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On the premiums of iShares

Natalya Delcoure [a,*], Maosen Zhong [b,c]

[a] *Mitchell College of Business, University of South Alabama, Mobile, AL 36688, United States*
[b] *UQ Business School The University of Queensland, Brisbane, QLD 4072, Australia*
[c] *Lingnan College, Zhongshan University, China*

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Abstract

We show that the newly developed exchange-traded world equity index funds, or iShares, trade at economically significant premiums for 10–50% of the times even after controlling for transaction costs and time-zone measurement errors. Moreover, iShares price returns exhibit excessive volatility relative to their NAV returns. These findings suggest a limit of arbitrage in the international iShares market where iShares can be created and redeemed at will and premiums that exceed the creation/redemption transaction costs should be immediately arbitraged away. However, our cointegration and persistence profile analyses indicate that the deviations of most iShares' prices from their NAVs are not persistent and converge to zero within two days. We propose several rational factors to explain the absolute value of iShares premiums. The panel regression results suggest that institutional ownership, bid–ask spread, trading volume, exchange rate volatility, political and financial crises and, to a lesser extent, the conditional correlation between the U.S. and home markets are the significant driving factors of the size of iShares premiums. However, a significant variation of the premiums still remains unexplained, which suggests that behavioral factors may account for some mispricing.

JEL classification: F36; G15
Keywords: iShares; Fund premiums; Limit of arbitrage; International diversification

* Corresponding author. Current address. College of Business Administration, Sam Houston State University, Huntsville, TX 77341-2056, United States. Tel.: +1 936 294 1283; fax: +1 936 294 3074.

E-mail addresses: nvd001@shsu.edu (N. Delcoure), m.zhong@business.uq.edu.au (M. Zhong).

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1. Introduction

In March 1996, the American Stock Exchange (AMEX) introduced a hybrid investment product, World Equity Benchmark (WEBs) exchange-traded funds, also called iShares.[1] These international iShares track the Morgan Stanley Capital International (MSCI) country indices. Touted as an alternative to the closed-end country funds for investors seeking international or region-specific exposure, iShares have advantages over closed-end country funds. iShares offer investors an inexpensive and easy way to obtain an index-based exposure to the stock market of a specific country or geographic region combined with built-in tax efficiency due to a low turnover ratio compared with actively managed closed-end country funds. The iShares have diversification characteristics similar to closed-end funds (CEFs), but trade as stocks that can be purchased and sold on an exchange.

International iShares are open-ended passively managed financial instruments, where fund share prices and net asset values (NAVs) are determined in two different market segments by two different groups of investors. Diversification benefits, direct or indirect barriers to foreign investment, may entice investors to pay premiums for iShares funds. At the same time, international iShares may trade at premiums or discounts because of some risk factors and costs of arbitrage.[2] iShares can be created or redeemed at will.[3] The creation and redemption features of iShares allow large institutional investors to arbitrage away any significant deviations from the NAV. For example, if an iShares series trades at a discount, institutional owners will buy blocks of iShares at the lower price and redeem them for underlying shares to arbitrage the price discrepancy. Therefore, in the efficient market, the deviation between iShares price and NAV should be economically insignificant. However, recently advocates for individual investors express their concern that, similar to closed-end funds, iShares trade at economically significant premiums and discounts.[4]

The most straightforward way to analyze pricing of iShares is to ask a question whether the observed deviation from NAV is really there, or whether it arises because of simple NAV miscalculation. The majority of existing empirical studies examining the economic nature of premiums and discounts are associated with the domestic and country-specific closed-end funds.

The purpose of our study is two-fold. First, we explore whether the fairly new but increasingly popular international diversification vehicles – country-specific iShares – are traded at their fundamental values. Finance literature has long debated whether security prices reflect their fundamental values. Keynes (1936) challenges the efficiency of financial markets by suggesting that security prices are an outcome of the mass psychology of less-than-rational investors. Friedman (1953) maintains that rational investors capitalize on less-than-rational investors' mistakes and, in the long run, eliminate securities' mispricing. Various studies, such as Hardouvelis, La Porta, and Wizman (1994), Bodurtha, Kim, and Lee (1995), Brown (1999), De Long, Bradford, Shleifer, Summers, and Waldmann (1990a), Lee and Hong (2002), Gemmill and Thomas (2002), find the support for the "noise traders" hypothesis which assumes the persistent

[1] WEBs also called iShares since June 2000.

[2] The Appendix provides a list of potential risk factors and the creation and redemption fee schedules.

[3] As a practical matter, only institutional or/and large investors purchase or/and redeem shares in large blocks of 50,000 or more, also called "creation units."

[4] Fund Democracy, LLS (May 4, 2000) and Consumer Federation of America (letter to the SEC Secretary, May 5, 2000) express their concern that exchange-traded funds trade at considerable discounts and premiums. In related work, Olienyk et al. (1999) and Durand and Scott (2003) find the support for both rational and the "noise traders" explanations of short-run inefficiencies in international iShares pricing.

existence of poorly informed and less-than-rational investors in the financial markets. Furthermore, the empirical work of Malkiel (1977), Shiller (1984), De Long et al. (1990a,b), Lee, Shleifer, and Thaler (1991), Abraham, Elan, and Marcus (1993), Pontiff (1997), and Brown (1999) argues that mispricing persists in financial markets over time. We find that even after controlling for transaction costs and time recording errors, international iShares exhibit excess price volatility relative to their NAVs and trade at significant premiums.[5] This finding suggests a limit of arbitrage given the creation and redemption feature of iShares. However, our cointegration and persistence profile analyses indicate that the observed price deviations from NAV are only temporary phenomena and tend to converge to zero within a short period of time.

Second, having found that international iShares are traded at economically significant but temporary premiums, we attempt to identify rational factors that explain these observed price deviations from NAVs. We construct a multifactor time-series and cross-sectional panel model to explain the average sensitivities of iShares' premiums (in absolute values) to a set of global, country-specific, and market microstructure factors. Our findings suggest that institutional ownership, trading volume, exchange rate volatility, bid–ask spread, and, to a lesser extent, the conditional correlation of the United States (U.S.) and home markets are the driving factors of the iShares premiums. The unfavorable features of these factors could make the creation–redemption process of iShares costly and ineffective in the short term. However, a significant variation of the premium size remains unexplained by the rational factors, which suggests that behavioral factors may account for some iShares' mispricing.

The rest of the paper is organized as follows. Section 2 introduces the data and discusses some related issues of iShares premiums. Section 3 analyzes the economic significance and properties of iShares premiums. Section 4 presents a multifactor panel regression model to explain the absolute values of iShares premiums. Section 5 concludes the paper.

2. Data and related issues

We collect closing prices[6] and NAVs on each trading day for 20 iShares, traded on the AMEX, from their inception day (eighteen iShares have been traded since March 12, 1996; Taiwan and South Korea iShares have been traded since summer 2000) through the end of October, 2002 from the Bloomberg Database. From the same database, we also obtain the daily trading volume of the 20 iShares, closing quotes for each of the 20 MSCI country-specific market indexes, and the exchange rate between the U.S. dollar and each iShares home-country currency for our sample period.

The possible deviation between iShares price and NAV may arise because iShares Series accumulate dividends and other distributions that are paid by the underlying stocks in a separate account. These cash distributions are dispersed to iShares investors annually. Appendix A gives a

[5] In this paper, we confine our study to the iShares' price premiums or discounts relative to the NAVs and do not attempt to investigate the premiums relative to the MSCI index because of the systematic tracking errors of iShares prices.

[6] We also collect the bid–ask midpoints to perform robustness tests. Bid/Ask midpoint (market price) is the midpoint between the highest bid and the lowest offer of the listing exchange (AMEX), as of the 4 p.m. EST. Except for iShares Malaysia, iShares South Korea, and iShares Taiwan, NAV for international fund is calculated according to the standard formula for valuing mutual fund shares by the Fund accountants using closing securities prices from local markets, and Reuters/WM FX rates at 4 p.m. London time. The Fund determines the NAV of each of the iShares Malaysia, iShares South Korea, and iShares Taiwan as of 11:00 a.m. EST on each day of trading. We report results based on closing prices in all tables but using the bid–ask midpoint quotes yields similar results.

brief description of the iShares features, risk factors, and ownership structure. Following Ackert and Tian (2000) approach, in order to avoid the contamination of dividend accumulation, dividends are excluded from iShares prices. In light of Pontiff (1997), we calculate each iShares series premium as the difference between the log price and log NAV (the negative value being the iShares discount).

Accurate calculation of iShares premiums is challenging because of the time-zone differences of the world markets. The traditional mutual fund pricing literature examines the presence of microstructure noise in the computation of daily NAVs for international open-end mutual funds. Goetzmann, Ivkovic and Rowenhorst (2001) point out that time-zone differences create a dilemma for the U.S. open-end funds that invest in foreign securities. The fact that international open-end funds' NAVs are determined at times usually much earlier than the U.S. market closing times makes the accurate NAV determination for daily redemption difficult and leaves the open-end funds exposed to speculative trading. Consider iShares Japan that invests in Japanese securities, most of which are not cross-listed in the U.S. Suppose the fund needs to determine the NAV in the U.S. dollars (U.S.D.) of its shares as of 4 p.m. U.S. Eastern Standard Time (EST). The iShares fund practice is to take the Yen closing prices from the Tokyo Stock Exchange (TSE) and use the Yen/U.S.D. exchange rate that prevails at 4 p.m. London time to compute the dollar value of the portfolio. The TSE closes at 1 a.m. EST, about nine hours before the AMEX opens. Thus, the premiums calculated based on the closing prices of iShares and the above-determined NAVs suffer the so-called "stale pricing" problem and are not accurate. Another similar problem pertaining to the Bloomberg Database is that the NAVs of iShares Malaysia, South Korea, and Taiwan are determined as of 8:30 a.m. EST on each day that the AMEX is open, but the NAVs of the rest of 17 iShares are determined as of the close of the regular trading session on the AMEX (ordinarily 4:00 p.m., EST).

One solution to this problem is to calculate the NAVs on a "real-time" basis, for example, to calculate NAVs of European iShares during the morning hours using the "synchronous" intraday transaction data of the iShares component stock values and exchange rates. However, calculation of the NAVs from intraday data is cumbersome and not even feasible because intraday data on asset holdings are not available for many funds. As Engle and Sarkar (2002) point out, even when one could successfully estimate the "real-time NAVs" using the most recent transaction price of each component security of the portfolio, the same stale quote possibility of the daily NAV still exists especially for thinly-traded stocks in iShares portfolios. Moreover, this practice provides little relief for the Asian funds that trade mostly during the hours when the U.S. market is closed. Therefore, this stale pricing/time recording error cannot be effectively eliminated by using intraday data and has to be explicitly corrected. We use two methods proposed by Goetzmann et al. (2001) and Engle and Sarkar (2002) to correct for this recording error.

Goetzmann et al. (2001) suggest adjusting the NAV by making it orthogonal to the available information in the market. If the price of an iShares portfolio reflects all value-relevant information, short term portfolio returns should be approximately unpredictable. If iShares series base their NAVs on stale prices, some value-relevant information will be reflected in the NAV only on the next day. Goetzmann et al. (2001) take the predictable portion of next day's NAV and include it in today's NAV. Thus, the "true" NAV is:

$$\mathrm{NAV}^*_{i,t} = \mathrm{NAV}_{i,t}(1 + \beta_i Z_t) \tag{1}$$

where β_i is the slope coefficient of regression of the next day NAV return on iShares series i on the instrumental variable Z_t, the S&P 500 index return on day t. This correction adjusts each daily NAV to reflect the additional value-relevant information, and will therefore produce a more reliable premium.

