive nature of index funds and the reinvestment of management fees into fund returns, the alpha coefficient should not be significantly different from zero. Likewise, the beta coefficient, β_i, which reflects the replication strategy employed by the fund, should not differ from unity for a fund fully invested in its underlying index. Therefore any exogenous noise in ETF returns, unexplained by variations in the index or the foreign currency, will be given by the error term, ε_i. The final tracking error calculation is the standard deviation of return differences between the ETF and benchmark index:

$$TE = \sqrt{\frac{\sum_{t=1}^{n}\left(e_{i,t} - \bar{e}_{i}\right)^{2}}{n-1}} \quad (6)$$

Where $e_{i,t}$ is the difference between the tracker's NAV returns and the index returns in week t. If the fund effectively tracks its benchmark, any divergence should not be significantly different from zero. Note that tracking errors in equations (4) and (6) are dependent on the number of days, n.

To arrive at an overall estimation of the ETF's tracking error, we calculate the mean of the three measures of tracking error for both the hedged (r_{LC}) and unhedged (r_{NAV}) return series (Tables 2 and 3). The first two columns contain the mean NAV returns; the following six columns present the results of the individual tracking errors calculations while columns nine and ten summarize the findings. A preliminary observation is that the tracking errors are systematically larger for Group B funds, whatever the orientation of the market. The overall mean tracking error is 1.2647 for these European ETFs in the fund currency and 0.8842 when measured in the local currency. For the Group A funds, the dollar and local currency mean NAV tracking errors are only 0.8961 and 0.2805, respectively. Based on this assessment, U.S.-domiciled country ETFs are more effective in replicating the benchmark indexes. Similarly, irrespective of the unit of evaluation, all thirty-seven sample funds revealed significantly greater tracking errors during bear markets when measured in the fund currency. Given the passive nature of ETF investing, this finding seems rather curious. We attribute the tracking error differential to slight fund allocation discrepancies with the benchmark due to optimized replication techniques, as well as the cash drag, which are magnified during periods of market turbulence.

In terms of divergence between hedged and unhedged NAV tracking errors, moving from local currency to fund currency returns within Group A increases the tracking error by three-fold on average. The iShares Brazil fund is the most sensitive to the currency impact (the overall tracking error increases almost five-fold when measured in the fund currency), while iShares Thailand is the least sensitive to the currency returns (increase of only 1.5 times). In regards to Group B funds, the tracking errors of unhedged NAV returns increase by just less than one and a half times versus the hedged currency returns, when considering the entire sample period. Interestingly, the tracking errors of the unhedged NAV returns only increase marginally for certain funds, such as iShares Japan, Lyxor Russia, and Lyxor Taiwan. Comparing the average tracking error for an ETF in its base currency against the tracking error for its currency hedged returns is one method to gain insight concerning the incidence of the foreign exchange movements on the ability of a given fund to replicate the benchmark index.

Risk-Adjusted Return

Since tracking error does not capture all the risk inherent in a country index fund, the study extends the analysis using the Sortino and Modified Sharpe ratios. Similar to the popular Sharpe ratio, the Sortino ratio uses downside deviation in the denominator instead of standard deviation (Sortino and Price, 1994). Other similar risk-adjusted performance ratios using the lower partial moment function are available, notably Kaplan and Knowles (2004) or Keating and Shadwick (2002). These ratios are very often used in the hedge funds industry due to the non-Gaussian pattern of alternative strategies' returns. However, from a practical standpoint, these ratios yield results very close to the Sharpe ratio (Eling and Schuhmacher, 2007). To adapt the Sortino ratio for the current analysis, we use the benchmark index return as the threshold θ instead of the risk-free rate or minimum acceptable return:

$$Sortino(\theta) = \frac{r_{NAV} - \theta}{\sqrt{lpm_{2}(\theta)}} \quad (7)$$

Where r_{NAV} and $\mathrm{lpm}_{m}(\theta)$ denote the unhedged return series and the lower partial moment function, respectively. The calculation therefore provides a risk-adjusted measure of ETF relative performance without penalizing the fund for upward price variation (positive tracking error). The greater the Sortino ratio, the lower the risk of outsized relative losses and the more attractive are the fund's risk/return characteristics. An alternative measure is given by the modified Sharpe ratio, where volatility is replaced by a value-at-risk (VaR) estimate to allow comparisons across funds under a scenario of negative excess returns. The modified Sharpe gives the ratio of excess tracker returns over the benchmark returns (denotedr_{index}) divided by the modified VaR:

$$Modified\ Sharpe\ ratio = \frac{r_{NAV} - r_{index}}{r_{index} - MVaR_{\alpha}} \quad (8)$$

TABLE2. TRACKING ERRORS BASED ON WEEKLY PERCENT RETURNS, GROUP A FUNDS (MARCH 13, 2003 – JUNE 30, 2014)

