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The efficiency of international information flow: Evidence from the ETF and CEF prices

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ABSTRACT

While similar in their trading and organization, closed-end funds (CEFs) and exchange-traded funds (ETFs) differ in their liquidity and ease of arbitrage. We compare their price transmission dynamics using a sample of funds that invest in foreign securities and are most likely to show the deficiencies in the manner in which they process information. Our analysis shows that ETF returns are more closely related to their portfolio returns than are CEF returns. However, both fund types underreact to portfolio returns but overreact to domestic stock market returns. A simple trading strategy using these results is profitable with roundtrip trading costs less than 1.38% for CEFs and 0.71% for ETFs.

1. Introduction

As globalization advances, the flow of information across countries becomes increasingly important. This is particularly true in securities markets, and the process by which stocks incorporate this international information flow is complicated. Since the world's securities markets are not open at the same time, price changes in one market are not reflected in another market's trading until it opens. Furthermore, arbitrage, which aligns prices of similar goods in different markets, is difficult to conduct across countries and regulators.

Previous studies have analyzed the international flow of information in the market for American Depository Receipts (ADRs). Kato, Linn, and Schallheim (1991) find that the ADR market does not offer persistent arbitrage opportunities. In contrast, Kim, Szakmary, and Mathur (2000) find that ADRs overreact to changes in the U.S. stock market and underreact to changes in the underlying stock prices.

While these studies of ADRs offer insight into the international linkages of stock markets, several characteristics of these securities make them unique examples of how prices are transmitted across nations. First, large price differences in the ADR market can be arbitraged away by the creation or cancellation of these securities. This mechanism for the arbitrage of prices across countries does not exist for the vast majority of securities. Second, it is difficult to tell if investors are trading ADRs to profit from trends in the company or the country. Finally, institutional investors, who are generally considered to be relatively sophisticated, often engage in a substantial portion of the trading in these securities. Thus, the prices of ADRs may not be as sensitive to the sentiments of individual investors.

While prior studies have examined the price transmission dynamics of ADRs, little is known about how daily price changes from foreign markets affect the values of closed-end country funds (CEFs) and exchange-traded funds (ETFs), which have different characteristics than ADRs. Unlike ADRs, the shares of CEFs cannot be easily arbitraged. As these funds hold a diversified portfolio of assets, the trading activity in these funds is less likely to reflect company-specific information than the trading in ADRs. While previous studies on country funds have used weekly data on NAVs, this weekly data is not of sufficient frequency to provided insight into the short-term transmission of information across markets.

An ETF is another type of investment company that is commonly used for international diversification. Like CEFs, ETFs own a portfolio of securities and trade on an exchange like ADRs. However, ETFs can be arbitraged through the fund distributor using an in-kind process. This process may cause ETF prices to quickly reflect the returns in foreign markets.

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We add to the literature by analyzing the transmission of price changes between ETF and CEF markets and their respective underlying portfolios. Our first objective is to use a vector autoregression model (VAR) to examine the daily dynamics of how fund prices respond to changes in underlying values. The impulse response functions from the VAR model reveal that shocks to NAV affect ETF prices for only two days at most but influence over three-fourths of the CEF prices for at least three days. Our second objective is to determine the sensitivity of fund prices to daily domestic stock returns. We find that the vast majority of CEF and ETF returns have a negative relation with either the one-day or two-day lagged domestic return. Finally, we examine whether ETFs process information more efficiently than CEFs. Despite the relative ease with which ETFs can be arbitraged, their returns underreact to portfolio returns and overreact to domestic stock returns like CEF and ADR returns. We examine the profitability of a trading strategy using these relationships and find that trading costs in ETFs need to be about half the level of transaction costs for CEFs to eliminate profitability.