Engle and Sarkar (2002) propose another solution to this so-called "errors-in-variables" problem and formulate a novel statistical model of the measurement error that preserves the possible cointegration between fund prices and NAVs. Let $u_{i,t}=1\text{n}(P_{i,t})-1\text{n}(NAV^{*}_{i,t})$ be the true premium of iShares i on day t, where $1\text{n}(P_{i,t})$ is the natural logarithm of the closing price. The true premium can be derived as regression residual from the following equation:

$$1\text{n}(P_t)-1\text{n}(\text{NAV}_t)=\alpha\Delta 1\text{n}(\text{NAV}_t)+\phi x_t+u_t \tag{2}$$

where x_t is a set of stationary exogenous or predetermined variables that explain the true premiums, and α and ϕ are regression coefficients. We use the currency exchange rate and the S&P 500 index return as the exogenous variables in x_t. The model in Eq. (2) prescribes that the iShares log price and log NAV are cointegrated and therefore, all variables on both sides of the equation are stationary.

Table 1 presents summary statistics of the absolute values of all 20 iShares premiums calculated from closing prices.[7] Panel A is for the adjusted premiums based on Goetzmann et al.'s (2001) method. Panel B is for the adjusted premiums based on Engle and Sarkar's (2002) method. Panel C is for the unadjusted premiums. Each panel displays the mean, the standard deviation (σ), the 75th percentile, the 90th percentile, the maximum and the first-order autocorrelation (ρ) of each iShares' premium absolute value. The far right column displays the maximum two-way variable transaction cost of cash purchase (creation) and redemption of the iShares as percentage of the net asset value. According to the iShares' Prospectus, each fund imposes a purchase/redemption transaction fee to offset transfer and other transaction costs associated with purchase/redemption of iShares. These fees presumably reflect the sponsor's cost of trading the underlying securities and could be used as an approximation for the relative cost of arbitrage.[8] Thus, we include the sum of the maximum variable charges for cash purchases and redemptions as the cap for iShares transaction costs. We ignore the fixed cash fee for in-kind and cash purchases/redemption because it is trivial compared to the large creation and redemption transactions, generally 50,000 iShares per creation unit. The mean, the 75th percentile, the 90th percentile and the maximum absolute value of iShares premiums that are greater than the maximum two-way variable transaction cost are highlighted in bold.

The three panels of Table 1 paint a very similar picture. The means of all iShares (adjusted and unadjusted) premiums are statistically significant based on a t-test.[9] The mean premiums of iShares Belgium, Canada, France, Germany, Japan, Malaysia, Netherlands, and Sweden exceed the maximum two-way transaction costs of creation and redemption. The medians (not reported here to save space) are almost the same as the means. The maximum absolute value of iShares premiums are all much higher than the maximum two-way creation/redemption costs, suggesting the presence of arbitrage opportunities. Moreover, 15 iShares have their 75th percentile premiums higher than maximum two-way transaction costs and 17 iShares have their 90th percentile premium higher than the two-way transaction costs. The remaining three iShares (Brazil, South Korea, and Taiwan) have their 90th percentile premiums higher than 2% of the iShares values.[10]

[7] We find that contrary to traditional closed-end funds, international iShares are traded at premiums instead of discounts. We do not report the summary statistics for the levels of premiums because of space consideration.

[8] We thank an anonymous referee for this idea.

[9] The significance is judged by a t-statistic in the form of $(\Sigma_{t=1}^{T}|\text{PM}|_t)/(\sigma\sqrt{N})$, where $|\text{PM}|_t$ and σ are the absolute value of premiums and their standard deviation, respectively, and N is the number of observations. We omit reporting the results for space consideration.

[10] According to iShares Statement of Additional Information, iShares Brazil, Malaysia, South Korea, and Taiwan maximum two-way transaction costs may not exceed 3%.

Table 1
Summary statistics of iShares premiums absolute values

iShares	Panel A						Panel B						Panel C						Maximum two-way trans. cost (%)
	Goetzmann et al.'s (2001) adjustment						Engle and Sarkar's (2002) adjustment						Without adjustment						
	Mean (%)	σ (%)	75% (%)	90% (%)	Max. (%)	ρ	Mean (%)	σ (%)	75% (%)	90% (%)	Max. (%)	ρ	Mean (%)	σ (%)	75% (%)	90% (%)	Max. (%)	ρ	
Australia	0.873	0.668	**1.226**	**1.791**	**7.898**	0.235	0.861	0.664	1.198	**1.801**	**7.921**	0.256	0.905	0.718	**1.269**	**1.859**	**10.025**	0.254	1.20
Austria	0.865	0.729	1.170	**1.730**	**9.179**	0.253	0.856	0.722	1.172	**1.691**	**9.219**	0.268	0.872	0.743	1.212	**1.725**	**9.020**	0.277	1.34
Belgium	**0.785**	0.627	**1.123**	**1.657**	**4.408**	0.240	**0.776**	0.615	**1.116**	**1.633**	**4.549**	0.244	**0.795**	0.644	**1.153**	**1.659**	**6.284**	0.231	0.60
Brazil	1.056	1.002	1.420	2.441	**7.239**	0.375	1.004	0.904	1.389	2.225	**6.965**	0.410	1.075	1.015	1.465	2.481	**6.880**	0.360	3.00
Canada	**0.768**	0.649	**1.077**	**1.658**	**4.178**	0.246	**0.729**	0.605	**1.027**	**1.540**	**4.709**	0.281	**0.747**	0.627	**1.057**	**1.624**	**3.851**	0.267	0.60
France	**0.551**	0.449	**0.778**	**1.117**	**3.727**	0.075	**0.532**	0.423	**0.741**	**1.069**	**3.658**	0.130	**0.574**	0.466	**0.793**	**1.138**	**4.745**	0.110	0.50
Germany	**0.641**	0.539	**0.870**	**1.329**	**7.203**	0.115	**0.616**	0.521	**0.845**	**1.267**	**6.926**	0.148	**0.684**	0.591	**0.951**	**1.428**	**7.465**	0.176	0.50
Hong Kong	0.996	1.175	**1.257**	**2.092**	**25.858**	0.408	0.975	1.118	**1.274**	**2.053**	**23.311**	0.434	**1.214**	1.346	**1.593**	**2.477**	**28.478**	0.340	1.20
Italy	0.562	0.448	**0.788**	**1.105**	**3.178**	0.115	0.576	0.438	**0.802**	**1.140**	**2.834**	0.085	0.573	0.471	**0.782**	**1.112**	**4.415**	0.156	0.60
Japan	**0.724**	0.631	**0.995**	**1.544**	**6.832**	0.272	**0.698**	0.604	**0.946**	**1.496**	**6.203**	0.265	**0.878**	0.739	**1.234**	**1.820**	**7.450**	0.199	0.55
				8.86		0.89	**3.77**	5.31	**3.96**			0.88	**3.34**	4.99	**3.27**	**8.95**		0.88	

(continued on next page)

Table 1 (*continued*)

iShares	Panel A Goetzmann et al.'s (2001) adjustment						Panel B Engle and Sarkar's (2002) adjustment						Panel C Without adjustment						Maximum two-way trans. cost (%)
	Mean (%)	σ (%)	75% (%)	90% (%)	Max. (%)	ρ	Mean (%)	σ (%)	75% (%)	90% (%)	Max. (%)	ρ	Mean (%)	σ (%)	75% (%)	90% (%)	Max. (%)	ρ	
Malaysia	**3.321**	4.979	**3.309**	**2**	**36.307**	3	**7**	7	**3**	**10.156**	**36.144**	8	**7**	6	**9**	**0**	**36.727**	7	3.00
				1.96		0.35	0.90	0.77	**1.25**			0.38	0.92	0.79	**1.28**	**1.97**		0.36	
Mexico	0.923	0.787	**1.289**	**9**	**6.063**	9	6	6	**5**	**1.945**	**6.092**	3	2	0	**0**	**0**	**6.297**	6	1.00
				1.25		0.11	**0.62**	0.46	**0.89**			0.12	**0.65**	0.50	**0.92**	**1.26**		0.13	
Netherlands	**0.648**	0.502	**0.913**	**9**	**5.698**	1	**4**	3	**3**	**1.212**	**5.122**	6	**4**	9	**0**	**3**	**5.643**	8	0.50
				2.97		0.47	1.45	1.28	1.96			0.48	1.54	1.39	2.09	**3.18**		0.41	
Singapore	1.459	1.304	1.991	2	**16.988**	7	5	8	7	**3.008**	**15.430**	7	1	1	3	7	**19.099**	1	2.90
				2.25		0.29	1.03	0.89	1.43			0.29	1.25	1.07	1.72	2.66		0.17	
South	1.041	0.898	1.434	5	**6.682**	3	7	4	1	2.203	**6.186**	3	0	6	3	8	**9.886**	3	3.00
Korea				**1.18**		0.11	0.56	0.47	**0.78**			0.12	0.59	0.51	**0.81**	**1.19**		0.12	
Spain	0.573	0.489	**0.811**	**2**	**4.356**	8	3	0	**1**	**1.137**	**4.302**	4	6	8	**8**	**7**	**6.505**	6	0.70
				1.52		0.10	**0.73**	0.62	**1.01**			0.11	**0.78**	0.68	**1.06**	**1.50**		0.15	
Sweden	**0.768**	0.658	**1.060**	**3**	**6.730**	1	**9**	3	**2**	**1.421**	**6.930**	3	**5**	0	**1**	**6**	**9.459**	1	0.60
				1.55		0.12	0.78	0.55	**1.13**			0.10	**0.81**	0.58	**1.15**	**1.58**		0.12	
Switzerland	0.791	0.557	**1.142**	**9**	**3.480**	0	5	0	**0**	**1.550**	**3.435**	1	**2**	8	**2**	**3**	**3.639**	8	0.80
				2.92		0.35	1.39	1.15	1.90			0.36	1.55	1.31	2.15	**3.23**		0.27	
Taiwan	1.423	1.182	1.974	7	**9.192**	9	9	2	0	2.764	**8.129**	3	9	6	8	**4**	**11.534**	1	3.00
				1.57		0.21	0.77	0.57	**1.10**			0.22	0.80	0.62	**1.14**	**1.62**		0.18	
UK	0.782	0.585	**1.111**	**0**	**4.058**	3	3	4	**3**	**1.572**	**4.010**	6	9	8	**1**	**3**	**5.449**	9	1.00
				2.12		0.26	0.98	0.93	1.29			0.28	1.03	0.99	**1.35**	**2.22**		0.26	
Average	0.977	0.943	1.287	**7**	**8.963**	9	4	6	7	**2.144**	**8.604**	1	0	3	**7**	**5**	**10.143**	1	1.33

Notes: The table contains summary statistics for each of the 20 iShares premiums absolute values based on closing prices. Panel A is for the adjusted premiums based on Goetzmann et al.'s (2001) method. Panel B is for the adjusted premiums based on Engle and Sarkar's (2002) method. Panel C is for the unadjusted premiums. Each panel displays the mean, the standard deviation (σ), the 75th percentile, the 90th percentile and the first-order autocorrelation (ρ) of each iShares' premium. The far right column displays the maximum two-way variable transaction cost of cash purchase (creation) and redemption of the iShares as percentage of the net asset value which are obtained from the iShares website. According to iShares Statement of Additional information, iShares Brazil, Malaysia, South Korea, and Taiwan maximum two-way transaction costs may not exceed 3%. The fixed in-kind and cash purchases/redemption fee is trivial (less than \$5000 per transaction) compared to a reasonable amount of arbitrage transaction and is not included. The mean, the 75th percentile and the 90th percentile that are greater than the maximum two-way variable transaction cost are highlighted in **bold**.