Tracker	Weekly mean return (%)		Tracking error 1		Tracking error 2		Tracking error 3		Mean (Fund currency)	Mean (Local currency)	N
	FC	LC	FC	LC	FC	LC	FC	LC			
Emerging markets											
iShares MSCI South Africa Fund	0.2878	0.3364	1.8089	0.5062	0.0828	0.0087	2.3880	0.7199	1.4266	0.4116	590
iShares MSCI Brazil Fund	0.3765	0.2974	1.4383	0.2907	0.0411	0.0006	2.0429	0.4438	1.1741	0.2450	590
iShares MSCI Chile Fund	0.0159	0.0399	1.3444	0.3327	0.0464	0.0147	1.9496	0.4758	1.1135	0.2744	345
iShares MSCI Korea Fund	0.2679	0.2366	0.9935	0.3975	0.0466	0.0077	1.5030	0.7171	0.8477	0.3741	590
iShares MSCI Mexico Fund	0.3373	0.3636	1.0859	0.4633	0.0777	0.0223	1.6579	0.6587	0.9405	0.3814	590
iShares MSCI Singapore Fund	0.2861	0.2305	0.5328	0.1539	0.0029	0.0063	0.7181	0.2110	0.4179	0.1237	590
iShares MSCI Taiwan Fund	0.1751	0.1497	0.5162	0.2759	0.0170	0.0026	0.8114	0.5660	0.4482	0.2815	590
iShares MSCI Thailand Fund	0.1958	0.2057	0.6594	0.4315	0.0153	0.0238	0.8976	0.6355	0.5241	0.3636	326
iShares MSCI Turkey Fund	0.0986	0.2494	1.3680	0.4341	0.0145	0.0115	2.0082	0.5911	1.1302	0.3456	326
Mean	0.2268	0.2344	1.0830	0.3651	0.0383	0.0109	1.5530	0.5577	0.8914	0.3112	504
t-test			7.23**	9.85**	4.03**	4.05**	7.62**	10.35**	7.44**	10.38**	
Developed markets											
iShares MSCI Australia Fund	0.2738	0.2010	1.3800	0.3523	0.1324	0.0141	1.9832	0.5144	1.1652	0.2936	590
iShares MSCI Canada Fund	0.2408	0.1869	1.0258	0.3408	0.0478	0.0044	1.3990	0.4746	0.8242	0.2733	590
iShares MSCI France Fund	0.1947	0.1583	1.0943	0.3205	0.0685	0.0052	1.4020	0.4576	0.8550	0.2611	590
iShares MSCI Germany Fund	0.2629	0.2265	1.1015	0.3277	0.0660	0.0065	1.4040	0.4786	0.8572	0.2710	590
iShares MSCI Israel Fund	0.0772	0.0686	1.0122	0.3043	0.0621	0.0106	1.3123	0.4155	0.7955	0.2435	326
iShares MSCI Japan Fund	0.1303	0.1058	1.1048	0.2760	0.0006	0.0131	1.4487	0.3859	0.8514	0.2250	590
iShares MSCI Sweden Fund	0.2918	0.2548	1.3516	0.3798	0.0055	0.0161	1.7345	0.5365	1.0306	0.3108	590
iShares MSCI Switzerland Fund	0.2544	0.1857	1.1860	0.1536	0.0317	0.0032	1.5317	0.3206	0.9165	0.1591	590
iShares MSCI UK Fund	0.1876	0.1773	1.0256	0.2628	0.0236	0.0060	1.3827	0.3615	0.8107	0.2101	590
Mean	0.2126	0.1739	1.1424	0.3020	0.0487	0.0088	1.5109	0.4384	0.9007	0.2497	561
t-test			24.89**	13.63**	3.63**	5.57**	21.10**	18.20**	22.20**	16.14**	
Global statistics											
Mean	0.2197	0.2041	1.1127	0.3335	0.0435	0.0099	1.5319	0.4980	0.8961	0.2805	532
Minimum	0.0159	0.0399	0.5162	0.1536	0.0006	0.0006	0.7181	0.2110	0.4179	0.1237	
Maximum	0.3765	0.3636	1.8089	0.5062	0.1324	0.0238	2.3880	0.7199	1.4266	0.4116	
t-test			14.58**	14.96**	5.38**	6.41**	14.60**	15.53**	14.61**	15.60**	

FC uses the unhedged fund NAV returns (r_{NAV}) and LC uses the local currency fund returns (r_{LC}). The t-tests evaluate if the mean of the tracking errors is significantly different from zero (** = significant at 1% level, * = significant at 5% level). The first tracking error corresponds to the average of absolute differences, the second to the absolute value of the regression error term, and the third to the standard deviation of return differences. For all tracking errors, the Kolmogorov–Smirnov statistic was calculated to test for normality.

The modified value-at-risk ($MVaR_{\alpha}$), based on a Cornish-Fisher expansion where risk is measured by standard deviation, skewness, and excess kurtosis at a given confidence level α, is similar to the classical VaR but will be worse in cases where the tracker posts extreme negative returns relative to the benchmark (Favre and Galeano, 2002). The confidence level is set to 95% for our calculations. The Sortino and Modified Sharpe ratios are applied to both the local (r_{LC}) and fund currency (r_{NAV}) series for each country ETF.