This suggests that, in general, iShares trade at economically significant (arbitrageable) premiums for 10 to 50% of the times.

Table 1 also shows that most iShares premiums demonstrate low first-order autocorrelations which can shed light on how persistent the premiums may be. Except for iShares Malaysia, all other iShares' autocorrelations are lower than 0.5. The average autocorrelations of premiums are 0.269 using the Goetzmann et al. adjustment, 0.281 using the Engle–Sarkar adjustment and 0.261 for unadjusted premiums. These low autocorrelations imply that the iShares premiums are only transitory phenomena. The only exception is iShares Malaysia with a premium autocorrelation of 0.89 which implies a fairly persistent premium. [11]None of the autocorrelations is greater than 1.0, suggesting that iShares premiums do not permanently drift away from zero.

The presence of economically significant premiums, even after controlling for transaction costs and time-zone measurement errors, suggests that risks in assembling iShares series package may inhibit the creation–redemption process. These risks may not be effectively hedged and therefore, the arbitrage mechanism becomes ineffective, risky, and costly causing international iShares to trade at significant premiums. In Section 3, we attempt to gain a better understanding about the nature of iShares premiums.

3. Properties of iShares premiums

Econometric theory dictates that when two non-stationary time-series are cointegrated, they tend to move together and are bound up by a stationary linear relation, and the deviation from this linear relation is only temporary (e.g., Engle and Granger, 1987). On the other hand, if the two time-series are not cointegrated, then they are likely to move apart from each other in the long run, and their stochastic gap is permanent. Therefore, if iShares prices and NAVs are found to be cointegrated with a one-to-one relation, then iShares price deviations from NAVs are only temporary in nature, and market force (such as, arbitrage activities) tends to drive the premiums down to zero over time. Hence, we investigate the transitory nature of iShares premiums using the cointegration test methodology.

We use the Johansen's (1991) procedure to test for cointegration using a multivariate framework to produce efficient estimates of cointegration coefficients. Two statistics are computed, the maximum eigenvalue and trace statistic:$\lambda_{\max}=-T\ln(1-\hat{\lambda}_{r+1})$, and $\text{Trace}=-T\sum_{i=r+1}^{n}\ln(1-\hat{\lambda}_{i})$, where T is the sample size, n is the number of variables in the system (-2 in our study), r is the hypothetical number of cointegrating vectors, and $\hat{\lambda}_i$ is the ith smallest squared canonical correlation in Johansen (1991). [12]The cointegration residual in our bivariate framework is obtained as:

$$\xi_t = 1\text{n}(P_t)-\gamma 1\text{n}(\text{NAV}_t) \tag{3}$$

where γ is the normalized cointegration coefficient. Because of the creation and redemption process, the cointegration coefficient γ should be unity such that the price converges to the NAV in the long run. If γ is unity, ξ_t is the premium.

[11] The half-life can be used to gauge the length of time (number of days) over which a shock to the premium diminishes to half its original size. The half-life is calculated as $\ln(0.5)/\ln(\rho)-1$, where ρ is the first-order autocorrelation of the premium. While other iShares' premiums have their half-lives of less than one day, iShares Malaysia premiums has a half-life of 5.12 days. Because the half-life is basically another measure of autocorrelation, we do not report it here for space consideration.

[12] Under the null of cointegration, the maximum likelihood estimator of $\hat{\lambda}_i$'s can be found by solving the equation:

$$|\lambda S_{\text{kk}}-S_{k0}S_{00}^{-1}S_{0k}|=0$$

where S_{00}, S_{0k}, and S_{kk} are the residual moment matrices and cross-product moment matrix of the least square regressions of Δx_t and Δx_{t-k} on x_{t-1}, ..., Δx_{t-k+1}, respectively. Here, x_t is the vector of the iShares price series and the NAV series.

Table 2 displays the Johansen's (1991) maximum eigenvalue and trace statistics of cointegration tests between iShares closing prices and NAVs as well as the cointegration coefficients. Panel A reports the cointegration test results for iShares prices and raw NAVs, while Panel B for iShares prices and adjusted NAVs using Goetzmann et al.'s (2001) method. The VAR lag profiles are 22, the average trading days per month. The statistics significant at the 95% level according to the Osterwald-Lenum (1992) table of critical values are highlighted in bold. The findings of cointegration tests confirm the presence of a common stochastic trend binding iShares prices and NAVs in our sample. The estimated normalized cointegration coefficient (γ) presented in Table 2 is very close to unity for all iShares. This suggests that the iShares premium is essentially the deviation from a long-term price-NAV equilibrium trend and therefore only temporary in nature. Should a shock to the price-NAV equilibrium system occur, the system should converge to equilibrium.

So how quickly does the price-NAV system reacts to a system-wide shock? We follow Darrat and Zhong (2005) and measure the speed of reaction using the persistence profile analysis developed by Pesaran and Shin (1996). [13]The estimated persistence profile should approach zero as its horizon lengthens, since the effect of a shock on the cointegrating relation is temporary by nature and eventually disappears as the system reverts back to equilibrium. Appendix B presents a description of the technical details of the persistence profile analysis and the graphs of the estimated profiles for all 20 iShares. The speed of reaction can be gauged by the number of days for the cointegrated system to complete the convergence to equilibrium. Table 2 displays the number of days for the price-NAV cointegrating relation (effectively the premium as defined in Eq. (3)) to complete 90 and 95% of the convergence. Except for iShares Australia and Malaysia, all other iShares' price-NAV systems complete 90% of the convergence, given a unit system-wide shock, within two days, regardless of the iShares' adjustment for time recording error. The majority of the iShares complete 95% of the convergence within only one day. The iShares Australia completes 95% convergence within 4 days. The iShares Malaysia price-NAV relation, the only exception, takes more than 20 days to revert to equilibrium given a unit system-wide shock. Overall, these results corroborate with the autocorrelation results in Table 1 and suggest that most iShares' premiums are only temporary and do not last over two days.

In light of this finding, we calculate another metric, the variance ratio à là Pontiff (1997) to detect a possible excessive volatility effect of iShares prices. According to Pontiff (1997), in integrated world markets, the creation and redemption features of iShares, as on open-end fund, should ensure that price and NAV volatility are equal. Excess price volatility relative to NAV volatility implies the ineffective arbitrage of pricing errors. Following Pontiff's approach, we compute the ratio of variance of iShares price returns to variance of NAV returns. The logarithm is taken to reduce skewness. The log variance ratio will be zero if the volatility of iShares price returns is equal to the volatility of its NAV returns. Pontiff (1997), however, did not provide a statistical test for the null hypothesis that the log variance ratio is zero.

To test whether the log variance ratio is statistically different from zero, we employ the Hansen (1982) general methods of moments (GMM) to estimate the standard error for the log

[13] As Darrat and Zhong (2005) point out, the persistence profile analysis has advantages over the impulse response function (IRF) analysis. Unlike the IRF, the persistence profile measures the responses to a system-wide shock rather than a shock to an individual series. Furthermore, traditional IRF imposes the Choleski decomposition which is sensitive to the ordering of variables in the underlying vector regressive model. The persistence profile is unique and do not require the prior orthogonalization of shocks.

Table 2
Cointegration between iShares closing prices and NAVs

iShares	Panel A. Prices and raw NAVs					Panel B. Prices and adjusted NAVs				
	H_0: $r=1$		Cointegrating coefficient	No. of days for a shock to complete convergence of		H_0: $r=1$		Cointegrating coefficient	No. of days for a shock to complete convergence of	
	λ-max	Trace	γ	>90%	>95%	λ-max	Trace	γ	>90%	>95%
Australia	**42.07**	**46.06**	1.00	4	4	**44.07**	**47.31**	1.00	4	4
Austria	**36.76**	**36.87**	1.01	1	2	**34.76**	**34.89**	1.01	1	1
Belgium	**31.18**	**32.82**	1.00	1	1	**26.62**	**28.28**	1.00	1	1
Brazil	**18.45**	**22.04**	1.02	1	1	**18.06**	**21.45**	1.02	1	1
Canada	**40.94**	**44.29**	1.00	1	1	**36.28**	**39.65**	1.00	1	1
France	**47.98**	**51.34**	1.00	1	1	**39.37**	**42.64**	1.00	1	1
Germany	**47.96**	**50.26**	1.01	1	1	**39.79**	**42.11**	1.01	1	1
Hong Kong	**33.70**	**38.05**	1.01	1	1	**29.91**	**34.10**	1.01	1	2
Italy	**77.89**	**82.06**	1.00	1	1	**74.59**	**78.54**	1.00	1	1
Japan	**62.68**	**65.82**	1.00	1	1	**57.59**	**60.71**	1.00	1	2
Malaysia	**28.28**	**32.58**	1.00	21	36	**23.78**	**28.08**	1.00	20	36
Mexico	**47.81**	**53.60**	1.00	1	2	**45.02**	**50.89**	1.00	1	2
Netherlands	**53.97**	**55.41**	1.01	1	1	**49.58**	**51.02**	1.01	1	1
Singapore	**16.80**	**21.83**	1.01	2	2	**16.44**	**21.28**	1.01	2	3
South Korea	**18.98**	**20.94**	1.00	1	2	**18.71**	**21.08**	0.99	1	2
Spain	**43.25**	**48.31**	1.00	1	1	**37.78**	**42.62**	1.00	1	1
Sweden	**48.99**	**51.05**	1.00	1	1	**43.98**	**46.03**	1.00	1	1
Switzerland	**44.30**	**49.00**	1.01	1	1	**44.99**	**49.78**	1.01	1	1
Taiwan	**27.23**	**33.90**	1.03	1	2	**25.84**	**32.57**	1.03	1	3
UK	**37.16**	**39.46**	1.01	1	1	**34.74**	**37.06**	1.01	1	1
95% Critical values	15.41	14.07				15.41	14.07			

Notes: The trace and maximal eigenvalue (λ-max) are the test statistics for the null hypothesis of no cointegration between the log iShares price and the log NAV. γ is the normalized cointegrating coefficient on the log NAV. Panel A reports the cointegration test results for iShares' prices and raw NAVs, while Panel B for iShares prices and adjusted NAVs using Goetzmann et al.'s (2001) method. We include an intercept in the cointegration vector estimation. The VAR lag profiles are 22, the average trading days per month. The 95% critical values (C.V.) for trace and λ-max are obtained from Osterwald-Lenum (1992, Table 1). The significant trace and λ-max statistics are highlighted in **bold**.

variance ratio for each iShares series. In light of Richardson and Smith (1993), we specify the following moment conditions for each iShares series:

$$g_T(\theta) \equiv \frac{1}{T}\sum_{t=1}^{T}\left\{\begin{array}{l} R_{\mathrm{Pt}}-\mu_P \\ R_{\mathrm{NAVt}}-\mu_{\mathrm{NAV}} \\ 1\mathrm{n}[(R_{\mathrm{Pt}}-\mu_P)^2/(R_{\mathrm{NAVt}}-\mu_{\mathrm{NAV}})^2]-\mathrm{LVR} \\ (R_{\mathrm{Pt}}-\mu_P)^2-\mathrm{var}(R_{\mathrm{Pt}}) \\ (R_{\mathrm{NAVt}}-\mu_{\mathrm{NAV}})^2-\mathrm{var}(R_{\mathrm{NAVt}}) \end{array}\right\}, \tag{4}$$

where R_{Pt} and R_{NAVt} are the iShares price return and the NAV return at time t, respectively; $\theta \equiv (\mu_p, \mu_{\mathrm{NAV}}, \mathrm{var}(R_{\mathrm{Pt}}), \mathrm{var}(R_{\mathrm{NAVt}}), LVR)$ is the set of parameters to be estimated, i.e., the estimated means and variances for the price return and NAV return, respectively, as well as the estimated log variance ratio. [14]The system is exactly identified, and the minimized value of the GMM objective function attains a value of zero. We compute the asymptotically consistent standard errors for the parameters using the Newey and West (1987) method, correcting for possible heteroscedasticity and autocorrelation of residuals for up to 22 lags.