The results from the Sortino ratio reveal the efficiency of the NAV series measured in the local currency (Tables 4 and 5). The full-period scores for all sample funds are not significantly different from zero, confirming that the hedged ETF returns present little downside risk relative to the benchmark index. Turning to the Modified Sharpe

ratio, the analysis supports the risk assessment provided by the Sortino ratio. U.S. dollar-listed country ETFs generally have a more attractive risk profile when unhedged while euro-denominated country ETFs tend to have less volatility after hedging the underlying currency movements.

TABLE3. TRACKING ERRORS BASED ON WEEKLY PERCENT RETURNS, GROUP B FUNDS (MARCH 13, 2003 – JUNE 30, 2014)

Tracker	Weekly mean return (%)		Tracking error 1		Tracking error 2		Tracking error 3		Mean (Fund currency)	Mean (Local currency)	N
	FC	LC	FC	LC	FC	LC	FC	LC			
Emerging markets											
Lyxor South Africa ETF	0.0817	0.1941	1.8440	1.1029	0.2124	0.0010	2.6096	2.1010	1.5553	1.0683	367
Lyxor Brazil ETF	0.0133	0.0375	1.7144	1.2200	0.0614	0.0006	2.5047	2.2508	1.4269	1.1571	386
iShares MSCI Brazil Fund	0.1178	0.1383	1.4495	0.6246	0.1335	0.0058	2.0091	0.9384	1.1973	0.5230	404
Lyxor MSCI India ETF	0.0731	0.1621	1.7143	1.1755	0.0238	0.0593	2.6528	2.3110	1.4636	1.1819	398
Lyxor ETF MSCI Korea	0.0805	0.1158	1.5105	1.0047	0.0211	0.0410	2.2716	1.9436	1.2677	0.9964	404
iShares MSCI Korea Fund	0.0889	0.1242	1.5461	1.1790	0.0754	0.0200	2.1493	1.6851	1.2570	0.9614	404
Lyxor Russia ETF	-0.0091	0.0661	1.8864	1.5860	0.0727	0.0091	3.4697	3.2625	1.8096	1.6192	404
Lyxor Taiwan ETF	0.0982	0.0581	1.3104	0.8010	0.0596	0.0170	2.0413	1.8130	1.1371	0.8770	327
iShares MSCI Taiwan Fund	0.0954	0.0885	1.2964	1.0549	0.0403	0.0478	1.8404	1.6127	1.0590	0.9051	404
Lyxor Turkey ETF	0.1308	0.2326	1.7421	1.1428	0.0023	0.0568	2.6568	2.3021	1.4671	1.1672	404
iShares MSCI Turkey Fund	0.0953	0.2131	1.3595	0.3915	0.0399	0.0001	1.8590	0.6545	1.0862	0.3487	388
Mean	0.0787	0.1300	1.5794	1.0257	0.0675	0.0235	2.3695	1.8977	1.3388	0.9823	390
t-test	-	-	24.67**	10.59**	3.76**	3.34**	16.44**	8.93**	19.42**	9.62**	-
Developed markets											
Lyxor ETF Japan	-0.0111	-0.0307	1.7168	0.8706	0.0711	0.0625	2.5045	1.4950	1.4308	0.8094	404
iShares MSCI Japan Fund	-0.0108	-0.0300	3.0552	2.7502	0.1166	0.1152	4.2624	3.6801	2.4780	2.1818	404
iShares FTSE 100 Fund	0.1424	0.1685	0.9035	0.2564	0.0086	0.0003	1.3273	0.5577	0.7465	0.2715	590
iShares SMI	0.2107	0.1783	0.5968	0.2052	0.0153	0.0031	0.9428	0.3507	0.5183	0.1863	590
Lyxor ETF MSCI USA	0.1179	0.1363	1.2939	0.7402	0.0213	0.0021	1.8448	1.3886	1.0533	0.7103	404
Lyxor ETF NASDAQ-100	0.2175	0.2539	1.4852	1.0299	0.0447	0.0225	2.0714	1.7156	1.2004	0.9227	590
iShares NASDAQ-100	0.2022	0.2206	1.2736	0.7286	0.0239	0.0514	1.7899	1.1724	1.0291	0.6508	404
iShares S&P500 Fund	0.1115	0.1299	1.0686	0.3090	0.0654	0.0111	1.4070	0.4656	0.8470	0.2619	404
Mean	0.1225	0.1284	1.4242	0.8613	0.0459	0.0335	2.0188	1.3532	1.1629	0.7493	474
t-test			5.42**	2.96*	3.53**	2.34*	5.57**	3.57**	5.48**	3.30**	
Global statistics											
Mean	0.0972	0.1293	1.5141	0.9565	0.0584	0.0277	2.2218	1.6684	1.2647	0.8842	425
Minimum	-0.0111	-0.0307	0.5968	0.2052	0.0023	0.0001	0.9428	0.3507	0.5183	0.1863	
Maximum	0.2175	0.2539	3.0552	2.7502	0.2124	0.1152	4.2624	3.6801	2.4780	2.1818	
t-test			13.30**	7.29**	4.98**	3.89**	12.85**	8.14**	13.10**	7.91**	

FC uses the unhedged fund NAV returns (r_{NAV}) and LC uses the local currency fund returns (r_{LC}). The t-tests evaluate if the mean of the tracking errors is significantly different from zero (** = significant at 1% level, * = significant at 5% level). The first tracking error corresponds to the average of absolute differences, the second to the absolute value of the regression error term, and the third to the standard deviation of return differences. For all tracking errors, the Kolmogorov–Smirnov statistic was calculated to test for normality.

Sources of Volatility

To better examine the contribution of the foreign currency returns, a more detailed analysis of variance breaks down the impact of currency risk on overall country fund volatility. As indicated, returns on foreign stocks denominated in dollars or in euros contain two components: the return due to variations in the prices of the underlying equities and the return attributable to movements of the foreign currency against the fund currency. It follows that the variance of a country fund can be decomposed into (1) the variance of yields on the foreign stocks within the fund, (2) the variance of foreign currency returns, and (3) two times the covariance between the returns of the foreign stocks and currency:

$$Var(r_{NAV}) = Var(r_{index}) + Var(r_{FX}) + 2Cov(r_{index}, r_{FX}) \quad (9)$$

Applying the method of Johnson et al. (1993), we use this measure of covariance in order to account for the interaction between the volatilities of the underlying stocks and currency. In practice, hedging the foreign exchange risk should eliminate the variance of fund returns attributable to the currency and covariance terms. However, before removing the effect of the exchange rate, an investor should consider the desirability of the

covariance term in respect to overall risk reduction. Importantly, in so far as the covariance between stock and currency returns offsets the variance of exchange rate movements, hedged and unhedged returns of a country fund should have similar variances.

TABLE 4. SORTINO AND MODIFIED SHARPE RATIOS, GROUP A (MARCH 13, 2003 – JUNE 30, 2014)

Tracker	Sortino ratio		Modified Sharpe ratio	
	FC	LC	FC	LC
Developed countries				
iShares MSCI Australia Fund	0.0361	0.0204	0.0234	0.0128
iShares MSCI Canada Fund	0.0390	0.0103	0.0242	0.0067
iShares MSCI France Fund	0.0293	0.0155	0.0184	0.0102
iShares MSCI Germany Fund	0.0291	0.0153	0.0185	0.0102
iShares MSCI Israel Fund	0.0124	0.0190	0.0078	0.0123
iShares MSCI Japan Fund	0.0166	-0.0046	0.0109	-0.0028
iShares MSCI Sweden Fund	0.0251	0.0173	0.0159	0.0112
iShares MSCI Switzerland Fund	0.0409	-0.0190	0.0253	-0.0008
iShares MSCI United Kingdom Fund	0.0046	-0.0091	0.0029	-0.0055
Emerging countries				
iShares MSCI South Africa Fund	-0.0200	-0.0066	-0.0127	-0.0041
iShares MSCI Brazil Fund	0.0325	-0.0124	0.0211	-0.0077
iShares MSCI Chili Fund	-0.0205	-0.0434	-0.0126	-0.0275
iShares MSCI Korea Fund	0.0167	-0.0069	0.0119	-0.0056
iShares MSCI Mexico Fund	-0.0053	0.0236	-0.0035	0.0168
iShares MSCI Singapore	0.0872	0.0453	0.0557	0.0294
iShares MSCI Taiwan Fund	0.0289	-0.0037	0.0210	-0.0028
iShares MSCI Thailand Fund	0.0175	0.0403	0.0110	0.0344
iShares MSCI Turkey Fund	-0.0615	0.0247	-0.0379	0.0158
Mean				
Developed countries	0.0259	0.0072	0.0164	0.0060
Emerging countries	0.0084	0.0068	0.0060	0.0054

FC uses the unhedged fund NAV returns (r_{NAV}) and LC uses the hedged, local currency returns(r_{LC}). The numbers in bold indicate the NAV series within each pair offering a superior risk profile.

TABLE5. SORTINO AND MODIFIED SHARPE RATIOS, GROUP B (MARCH 13, 2003 – JUNE 30, 2014)