In Table 3 Panel A, we report the estimated variances and the log variance ratios for the raw closing price returns and the NAV returns, corrected for time recording errors of the NAV, using Goetzmann et al.'s (2001) method. All iShares log variance ratios are significantly larger than zero at the 10% level according to the one-tail t-test. This suggests that iShares price returns exhibit excess volatility relative to their NAV returns, even after controlling for time recording errors.[15]

Following Pontiff (1997), we gauge the excess volatility of iShares returns using the price return variance decomposition given by the following definition:

$$R_{\mathrm{Pt}} = \Delta \mathrm{PM}_t + R_{\mathrm{NAVt}}, \tag{5}$$

Hence, the basic variance properties can be written as:

$$\mathrm{var}(R_{\mathrm{Pt}}) = \mathrm{var}(\Delta PM_l) + \mathrm{var}(R_{\mathrm{NAVt}}) + 2\mathrm{cov}(\Delta \mathrm{PM}_t, R_{\mathrm{NAVt}}) \tag{6}$$

Therefore, $\mathrm{var}(R_{\mathrm{Pt}}) > \mathrm{var}(R_{\mathrm{NAVt}})$, if and only if $\mathrm{var}(\Delta \mathrm{PM}_t) > -2\mathrm{cov}(\Delta \mathrm{PM}_t, R_{\mathrm{NAVt}})$, or

$$\frac{\mathrm{cov}(\Delta \mathrm{PM}_t, R_{\mathrm{NAVt}})}{\mathrm{var}(\Delta \mathrm{PM}_\mathrm{t})} > -0.5. \tag{7}$$

Eq. (7) expresses the condition for the excess volatility of price returns relative to NAV returns. This condition may be interpreted as a slope coefficient (beta) from a regression of net asset returns on premium changes and can be easily tested using a one-tail t-test. Since the premium change is the difference between iShares price returns and NAV returns, a negative (positive) covariance implies that iShares price returns underreact (overreact) to NAV returns.

Table 3 Panel B displays the estimated betas, the two-tail t-tests for the null hypothesis that the regression beta is zero, and the one-tail t-test for the null hypothesis that the regression beta is less than −0.5. We use the Newey and West (1987) method to compute the standard errors associated with the t-statistics. Except for iShares Taiwan, all other iShares' betas are negative and significantly different from zero, suggesting that iShares price returns underreact to NAV returns. Despite the underreaction, price returns appear to be excessively volatile for 19 of the 20 iShares (except iShares France) according to 10% significance level of a one-tail t-test for the condition in Eq. (7).

4. Explaining iShares premiums

In Sections 2 and 3, we establish that iShares premiums are sizable but temporary in nature and that price returns demonstrate excess volatility. What factors explain the temporary limit of

[14] Note that the variances ($\mathrm{var}(R_{Pt})$ and $\mathrm{var}(R_{NAVt})$) and the log variance ratio (LVR) are estimated coefficients from the GMM and contain estimation errors. Thus, LVR is not necessarily identical to $\ln[\mathrm{var}(R_{Pt})/\mathrm{var}(R_{NAVt})]$.

[15] In unreported analysis, the results using the raw NAVs are similar.

Table 3
Tests of excess volatility of iShares closing price returns relative to adjusted NAVs

Panel A

$$\text{Beta} = \frac{\text{cov}(\Delta \text{PM}_t, R_{\text{NAVt}})}{\text{var}(R_{\text{NAVt}})}$$

$$\text{LVR} = \ln\left(\frac{\text{var}(R_{\text{Pt}})}{\text{var}(R_{\text{NAVt}})}\right)$$

Panel B

Panel A					Panel B		
iShares	var(R_{Pt}) ($\times 10^{-4}$)	var(R_{NAVt}) ($\times 10^{-4}$)	Estimated *LVR*	One-tail t-test for H_0: $LVR<0.0$	Estimated value	Two-tail t-test for H_0: $Beta<0.0$	One-tail t-test for H_0: $Beta<-0.5$
Australia	**2.304**	**1.383**	0.231	**3.654**	−0.149	**−6.726**	**15.837**
Austria	**2.159**	**1.184**	0.324	**4.932**	−0.166	**−6.211**	**12.492**
Belgium	**2.725**	**1.992**	0.348	**5.772**	−0.216	**−6.392**	**8.421**
Brazil	**6.287**	**4.793**	0.296	**3.383**	−0.183	**−2.264**	**3.910**
Canada	**2.299**	**1.916**	0.156	**2.443**	−0.355	**−13.540**	**5.553**
France	**2.306**	**2.349**	0.135	**2.405**	−0.521	**−8.365**	−0.335
Germany	**2.747**	**2.931**	0.115	**2.130**	−0.596	**−8.557**	*−1.374*
Hong Kong	**4.507**	**3.411**	0.357	**6.534**	−0.204	**−2.743**	**3.992**
Italy	**2.475**	**2.243**	0.178	**3.345**	−0.341	**−7.995**	**3.730**
Japan	**2.901**	**2.383**	0.149	**2.716**	−0.236	**−4.065**	**4.559**
Malaysia	**6.530**	**5.022**	0.542	**8.319**	−0.281	**−3.489**	**2.721**
Mexico	**4.761**	**3.913**	0.346	**5.919**	−0.232	**−5.033**	**5.818**
Netherlands	**2.589**	**2.403**	0.095	*1.546*	−0.416	**−8.059**	*1.638*
Singapore	**4.941**	**3.206**	0.481	**8.249**	−0.128	**−3.318**	**9.691**
South Korea	**6.555**	**5.826**	0.128	**1.883**	−0.277	**−3.861**	**3.097**
Spain	**2.517**	**2.164**	0.218	**3.847**	−0.316	**−7.072**	**4.122**
Sweden	**4.286**	**3.829**	0.137	**2.387**	−0.371	**−9.314**	**3.246**
Switzerland	**2.432**	**1.526**	0.599	**10.178**	−0.108	**−4.084**	**14.756**
Taiwan	**6.477**	**4.211**	0.401	**4.814**	−0.039	−0.637	**7.609**
UK	**2.111**	**1.621**	0.200	**3.380**	−0.245	**−6.135**	**6.408**

Notes: Goetzmann et al.'s (2001) method is used to adjust the NAV for recording errors. Panel A displays (i) the estimated variance of price return, (ii) the estimated variance of NAV return, (iii) the estimated log variance ratio of the price return and NAV return of iShares Series and (iv) the one-tail t-test for the null hypothesis that the log variance ratio is zero. The natural logarithm of the variance ratio is computed in a GMM system of Hansen (1982), and the t-statistics are consistent with heteroskedasticity and serial correlation of residuals for up to 22 lags. Panel B reports (i) the estimated ratio of the covariance between the premium changes and NAV return to the variance of the NAV return based on OLS regression, (ii) the two-tail t-test for the null hypothesis that the ratio is zero, (iii) the one-tail t-test for the null hypothesis that the ratio is less than −0.5. The NAV prices are adjusted using the Goetzmann et al. (2001) method. The estimated coefficients and test statistics that are significant at the 5% (10%) level are highlighted in **bold** (*italic*).

arbitrage in the iShares market? The behavioral finance theory suggests that the presence of noise traders imply persistent mispricing. However, the temporary mispricing and excess price volatility documented in our study may be due to the U.S. and international market imperfections unrelated to the behavioral factors. While we do not directly test the behavioral hypotheses in the present study, we address the sources of the observed iShares premiums within the rational expectation framework in this section. We propose several factors for explaining the magnitudes (absolute values) of iShares premiums. We conduct panel regression analyses that capture both time-series and cross-sectional variations of iShares premiums to gain an overall understanding of what factors affect iShares mispricing. Our choice of factors is motivated by previous theoretical and empirical work and economic reasoning.

4.1. Institutional ownership

Chopra, Lee, Shleifer and Thaler (1993) and Bodurtha et al. (1995) document that lower institutional ownership exhibits positive effect on the changes in closed-end country funds premiums. Grullon and Wang (2001) demonstrate that closed-end fund discounts are affected by information asymmetry between institutional and individual investors about the assets they invest in and differences in the institutional ownership of closed-end funds and underlying assets. At the same time, Hughen and McDonald (2005) argue that large daily closed-end fund discount changes are associated with institutional rather than retail trading. Their empirical work shows that the observed closed-end fund discounts reflect the differential risk perceptions of individual and institutional investors.

We speculate that institutional investors of iShares are not only better informed than individual investors, but also more able to engage in arbitrage activities through iShares creation and redemption. Thus, higher institutional ownership tends to drive the iShares price closer to the fundamental value of the underlying assets. That is, iShares institutional ownership IO_i, is inversely related to the magnitude of the iShares premium (mispricing). Although there is little time-series variation of institutional ownership, its cross-sectional variation can still be captured in the panel regression.

4.2. Bid–ask price spread

In a frictionless market, if an iShares Series is sold at a premium (discount), arbitrageurs would go short (long) for the overpriced (underpriced) Series. This arbitrage process continues until price pressure eliminates the iShares' premium/discount. However, actual arbitrage strategies are impeded by transactions costs. We use the spread between the highest bid and the lowest ask prices of iShares traded on the AMEX, as of 4 p.m. EST, to measure the time-varying transaction costs.[16] The bid–ask spread variable, $SPRD_{it}$, is expected to have positive effect on the premiums' magnitude because higher transaction cost reduces the incentive to arbitrage and leads to larger mispricing.

4.3. Trading volume

iShares trading volume may have an important implication on the size of iShares premiums. Blume, Easley and O'Hara (1994) study the relationship between trading volume, information precision, and security price and demonstrate that trading volume contains information about information quality that cannot be construed from the asset price. They argue that trading is induced by different beliefs of investors about the asset fundamental value. The higher level of differences in investors' beliefs, the greater is asset price divergence from its fundamental value. Thus, using trading volume as a proxy for the difference in investors' beliefs, we hypothesize a positive relation between the size of iShares premiums and the natural log of daily trading volume ($\ln V_{it}$).