Tracker	Sortino ratio		Modified Sharpe ratio	
	FC	LC	FC	LC
Developed countries				
Lyxor ETF Japan	0.0063	-0.0035	0.0050	-0.0022
iShares MSCI Japan Fund	0.0044	-0.0003	0.0028	-0.0002
iShares FTSE 100 Fund	-0.0310	-0.0219	-0.0335	-0.0748
iShares SMI	0.0243	-0.0229	0.0156	-0.0153
Lyxor ETF MSCI USA	-0.0052	0.0061	-0.0033	0.0039
Lyxor ETF NASDAQ-100	-0.0129	0.0059	-0.0085	0.0042
iShares NASDAQ-100	-0.0148	-0.0042	-0.0112	-0.0028
iShares S&P500 Fund	-0.0091	0.0135	-0.0057	0.0088
Emerging countries				
Lyxor South Africa ETF	-0.0394	-0.0021	-0.0241	-0.0014
Lyxor Brazil ETF	-0.0116	-0.0026	-0.0078	-0.0020
iShares MSCI Brazil Fund	-0.0095	-0.0001	-0.0059	-0.0001
Lyxor MSCI India ETF	-0.0330	-0.0021	-0.0199	-0.0013
Lyxor ETF MSCI Korea	-0.0177	-0.0036	-0.0113	-0.0024
iShares MSCI Korea Fund	-0.0152	0.0007	-0.0097	0.0005
Lyxor Russia ETF	0.0093	0.0343	0.0101	0.0429
Lyxor Taiwan ETF	0.0259	0.0081	0.0178	0.0063
iShares MSCI Taiwan Fund	0.0035	-0.0003	0.0024	-0.0002
Lyxor Turkey ETF	-0.0399	-0.0041	-0.0245	-0.0028
Mean				
Developed countries	-0.0048	-0.0034	-0.0049	-0.0098
Emerging countries	-0.0164	0.0055	-0.0099	0.0060

FC uses the unhedged fund NAV returns (r_{NAV}) and LC uses the hedged, local currency returns(r_{LC}). The numbers in bold indicate the NAV series within each pair offering a superior risk profile.

TABLE6. SOURCES OF VOLATILITY, GROUP A FUNDS (MARCH 13, 2003 – JUNE, 30 2014)

Tracker	$Var[NAV_{dir}(\$)]$	$Var[NAV_{est}(\$)]$ =	Var[local] +	Var[FX] +	2 Cov [local, FX]
Developed Countries					
ishares MSCI Australia Fund	0.1366*	0.1334	0.0517	0.0382	0.0436
iShares MSCI Canada Fund	0.1143*	0.1107	0.0597	0.0185	0.0326
iShares MSCI France Fund	0.1216	0.1213	0.0854	0.0194	0.0164
iShares MSCI Germany Fund	0.1325	0.1338	0.0975	0.0194	0.0169
iShares MSCI Israel Fund	0.0920*	0.0966	0.0611	0.0205	0.0151
iShares MSCI Japan Fund	0.0695	0.0703	0.0837	0.0203	-0.0338
iShares MSCI Sweden Fund	0.1560	0.1579	0.0916	0.0308	0.0355
iShares MSCI Switzerland Fund	0.0747*	0.0764	0.0626	0.0232	-0.0093
iShares MSCI UK Fund	0.0949	0.0929	0.0615	0.0181	0.0132
Emerging Countries					
iShares MSCI South Africa Fund	0.1632	0.1657	0.0689	0.0592	0.0376
iShares MSCI Brazil Fund	0.2504	0.2514	0.1244	0.0411	0.0858
iShares MSCI Chile Fund	0.1689	0.1724	0.0903	0.0374	0.0447
iShares MSCI Korea Fund	0.1800	0.1797	0.1068	0.0202	0.0527
iShares MSCI Mexico Fund	0.1599*	0.1529	0.0892	0.0222	0.0414
iShares MSCI Singapore	0.0928	0.0937	0.0728	0.0052	0.0156
iShares MSCI Taiwan Fund	0.1003	0.1003	0.0817	0.0036	0.0149
iShares MSCI Thailand Fund	0.1492*	0.1580	0.1315	0.0049	0.0215
iShares MSCI Turkey Fund	0.3088*	0.3158	0.1704	0.0390	0.1063

The first column calculates directly the ETF variance while the second column estimates the variance from the variances of the component stocks and the foreign currency plus their covariance. The null hypothesis of no difference between the direct and estimated variances of the fund is tested. * signifies rejection of null at 1% level, ** rejection at the 5% level.

TABLE7. SOURCES OF VOLATILITY, GROUP B FUNDS (MARCH 13, 2003 – JUNE, 30 2014)

Tracker	$Var[NAV_{dir}(\$)]$	$Var[NAV_{est}(\$)]$ =	Var[local] +	Var[FX] +	2 Cov [local, FX]
Developed Countries					
Lyxor ETF Japan	0.0668*	0.0644	0.0944	0.0369	-0.0669
iShares MSCI Japan Fund	0.0739**	0.0664	0.0986	0.0369	-0.0690
iShares FTSE 100 Fund	0.0755	0.0748	0.0617	0.0137	-0.0006
iShares SMI	0.0563*	0.0577	0.0649	0.0079	-0.0151
Lyxor ETF MSCI USA	0.0768*	0.0717	0.0778	0.0203	-0.0264
Lyxor ETF NASDAQ-100	0.0877**	0.0793	0.0771	0.0194	-0.0172
iShares NASDAQ-100	0.0812	0.0812	0.0858	0.0203	-0.0249
iShares S&P500 Fund	0.0745*	0.0718	0.0774	0.0203	-0.0260
Emerging Countries					
Lyxor South Africa ETF	0.1533**	0.1743	0.0953	0.0468	0.0322
Lyxor Brazil ETF	0.2248**	0.2568	0.1442	0.0406	0.0720
iShares MSCI Brazil Fund	0.2422*	0.2345	0.1320	0.0394	0.0631
Lyxor MSCI India ETF	0.1611	0.1620	0.1239	0.0216	0.0165
Lyxor ETF MSCI Korea	0.1730	0.1755	0.1079	0.0276	0.0401
iShares MSCI Korea Fund	0.1894	0.1755	0.1079	0.0276	0.0401
Lyxor Russia ETF	0.2648**	0.3161	0.2818	0.0174	0.0169
Lyxor Taiwan ETF	0.1081**	0.0933	0.0862	0.0172	-0.0101
iShares MSCI Taiwan Fund	0.1094**	0.0895	0.0838	0.0158	-0.0100
Lyxor Turkey ETF	0.2759*	0.2694	0.1634	0.0305	0.0755
iShares MSCI Turkey Fund	0.2830	0.2774	0.1692	0.0309	0.0773