4.4. Conditional market correlation

Khorana, Nelling, and Trester (1998) and Pennathur, Delcoure and Anderson (2002) claim that iShares maintain extensive exposure to the U.S. market. Patro (2001) argues that listing of

[16] Arbitrageurs can also create and redeem iShares and pay fixed and variable transaction fees as mentioned above. However, these transaction fees data do not have sufficient time-series and cross-sectional variations and may not capture the dynamic cost of arbitrage over time. Thus, we use bid–ask price spread instead.

international iShares on the AMEX significantly decreases premiums of closed-end country funds and serves as an effective mechanism for international capital market integration. Over time, rapid deregulation and liberalization of emerging financial markets have reduced most of developing countries' closed-end funds premiums (e.g., Bonser-Neal et al., 1990; Patro, 2005).

Dimson and Minio-Paluello (2003) explain closed-end country funds premiums/discounts by the level of the segmentation/integration between the U.S. and home-country markets. Using the approach commonly employed in a significant number of papers examining increased linkages among world equity markets (e.g., Campbell, 1987; Harvey, 1989, 1991; Bekaert and Harvey, 1995), we use conditional correlation coefficient to proxy "market integration". Bekaert and Harvey (1995) point out that over time market integration grows leading to increase in market correlations.

If iShares home market and the U.S. market are fully integrated, arbitrage activities should eliminate any iShares mispricing. Hence, we use the conditional correlation between the U.S. and home markets to measure the degree of market integration, which hypothetically has a negative association with the size of iShares' mispricing. To proxy the "market integration," we extract the time-varying conditional correlation from a bivariate GARCH(1,1) model for each iShares' home-country market index returns (R_t^i) and the U.S. market index returns (R_t^{US}). To remove serial correlations, we employ the following second-order vector autoregression (VAR) model:[17]

$$R_t^{\mathrm{US}} = m_0^{\mathrm{US}} + \sum_{k=1}^{2} m_k^{\mathrm{US}} R_{t-k}^{\mathrm{US}} + \sum_{k=1}^{2} m_k^i R_{t-k}^i + \varepsilon_t^{\mathrm{US}} \tag{8}$$

$$R_t^i = m_0^i + \sum_{k=1}^{2} m_k^{\mathrm{US}} R_{t-k}^{\mathrm{US}} + \sum_{k=1}^{2} m_k^i R_{t-k}^i + \varepsilon_t^i \tag{9}$$

We parameterize the residual vector (ε_t) in Eqs. (8) and (9) as a two-dimensional GARCH(1,1) process, with a conditional bivariate normal distribution with zero mean and a conditional variance–covariance matrix:

$$E_t = \begin{bmatrix} \varepsilon_t^{\mathrm{US}} \\ \varepsilon_t^i \end{bmatrix} \sim N(0, \Sigma_t | \Omega_{t-1}) \tag{10}$$

where $\Sigma_t = \begin{bmatrix} \sigma_{1,t}^2 & \\ \sigma_{12,t} & \sigma_{2,t}^2 \end{bmatrix}$, and the information set Ω_{t-1} contains past information on the first- and second-moments. We parameterize the variance–covariance matrix Σ_t with a bivariate GARCH (1,1) process using Engle and Kroner's (1995) positive definite parameterization:

$$\Sigma_t = C'C + A'E_t E_t' A + B' \Sigma_{t-1} B \tag{11}$$

Next, we estimate Eqs. (8)–(9) together with Eq. (11) through maximizing the standard log likelihood function based on the multivariate normal distribution with respect to the parameter

[17] The two lags of the VAR model are selected by the Akaike Information Criterion.

vector containing a total of 23 free parameters of the model. Hence, the proxy for the "market integration," the time-varying conditional correlation coefficient, $corr_{it}$ between the U.S. market and iShares i's home market is:

$$\mathrm{corr}_{it} = \frac{\sigma_{12t}}{\sqrt{\sigma_{1t}^2 \sigma_{2t}^2}} \tag{12}$$

4.5. Exchange rate volatility

When purchasing power parity does not hold, investors face exchange rate risk for investing internationally (e.g., Solnik, 1974; Adler and Dumas, 1983; Ferson and Harvey, 1993, 1998). Because iShares are created and denominated in the U.S. dollars, the U.S. investors who hold iShares may experience losses if the currency of a foreign market depreciates against the U.S. dollar, even if the local currency value of the fund's holdings rises. Arbitrageurs, who try to "wipe out" iShares' mispricing, also face the exchange rate risk because the creation and redemption process involves the trading of the iShares home-country stocks in local currencies. Volatile exchange rate fluctuation discourages arbitrage activities, leading to sizeable mispricing. Hence, the parameter of the exchange rate volatility variable, $VOLEX_{it}$, in the panel regression of the absolute value of iShares premiums is expected to be positive. We compute the 22-day moving standard deviation of each iShares home-country exchange rate changes and use it as a proxy for the exchange rate volatility in our model.

4.6. Financial and economic crisis

Finally, Chandar and Patro (2000) show that the volatility of closed-end country funds premiums increases dramatically during currency crises. They find that fund NAVs react more dramatically to decline in home-country market compared to fund prices. While fund prices also fall in response to economic instability, they react in global context. We use a set of dummy variables to account for the U.S. September 11, 2001 tragedy ($US911_t$), the 1997 Asian currency crisis ($ASIA_t$), and the 1998 Russian financial crisis ($RUSSIA_t$).[18]

4.7. Panel regression results

Based on the above arguments, we run the following panel regression model to explain the absolute value of iShares premiums:

$$\begin{aligned}|\mathrm{PM}|_{\mathrm{it}} = {} & \beta^0 + \beta^{\mathrm{IO}}\mathrm{IO}_i + \beta^{\mathrm{SPRD}} SPRD_{\mathrm{it}} + \beta^{v} \ln V_{\mathrm{it}} + \beta^{\mathrm{corr}}\mathrm{corr}_{\mathrm{it}} + \beta^{\mathrm{VOLEX}} VOLEX_{\mathrm{it}} \\ & + \beta^{\mathrm{US911}} US911_t + \beta^{\mathrm{ASIA}} ASIA_t + \beta^{\mathrm{RUSSIA}} RUSSIA_t + \varepsilon_{\mathrm{it}}\end{aligned} \tag{13}$$

Here $|\mathrm{PM}|_{\mathrm{it}}$ is the absolute value of iShares i's premium on day t. To ensure the robustness of results, we conduct tests on both unadjusted premiums and adjusted premiums using Goetzmann et

[18] All these dummy variables take the value of one on and after the defined crisis dates and zero otherwise. In a separate panel regression, we also include the dummy variables for the 1997 South Korean economic crisis, the 1998 Malaysian economic crisis, and the 2002 Argentina economic crisis but they were not statistically significant. Hence, we omit them in our reported results to preserve degrees of freedom.

Table 4
Panel regressions for iShares premium absolute value

$$|PM|_{it}=\beta^0+\beta^{IO}IO_i+\beta^{SPRD}SPRD_{it}+\beta^{V}\ln V_{it}+\beta^{corr}\mathrm{corr}+\beta^{VOLEX}VOLEX_{it}+\beta^{US911}US911_t+\beta^{ASIA}ASIA_t+\beta^{RUSSIA}RUSSIA_t+\varepsilon_{it}$$

Expected sign	Intercept	IO_i Negative	$SPRD_{it}$ Positive	$\ln V_{it}$ Positive	corr_{it} Negative	$VOLEX_{it}$ Positive	$US911_t$	$ASIA_t$	$RUSSIA_t$	$\overline{R}^2$	F-statistic (p-value)
Panel A. (*based on closing prices and adjusted NAVs using Goetzmann et al.'s (2001) method*)											
Coefficient	**0.015**	**−0.0057**	**0.012**	**0.00032**	*−0.0008*	**0.619**	*0.0004*	**−0.0036**	**−0.0032**	13%	**149.17**
t-statistic	13.56	−7.68	9.79	6.46	−1.70	21.30	1.73	−11.53	−12.90		(0.00)
Panel B. (*based on closing prices and adjusted premiums using Engle and Sarkar's (2002) method*)											
Coefficient	**0.015**	**−0.0050**	**0.013**	*0.00009*	−0.0006	**0.616**	**0.001**	**−0.0033**	**−0.0035**	14%	**158.68**
t-statistic	12.91	−6.72	10.66	1.84	−1.31	21.05	3.92	−10.51	−13.73		(0.00)
Panel C. (*based on closing prices and unadjusted NAVs*)											
Coefficient	**0.015**	**−0.0056**	**0.013**	**0.00051**	**−0.0010**	**0.560**	0.00003	**−0.0033**	**−0.0033**	13%	**154.57**
t-statistic	13.83	−7.51	10.47	10.43	−2.19	19.18	0.15	−10.43	−13.16		(0.00)

Notes: The factors proposed to explain the absolute value of the iShare premium are: IO_i — institutional ownership defined as percentage of total shares owned by institutional investors, $SPRD_{it}$ — the spread between the closing bid and ask prices quoted on the AMEX, $\ln V_{it}$ — trading volume defined as log of daily trading volume of each iShares, conditional correlation from a bivariate GARCH(1,1) model for each iShares' home-country market index returns and the U.S. market index returns, $VOLEX_{it}$ — exchange rate volatility measured by computing the 22-day moving standard deviation of each iShares home-country exchange rate changes, $US911_t$ — the U.S. September 11, 2001 tragedy, $ASIA_t$ — 1997 Asian currency crisis, and $RUSSIA_t$ — 1998 Russian financial crisis. Each panel of the table displays the result for a different case with the adjusted premiums using Goetzmann et al.'s (2001) method (Panel A) or Engle and Sarkar's (2002) method (Panel B) or unadjusted premiums (Panel C). The t-statistics are reported underneath the estimated coefficients. The F-statistics test the overall significance of the model. The regression coefficients and the F-statistics that are statistically significant at the 5% (10%) level are highlighted in **bold** (*italic*).

al.'s (2001) or Engle and Sarkar's (2002) methods. The right-hand side variables are: IO_i — institutional ownership for iShares i, $SPRD_{it}$ — transactions cost as measured by the bid–ask spread on day t for iShares i, $1nV_{it}$ — log trading volume on day t for iShares i, $corr_{it}$ — conditional correlation between the U.S. and iShares i's home markets on day t, $VOLEX_{it}$ — exchange rate volatility on day t for iShares i, $US911_t$ — dummy variable for the U.S. September 11, 2001 tragedy, $ASIA_t$ — dummy variable for the 1997 Asian currency crisis, $RUSSIA_t$ — dummy variable for the 1998 Russian financial crisis, and ε_{it} — panel regression residuals. Table 4 displays the expected signs of each of the independent variables in the panel regression.

The adjusted R-squared and the overall F-test statistic from the panel regression can be used to judge the explanatory power of the regressors. If the changes in iShares premiums are explained purely by the proposed factors, the adjusted R-squared and F-statistic should be high and significant whereas the intercept should be insignificant. All individual time-series variables used in the regressions prove to be stationary according to the augmented Dickey–Fuller and Philips–Perron stationarity tests[19]. We impose the random effects assumption in the panel regression.

Panels A–C of Table 4 report regression results for the absolute values of iShares premiums using Goetzmann et al.'s (2001) adjustment, Engle and Sarkar's (2002) adjustment and without adjustments for time-zone measurement errors, respectively. All three panels of Table 4 display consistent results. We find that estimated coefficients for institutional ownership, bid–ask spread, trading volume, and exchange rate volatility are significant at the 5% significance level and exhibit the expected signs. Thus, lower iShares' institutional ownership implies less informed trading and induces a larger size of iShares premiums. The transaction costs and exchange rate volatility are significant hindrances to the arbitrage activities that attempt to "wipe out" the mispricing. A larger difference in opinions of investors as reflected by higher trading volume drives the iShares price away from the NAV, causing a larger absolute value of the premium. The conditional correlation between the iShares' home-country market and the U.S. market displays a correct (negative) sign but is significant only at the 10% level for the premium with Goetzmann et al.'s adjusted NAV (Panel A) and significant at the 5% level for the raw premium (Panel C). Finally, we show that iShares premiums are sensitive to the Asian financial crisis of 1997, the Russian financial crisis of 1998 and to a lesser extent, the U.S. 911 terrorist attack in 2001.

Overall, the panel regression results indicate that the iShares premiums are enlarged by i) lower institutional ownership, ii) higher bid–ask price spread, iii) higher level of trading volume, iv) higher exchange rate volatility, v) stronger correlation between the U.S. and the home-country markets, and v) political, economic, and financial crises. The F-statistics for the joint significance of these proposed factors are highly significant for all three panels. However, the adjusted R-squares are only 13–14% and the regression intercepts are also significant. This suggests that a significant portion of the premium size still remains unexplained.

5. Conclusion

In this paper, we investigate the features of the premiums of the iShares MSCI series and find that the international iShares trade at economically significant premiums, even after controlling for transaction costs and possible time recording errors. The iShares price returns also exhibit

[19] The augmented Dickey–Fuller and the Philips–Perron tests are conducted individually for each time series. The results provide the rejection of the null hypothesis of non-stationarity of all right-hand side variables at 5% significance level. For space consideration, we omit them in our reported results.

excess volatility relative to their NAV returns. Given the creation and redemption feature of iShares, these findings appear to be puzzling. However, the results of cointegration and persistence profile analyses show that most deviations of funds' prices from their net asset values are only temporary. Most iShares mispricing is not persistent but converges to zero within a short period of time.

Moreover, we attempt to explain the observed iShares premiums using a number of factors motivated by rational arbitrage argument. We use the panel regression approach to incorporate both the time-series and cross-sectional variations of the iShares premiums. Our empirical findings suggest that the size of iShares premiums is associated with lower institutional ownership, higher bid–ask price spread, higher level of trading volume, higher exchange rate volatility, regional political, economic, and financial instability, and, to a lesser extent, stronger correlation between the U.S. and the home-country markets. The unfavorable features of these factors could make the trading and/or the creation–redemption processes of iShares costly and ineffective and prevent arbitrage activities to wipe out the deviations from price parity. However, a significant variation of the mispricing still remains unexplained. Future research may investigate the explanatory power of possible behavioral factors (e.g., overconfidence effect as suggested by Mei, Scheinkman and Xiong (2003)) causing iShares mispricing.

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Appendix A. Some important features of iShares

Because iShares are organized as an open-end investment company, they have an attractive tax advantage compared to their rivals – closed-end mutual funds – the lack of restrictions on taxable distributions. Organized as a series fund under the Investment Company Act of 1940, iShares do not invest in every security in the index they follow, but instead select an optimized portfolio based on the index using "replication" and "representative sampling" techniques. Under these approaches, each stock is considered for inclusion based on its relevance to the underlying index and its contribution to certain capitalization, industry, and fundamental characteristics. iShares' baskets are weighted by market value and can get top-heavy in some markets. The portfolio composition of iShares may be rebalanced at times to better align the performance of iShares series with that of the relevant MSCI index. Such rebalancing leads to transaction costs and other expenses. According to the iShare 2004 prospectus, the values of iShares are subject to the following risks:

Market risk	iShares NAV fluctuates as the market value of the stocks it holds changes
Foreign security risk	iShares invest in foreign markets, which may be suffering from greater price volatility; exchange rate fluctuations and exchange controls; higher taxes, transaction, and information costs; higher economic and social-political uncertainties.

Management risk	iShares investment advisor's strategy is constrained by the Internal Revenue Code (e.g., Single Issuer Rule and 5/50 Rule) and local market restrictions on share ownership by foreigners.
Currency risk	iShares' NAV is determined on the basis of U.S. dollars, and the local currency may depreciate against the U.S. dollar.
Emerging market risk	Emerging markets are exposed to greater market volatility, lower trading volume, political and economical instability, local market restrictions on share ownership by owners.
Trading risk	While iShares' creation and redemption feature is designed to make it likely that they will trade close to their NAV, disruptions to creations and redemptions may result in trading prices that differ significantly from NAV. Also, there can be no assurance that an active trading will exist for iShares Series on the exchange.

iShares and closed-end country funds institutional ownership

iShares	Ticker	Institutional ownership (%)		Ticker	Institutional ownership(%)
Austria	EWO	18.9	Aberdeen Australia Equity	IAF	5.72
Belgium	EWK	80.3	–		
France	WQ	34.2	–		
Germany	EWG	38.3	Germany Fund	GER	10.93
Italy	EWI	37.4	Italy Fund	ITA	NA
Netherlands	EWN	21.2	–		
Spain	WP	66.4	Spain Fund	SNF	0.73
Sweden	WD	68.0	–		
Switzerland	EWL	9.9	Swiss Helvetia Fund	SWZ	18.34
UK	EWU	45.2	–		
Australia	EWA	72.8	–		
Hong Kong	EWH	30.7	–		
Japan	EWJ	20.3	Japan Equity	JEQ	9.23
Malaysia	EWM	15.3	Malaysia Fund	MF	9.02
Singapore	EWS	19.3	Singapore Fund	SGF	20.84
South Korea	EWY	40.1	Korea Fund	KF	36.98
Taiwan	EWT	55.6	ROC Taiwan	ROC	20.18
Brazil	EWZ	61.7	Brazil Fund	BZF	38.72
Canada	EWC	7.4	Central Fund of Canada	CEF	17.27
Mexico	EWM	77.1	Mexico equity and Income	MXE	15.29
Mean		40.98			16.94

Note: iShares institutional ownership information is available on http://www.NASDAQ.com website;closed-end country funds institutional ownership information is available on http://closedendfundforum.com.

Creation and redemption fee schedule (according to the 2004 Prospectus)

Fund	In-kind and cash purchases/redemptions	Maximum additional variable charges for cash purchases*	Maximum additional variable charges for cash redemptions*
Australia	$2400	0.60%	0.60%
Austria	$600	0.67%	0.67%
Belgium	$700	0.30%	0.30%
Brazil	$2400	**	***
Canada	$1900	0.30%	0.30%
France	$2900	0.25%	0.25%
Germany	$1500	0.25%	0.25%
Hong Kong	$2000	0.60%	0.60%
Italy	$1400	0.30%	0.30%
Japan	$5000	0.15%	0.40%
Malaysia	$5000	**	***
Mexico	$1400	0.50%	0.50%

Appendix A (*continued*)

Netherlands	\$1000	0.25%	0.25%
Singapore	\$2000	1.60%	1.30%
South Korea	\$4000	**	***
Spain	\$1500	0.25%	0.45%
Sweden	\$1300	0.30%	0.30%
Switzerland	\$1500	0.40%	0.40%
Taiwan	\$4500	**	***
United Kingdom	\$3500	0.25%	0.75%

Note: According to iShares, Inc. Statement of Additional Information.

* As a percentage of the value of amount invested.

** The maximum additional variable charge for cash purchases will be a percentage of the value of the deposit Securities, which will not exceed 3.00%.

*** The maximum additional variable charge for cash redemptions will be a percentage of the value of the deposit Securities, which will not exceed 2.00%.

Appendix B. Technical Details Of Persistence Profile Analyses

The procedure designed by Pesaran and Shin (1996) is outlined below. The first step is to estimate the VECM below:

$$\Delta \boldsymbol{x}_t = \boldsymbol{A}_0 + \alpha\beta' \boldsymbol{x}_{t-1} + \sum_{i=1}^{p} \Gamma_i \Delta \boldsymbol{x}_{t-1} + \varepsilon_t \tag{A.1}$$

where x_t is a 2×1 vector of log price and log NAV of iShares, $\Delta\boldsymbol{x}_t$ is a 2×1 vector of continuously compounded returns, $\boldsymbol{A}_0$ is a 2×1 vector of intercepts, α and Γ are 2×1 coefficient matrices and β is the $2\times r$ long run coefficient matrix. Eq. (A.1) is estimated using the Johansen (1991) method to derive an approximation of the coefficient matrix β and the covariance matrix of the residuals, Ω.

The Beveridge and Nelson (1981) procedure is used to decompose the price vector x_t, such that:

$$\boldsymbol{x}_t = \tau_t + \varpi_t \tag{A.2}$$

where

$$\varpi_t = \sum_{l=0}^{\infty} C_l \varepsilon_{t-l}, \text{and } C_l = -\sum_{l=0}^{\infty} A_l + B_l, \text{and } B_l = \sum_{j=0}^{l} A_j \tag{A.3}$$

$$\tau_t = \mu + \tau_{t-l} + \boldsymbol{A}_0\varepsilon_t + A_1\varepsilon_{t-1} \tag{A.4}$$

The price-NAV cointegrating relation can be written as:

$$\beta' x_t = \xi_t = \beta'\tau_0 + (\beta'\mu)t + \sum_{l=0}^{\infty} \beta' B_l \varepsilon_{t-1} \tag{A.5}$$

With r cointegrating vectors, the unscaled (i, j) elements of the persistence profile matrix ξ_t are given by:

$$H_{\mathrm{ij}} = \beta_i' B_n \Omega B_n \beta_j', \text{where } i \neq j, \text{and for } i,j = 1,2,\ldots,r \quad n = 0,1,2,\ldots \tag{A.6}$$