The first column calculates directly the ETF variance while the second column estimates the variance from the variances of the component stocks and the foreign currency plus their covariance. The null hypothesis of no difference between the direct and estimated variances of the fund is tested. * signifies rejection of null at 1% level, ** rejection at the 5% level.

Tables 6 and 7 present the findings for the period March 2003 to June 2014. The first column of data reports the variance of ETF returns calculated directly from the NAV values in the fund currency. The four columns on the right attempt to estimate the theoretical fund variance based on equation 9. Note that any divergence between the fund variance calculated directly and the estimation based on the variances of the underlying foreign stocks and currency would signal inefficiency in the construction or management of the ETF. An analysis of the covariance values reveals that, for one fund in Group A (iShares Japan) and six funds in Group B (Lyxor Japan, iShares Japan,

iShares SMI, Lyxor USA, iShares Nasdaq-100, and iShares S&P 500), the covariance is greater in absolute terms and opposite in sign to the foreign currency variance. This implies that the exposure to the foreign currency is actually beneficial in reducing volatility of the country fund. In most cases, however, the covariance between index returns and exchange rate fluctuations is positive or does not completely offset the currency risk, indicating the possibility of reducing overall fund volatility through hedging.

Hedging ETF Currency Risk

Empirical Rules of Thumb

The decision to hedge currency risk should not be taken on the sole basis of historical volatilities. The investor must also factor in transactions costs, the possible roll of futures contracts, and prevailing interest rate differentials. If the rate on the foreign currency is *greater* than the dollar (euro) rate, the investor will pay for the hedge. If the rate on the foreign currency is *less* than the dollar (euro) rate, the investor will gain on the trade. Given that hedging entails additional costs, in cases where the neutralization of currency volatility only reduces risk modestly, it would be advisable to leave the exchange rate risk unhedged. We propose two metrics for ETF investors deciding whether to hedge a country ETF's underlying currency risk.

One simple rule of thumb for determining whether or not to hedge an individual currency exposure would be to consider the net currency variance as a percent of total NAV variance. The net currency variance is obtained by summing columns four and five in Tables 6 and 7. A possible decision rule for an investor concerned mainly about tracking error would be to actively hedge the foreign exchange risk for funds whose ratio exceeds +25%. Using this level, an inspection of sample funds in Group A suggests that fully hedging the foreign currency would have been advantageous in reducing volatility in all funds during the period, *except* in the cases of iShares Japan, iShares Switzerland, iShares Singapore, iShares Taiwan, and iShares Thailand. Among Group B funds, only Lyxor South Africa and the pairs of funds tracking Brazil, Korea, and Turkey would necessitate full currency hedging based on the above decision rule. A euro-based investor would always be advised to accept the risk from other developed-market currencies.

Although hedging foreign exchange exposure may reduce portfolio variance, investors should also be mindful that this risk reduction is *not* accompanied by an offsetting, significant drop in returns. To address this question, we turn to the universal hedging formula first proposed by Fischer Black (1989). While in practice, investors calculate any hedging ratio based on their global portfolio and apply an overlay strategy, to simplify the demonstration we consider a series of two-asset portfolios consisting of the same amounts of domestic equities (in dollars or euros) and a single country ETF. Our second hedging metric therefore modifies Black's universal hedging formula to test our sample of funds:

$$h^* = \left| \frac{u_m - \sigma_m^2}{u_m - \frac{1}{2}\sigma_e^2} \right| \tag{10}$$

Where $u_m$the excess return on a simple two-asset portfolio is over the period of study, σ_m^2 is the variance of the two-asset portfolio, and σ_e^2 is the variance on the fund's underlying currency pair.

Tables 8 and 9 present the summary statistics. For example, taking iShares Australia, a simple two asset portfolio composed of domestic equities (iShares Russell 1000) and Australian equities yielded an annualized excess return of 7.18% over the period with an annualized volatility (variance) of 2.69%. The annualized volatility on the AUD/USD currency cross was 1.98% during the study period. Given these inputs, the hedging formula recommends that 72.5% of the portfolio's foreign currency exposure should have been hedged:

$$0.725 = \left| \frac{0.0718 - 0.0269}{0.0718 - \frac{1}{2}(0.0198)} \right|$$

Among dollar-listed country funds, the optimal hedging ratio indicates an investor should partially accept the foreign currency volatility for all but two funds (Table 8). Conversely, the hedge ratio recommends fully hedging currency risk for all but three euro-denominated funds (Table 9). These results confirm our findings in the previous

section.