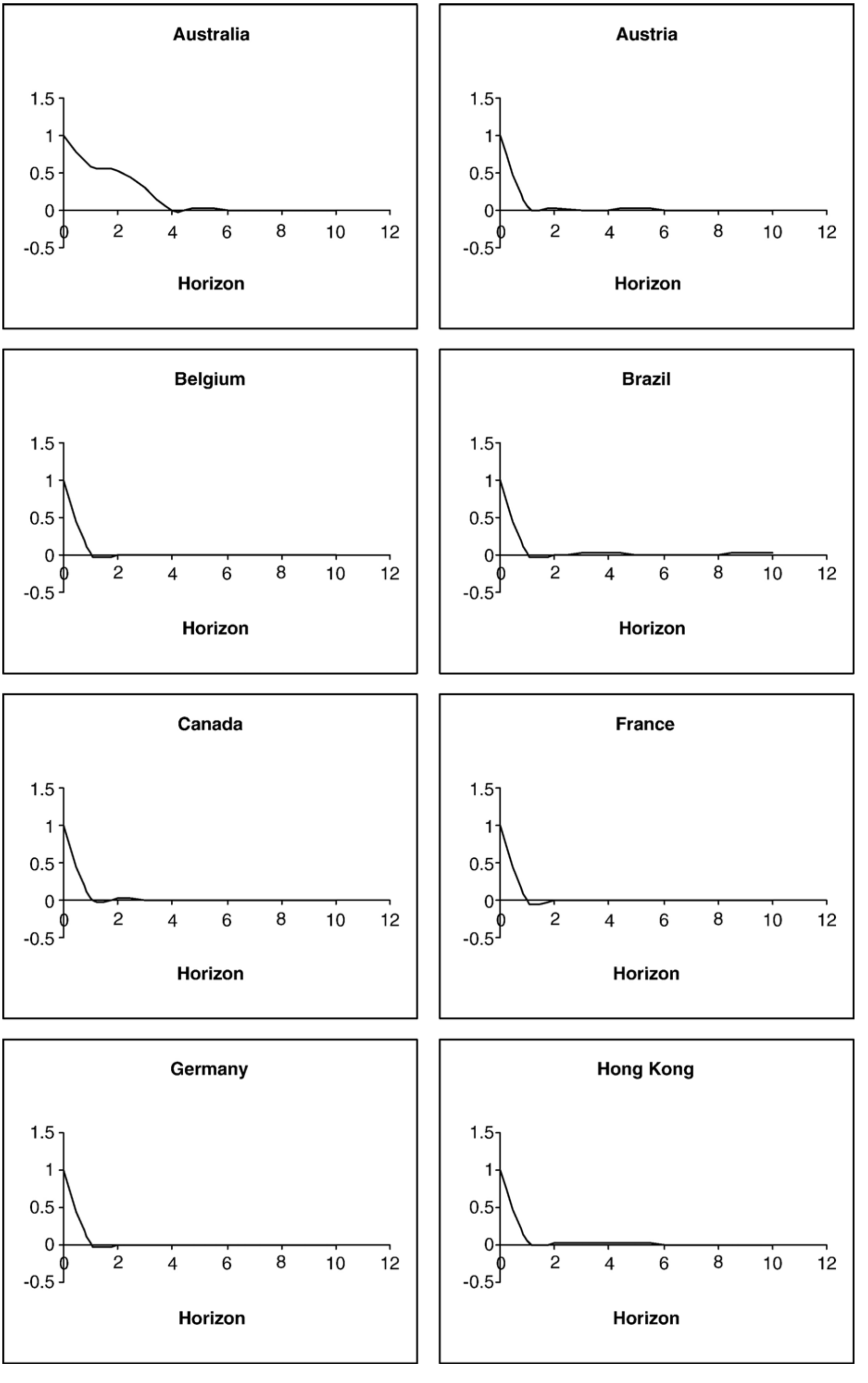

Fig. A 2.1. Persistence profiles for the cointegrated system of the price and raw NAV given a unit system-wide shock for each of the 20 iShares.

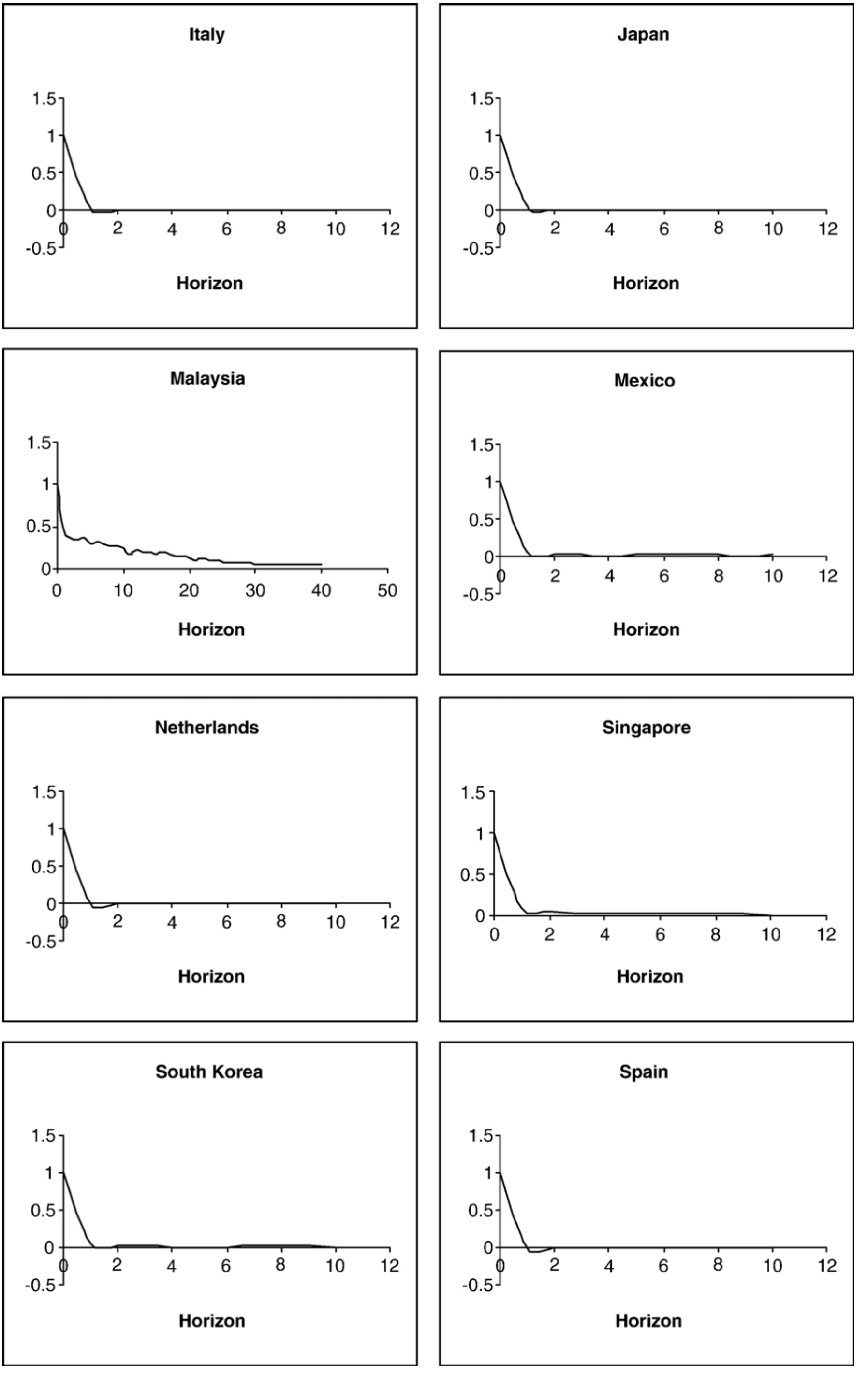

Fig. A 2.1 (*continued*).

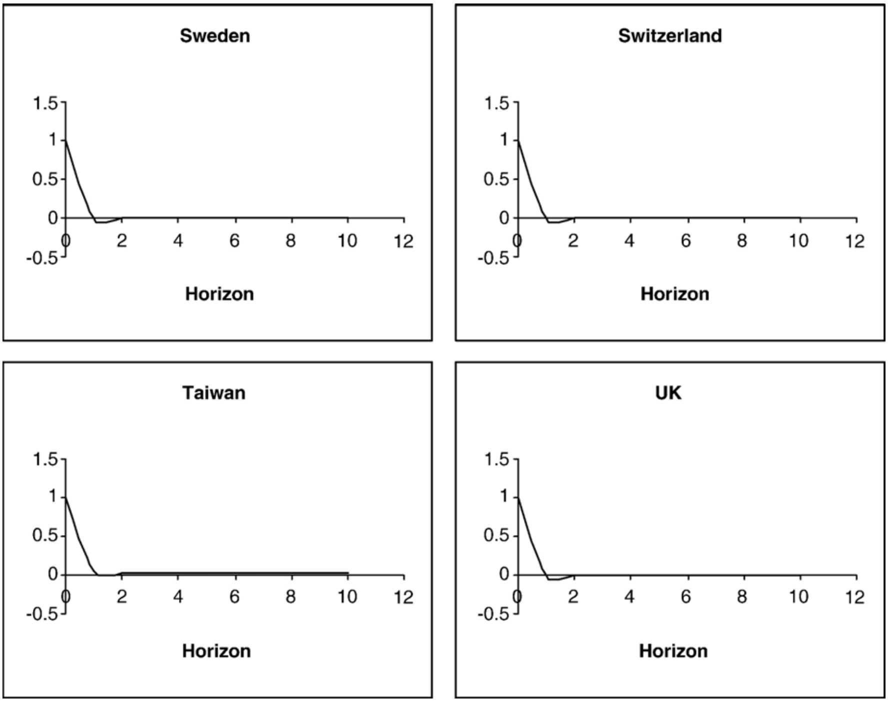

Fig. A 2.1 (*continued*).

where β_i', β_j' and Ω are obtained from Eq. (A.1), and B_n is the "cumulative effect" matrix defined in Eq. (A.3) and is computed from the following recursive relation:

$$\begin{aligned} B_n &= \Phi_1 B_{n-1} + \Phi_2 B_{n-2} + \ldots + \Phi_p B_{n-p}, n \\ &= 1, 2\ldots \text{ and } p \text{ is the order of the VAR} \end{aligned} \quad (A.7)$$

where $B_0 = I_{12\times12}$, $B_n = 0$ for $n \leq 0$ and the Φ_i's come from the matrices α and β in Eq. (A.1) such that:

$$\alpha\beta' = I_{12\times12} - \Phi_1 - \Phi_2 - \ldots - \Phi_p \quad (A.8)$$

Therefore, the scaled measure of the persistent profile matrix of ξ_t is obtained as the elements of:

$$\begin{aligned} h_Z(n) &= \mathrm{GH}_Z(n)G = \{h_{\mathrm{ij}}(n)\}, \text{where} \\ G &= \mathrm{diag}\{H_{11}(0)^{-1/2}, H_{22}(0)^{-1/2}, H_{\mathrm{rr}}(0)^{-1/2}\} \end{aligned} \quad (A.9)$$