The results in Tables 8 and 9 also show that equity investors seeking risk reduction, should hedge those currencies that are more positively correlated with equity returns and should hold long positions in those currencies that are more negatively correlated with stock returns. Contrary to Campbell, De Medeiros, and Viceira (2010), we found no evidence over our period that equity investors seeking risk reduction should increase exposure to high interest rate currencies (column 1) with a large carry trade demand. Our findings are rather more consistent with Katechos (2011) in that the value of currencies with lower interest rates are negatively related to equity portfolio returns, whereas the value of currencies with higher interest rates are positively related to equity portfolio returns. An inspection of the last columns of Tables 6 and 7 confirms that the positive correlation between equities and the carry trade coincide with negative covariances between foreign exchange risk of short carry trade currencies (notably the yen and franc) and equity risk.

TABLE8. ANNUALIZED HEDGING STATISTICS, GROUP A FUNDS

Tracker	i_{local}	r_{NAV}	u_m	σ_m^2	σ_e^2	h^*	NCV
iShare Russell 1000	0.0214	0.0694	0.0480	0.0385	-	-	-
Developed Countries							
ishares MSCI Australia	0.0467	0.1104	0.0718	0.0269	0.0198	0.7253	0.0818*
iShares MSCI Canada	0.0220	0.0990	0.0743	0.0407	0.0096	0.4840	0.0511*
iShares MSCI France	0.0213	0.0710	0.0606	0.0426	0.0101	0.3247	0.0358
iShares MSCI Germany	0.0213	0.1065	0.0786	0.0450	0.0101	0.4573	0.0363
iShares MSCI Israel	0.0279	0.0161	0.0223	0.0366	0.0106	0.8436	0.0356
iShares MSCI Japan	0.0052	0.0507	0.0599	0.0259	0.0106	0.6217	-0.0135
iShares MSCI Sweden	0.0247	0.1165	0.0833	0.0485	0.0160	0.4623	0.0663*
iShares MSCI Switzerland	0.0096	0.1187	0.0897	0.0312	0.0121	0.6989	0.0139
iShares MSCI U.K.	0.0298	0.0746	0.0574	0.0369	0.0094	0.3884	0.0313
Emerging Countries							
iShares MSCI South Africa	0.0718	0.1129	0.0600	0.0466	0.0308	0.2991	0.0968*
iShares MSCI Brazil	0.1226	0.1368	0.0490	0.0653	0.0214	0.4252	0.1269*
iShares MSCI Chile	0.0446	-0.0378	-0.0227	0.0544	0.0195	1.0000	0.0821*
iShares MSCI Korea	0.0369	0.0958	0.0704	0.0486	0.0105	0.3351	0.0729*
iShares MSCI Mexico	0.0626	0.1413	0.0762	0.0503	0.0115	0.3680	0.0636*
iShares MSCI Singapore	0.0139	0.1323	0.0959	0.0329	0.0027	0.6664	0.0208
iShares MSCI Taiwan	0.0120	0.0667	0.0658	0.0321	0.0019	0.5199	0.0185
iShares MSCI Thailand	0.0275	0.0633	0.0493	0.0462	0.0025	0.0647	0.0264
iShares MSCI Turkey	0.1071	-0.0304	-0.0342	0.0790	0.0203	1.0000	0.1453*
Mean							
Developed countries	0.0232	0.0848	0.0664	0.0371	0.0120	0.5562	0.0376
Emerging countries	0.0554	0.0757	0.0455	0.0506	0.0135	0.5198	0.0726*

From left to right, the columns show the local one-year currency swap rate; the annualized fund return in dollars ; the annualized excess return the 2-asset portfolios ; the annualized variance on the 2-asset portfolios ; the variance of the underlying foreign currency versus the dollar ; the optimal currency hedge ratio ; and the net currency variance. For funds with a NCV greater than 5% (marked by an asterisk *), a benchmark-oriented investor would be advised to hedge the underlying currency risk.

Practical Applications

The results above highlight a key finding: while the majority of country funds accurately track the performance of the underlying foreign index when measured in the local currency, returns in the fund currency can be much more volatile. In breaking down the sources of country fund volatility, the paper demonstrates the impact of the underlying currency movements on overall fund risk. In cases where the currency impact has a significant impact on fund tracking errors, an index-oriented investor benefits from neutralizing the exchange rate effect. Additionally, as the Sortino and Modified Sharpe measures suggest that the underlying currency exposure offers, in most cases, a better risk-adjusted return for country ETFs in the listing currency, we also calculate the risk-minimizing foreign currency exposure for each fund and propose a decision rule based on the net currency variance to decide whether to hedge the ETF's currency risk. The optimal hedge ratio indicates that U.S.-based

investors should only partially hedge the underlying currency risk while European-based investors are better off fully hedging currency risk. In all cases, rebalancing is advised on at least a quarterly basis to account for the changing dynamics within the hedge ratio.

The study addresses whether or not adding offsetting forward currency positions to an equity portfolio containing a country ETF improves the risk/return profile. Specifically, it shows that certain country funds with pro-cyclical underlying currencies may create an unacceptable level of volatility for a portfolio denominated in dollars (or euros) or produce returns not in line with the performance of the underlying index. The paper also shows that country ETFs with higher yielding currencies (long carry trade currencies) have a strong positive covariance between equity and currency returns while those funds with lower yielding currencies (short carry trade currencies) have negative covariances. The decomposition of fund volatility allows both international investors and money managers with a benchmark-oriented mandate to better isolate the foreign exchange risk and make informed decisions on whether or not to actively hedge this risk.

TABLE9. ANNUALIZED HEDGING STATISTICS, GROUP B FUNDS

Tracker	i_{local}	r_{NAV}	u_m	σ_m^2	σ_e^2	h^*	NCV
iShare Russell 1000	0.0213	0.0614	0.401	0.0436	-	-	-
Developed Countries							
Lyxor Japan	0.0052	-0.0230	-0.0240	0.0287	0.0192	1.0000	-0.0300
iShares MSCI Japan	0.0052	-0.0248	-0.0193	0.0202	0.0192	1.0000	-0.0321
iShares FTSE 100	0.0298	0.0553	0.0344	0.0382	0.0071	0.1218	0.0131
iShares SMI	0.0096	0.0991	0.0666	0.0326	0.0041	0.5272	-0.0072
Lyxor MSCI USA	0.0214	0.0416	-0.0049	0.0408	0.0106	1.0000	-0.0061
Lyxor NASDAQ-100	0.0214	0.0942	0.0608	0.0363	0.0101	0.4390	0.0022
iShares NASDAQ-100	0.0214	0.0872	0.0174	0.0414	0.0106	1.0000	-0.0046
iShares S&P500	0.0214	0.0392	-0.0061	0.0404	0.0106	1.0000	-0.0057
Emerging Countries :							
Lyxor South Africa	0.0718	0.0029	-0.0609	0.0575	0.0243	1.0000	0.0790*
Lyxor Brazil	0.1226	-0.0523	-0.1051	0.0711	0.0211	1.0000	0.1126*
iShares MSCI Brazil	0.1226	-0.0033	-0.0742	0.0770	0.0205	1.0000	0.1025*
Lyxor MSCI India	0.0658	-0.0043	-0.0466	0.0505	0.0112	1.0000	0.0381
Lyxor ETF MSCI Korea	0.0369	-0.0038	-0.0306	0.0570	0.0144	1.0000	0.0677*
iShares MSCI Korea	0.0369	-0.0041	-0.0324	0.0647	0.0144	1.0000	0.0677*
Lyxor Russia	0.0788	-0.0723	-0.0819	0.0715	0.0090	1.0000	0.0343
Lyxor Taiwan	0.0120	0.0232	0.0001	0.0425	0.0090	1.0000	0.0071
iShares MSCI Taiwan	0.0120	0.0209	-0.0087	0.0460	0.0082	1.0000	0.0058
Lyxor Turkey	0.1071	-0.0050	-0.0606	0.0729	0.0159	1.0000	0.1060*
iShares MSCI Turkey	0.1071	-0.0241	-0.0790	0.0794	0.0160	1.0000	0.1082*
Mean							
Developed countries	0.0169	0.0461	0.0156	0.0348	0.0114	0.7610	-0.0088
Emerging countries	0.0703	-0.0111	-0.0527	0.0627	0.0149	1.0000	0.0663*

From left to right, the columns show the local one-year currency swap rate; the annualized fund return in dollars ; the annualized excess return the 2-asset portfolios ; the annualized variance on the 2-asset portfolios ; the variance of the underlying foreign currency versus the dollar ; the optimal currency hedge ratio ; and the net currency variance. For funds with a NCV greater than 5% (marked by an asterisk *), a benchmark-oriented investor would be advised to hedge the underlying currency risk.

Conclusion

By evaluating both the hedged and unhedged NAV return tracking errors, this paper classifies the country funds by their sensitivity to the currency impact. While the ability of some funds to reproduce the performance of the underlying index is relatively little impacted by accepting the foreign exchange risk, for other funds (notably on emerging market indexes) the return profile is greatly distorted by the currency effect. Results suggest an optimal position in a country ETF would involve at least partial hedging of the underlying foreign exchange risk. However, as results based on historical data are time-frame dependent, a proactive investor would use personal, forward-looking return and volatility expectations in determining his own optimal hedging ratio.

Notes

[1]As opposed to country funds, which only invest in stocks of a single country, international ETFs invest across countries or regions thereby presenting exposure to numerous foreign currencies.

[2]Complete test results are available from the authors upon request.

[3]While the argument can be advanced that the yen has been a counter-cyclical currency over the period of the study, the low volatility of unhedged returns for iShares Taiwan reflects rather the managed float of the TWD versus the USD.

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