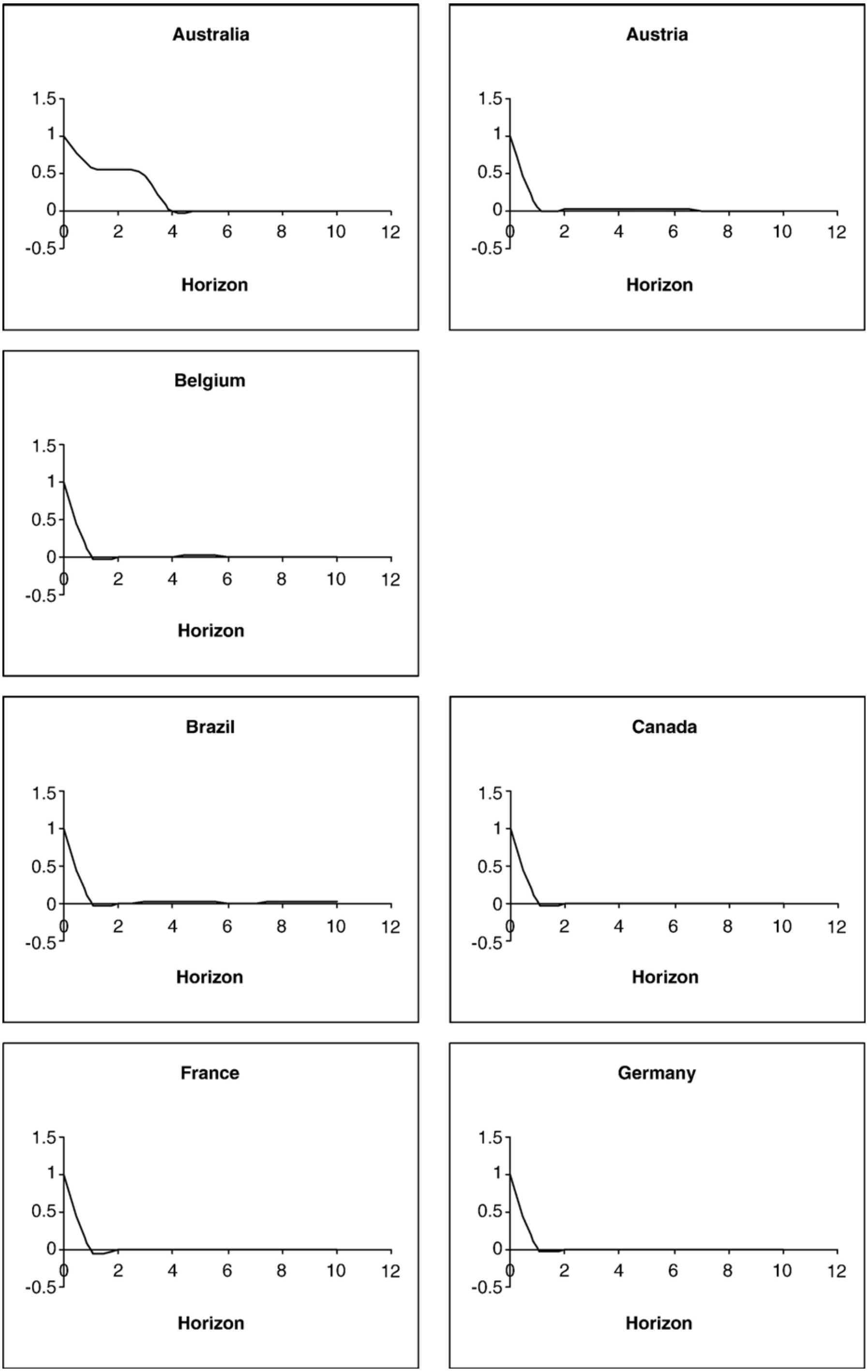

Fig. A 2.2. Persistence profiles for the cointegrated system of the price and adjusted NAV given a unit system-wide shock for each of the 20 iShares.

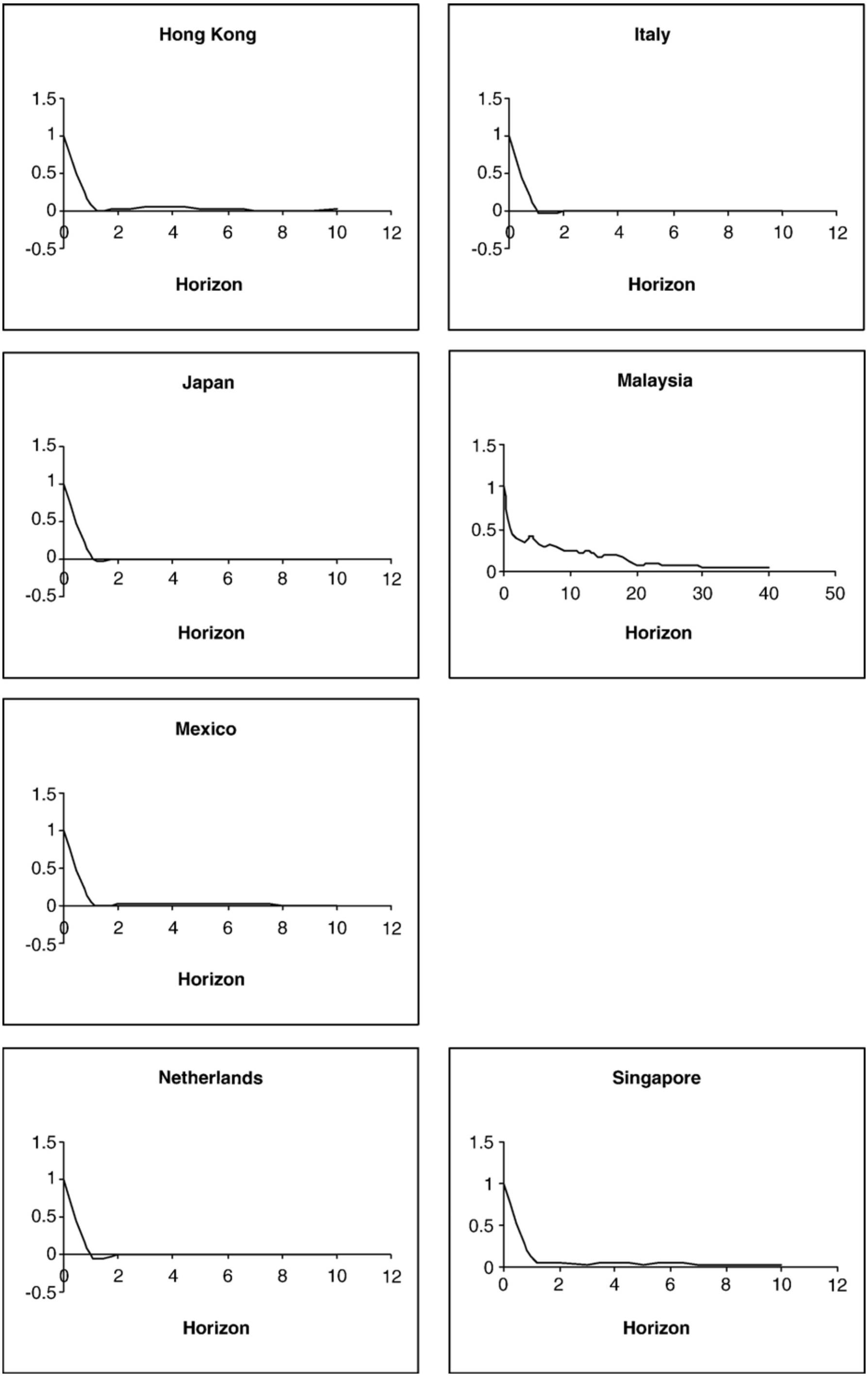

Fig. A 2.2 (*continued*).

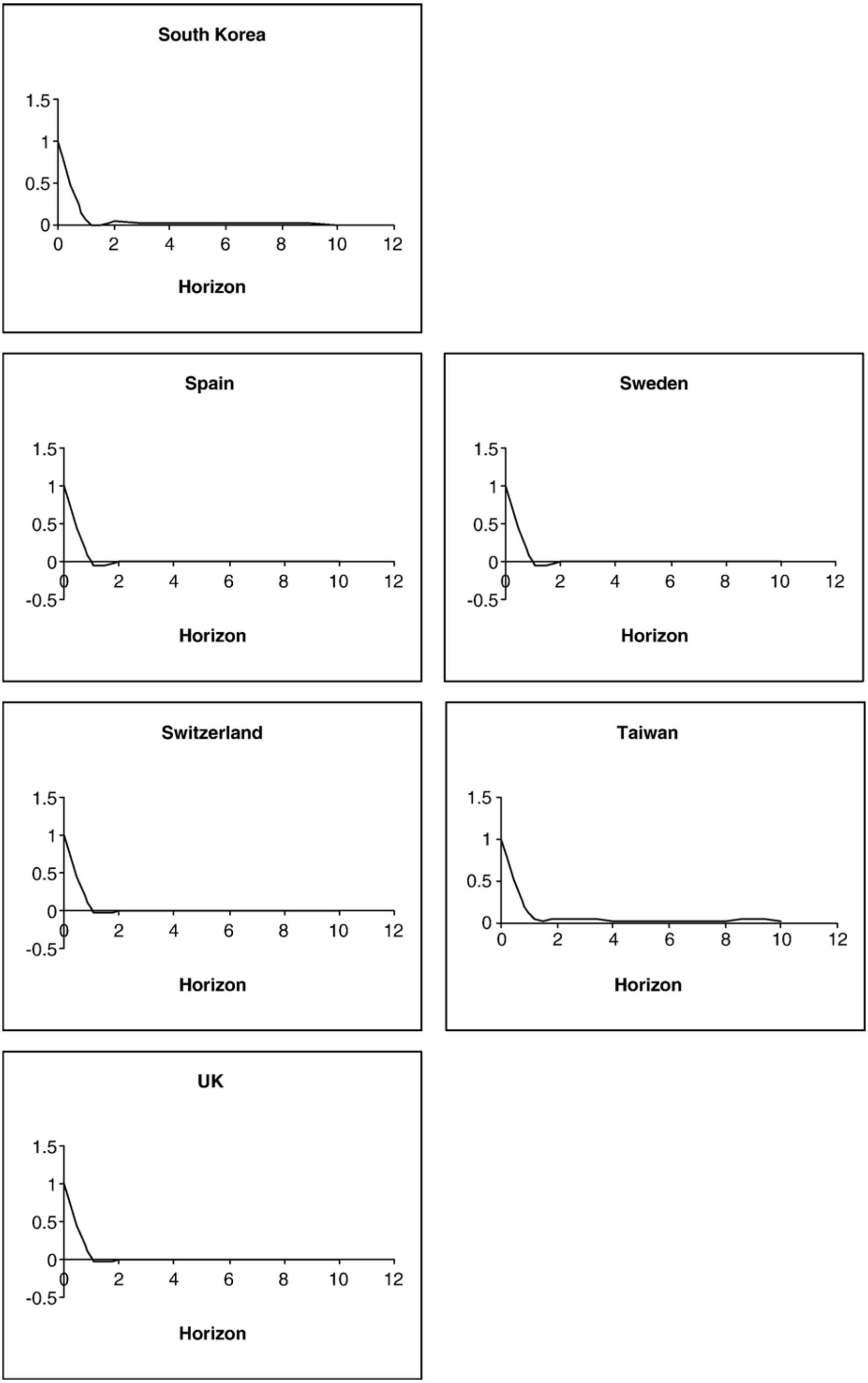

Fig. A 2.2 (*continued*).

Under one cointegrating vector binding the price and NAV, the persistence profile in Eq. (A.9) can also be interpreted as the square of the impulse response function of the price-NAV equilibrium to a unit composite shock u_t, where u_t is defined as:[20]

$$u_t = \beta' \varepsilon_t \sim \text{iid}(0, \sigma_u^2).$$

Following a unit composite shock to the cointegrating vector in a stationary system, convergence to zero will occur.

Fig. A 2.1 (Fig. A 2.2) present the graphs of the estimated persistence profiles of all 20 iShares' cointegrated system of price and raw (Goetzmann et al. — adjusted) NAV, given a unit system-wide shock. As graphs show, except for iShares Australia and Malaysia, all other iShares' price-NAV systems complete the convergence within two days. This suggests that most iShares' premiums are only temporary and do not last over two days.

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[20] To see this, rewrite Eq. (A.5) as

$$\xi_t = \beta' \tau_0 + (\beta' \mu) t + \sum_{l=0}^{\infty} \delta_l \mu_{t-l}$$

with $\delta_0 = 1$, $\text{var}(u_t) = \sigma_u^2 = \beta' \Omega \beta$, and $\delta_l^2 = (\beta' B_l \Omega B_l' \beta) / (\beta' \Omega \beta) = h_\xi(l)$.

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