2. Literature review

Between 1990 and 2005, the market value of foreign equities owned by U.S. residents increased 16 times.[2] Many American investors gain exposure to foreign markets using ADRs. These are dollar-denominated receipts that trade in the local market but represent a claim to stock in a non-U.S. company. If ADR prices deviate from the value of the underlying foreign shares, the supply of ADR shares can be changed by issuance or cancellation through the depositary institution. While this process is typically reserved for institutional investors, it prevents large, persistent discounts or premiums on ADRs.

Research on ADRs offers conflicting results on how closely ADR prices reflect the underlying share values. Kato et al. (1991) fail to document arbitrage opportunities in the ADR market, which they conclude is consistent with the law of one price. Kim et al. (2000) examine the daily price transmission dynamics in the ADR market. While a significant portion of the price changes in foreign markets are quickly incorporated in ADR prices, some price shocks take days to be completely reflected in ADR prices. They also find that ADRs overreact to US markets and underreact to underlying prices.

Investors can also participate in foreign equity markets through investments in CEFs. The shares of these investment companies typically trade at prices that are substantially different than the per share values of their underlying portfolios. Unlike with ADRs, the supply of CEF shares is controlled by the management of the investment company, and CEFs do not typically provide full disclosure of their portfolio holdings. When CEF share prices fail to reflect price changes in foreign markets, arbitrageurs are unable to easily correct such divergences. Pontiff (1996) documents that arbitrage impediments explain about a quarter of the magnitude of CEF pricing discrepancies. In related research, Bailey and Lim (1992), Bodurtha, Kim, and Lee (1995), and Chang, Eun, and Kolodny (1995) conclude that closed-end country funds are sensitive to U.S. returns and provide fewer diversification benefits than direct investments.

Other researchers have found that certain events can trigger divergences between CEF share prices and underlying portfolio values. Klibanoff, Lamont, and Wizman (1998) investigate the reaction of the share price of closed-end country funds to news that affects fundamentals. Local investors overreact to news that receives major local coverage but underreact to other news about foreign fundamentals. Kramer and Smith (1998), Frankel and Schmukler (1996), and Levy-Yeyati and Ubide (2000) document the closed-end country fund puzzle, which is the tendency for closed-end country funds to trade at large premiums when the country is involved in an economic crisis. Bonser-Neal, Brauer, Neal and Wheatley (1990) examine changes in international investment restrictions to show that CEF share prices reflect the level of market segmentation.

ETFs are another type of investment company that facilitates international diversification. In contrast to CEFs, ETFs face few arbitrage impediments so changes in foreign market prices should be fully reflected in ETF share prices. If the share price deviates from the portfolio value, institutional investors can arbitrage the shares through a process of in-kind redemption/creation facilitated by the sponsoring fund company. ETF shares can be created or redeemed from the fund's distributor in large blocks called creation units. When creating ETF shares, the fund's distributor requires a payment of cash and securities that approximates the holdings of the fund. A list of these securities is made available prior to the start of the trading session on the U.S. stock exchange. ETF shares are normally redeemed in the form of creation units. In exchange for the fund shares, the redeeming investor receives a combination of cash and securities from the fund's portfolio.

Researchers disagree about whether ETF share prices quickly reflect price changes in their portfolio securities. Khorana, Nelling, and Tester (1998) examine a sample of ETFs representing an investment in individual MSCI country indexes. They find that ETF share prices closely track their respective index. Tse and Martinez (2007) also investigate the returns on international ETFs. They find that ETF share prices fully incorporate the value of the underlying stock prices and are primarily influenced by the information released during the underlying country's market trading hours. In contrast, Olienyk, Schwebach, and Zumwalt (1999) document characteristics of ETF prices that may be consistent with arbitrage opportunities. These include cointegration between CEF and ETF prices and causal relationships between international ETF prices. Mazumder, Chu, Miller, and Prather (2008) find that ETFs (iShares) exhibit day-of-the-week patterns. They show that these patterns can be exploited using a dynamic trading strategy. Pennathur, Delcoure, and Anderson (2002) find that while international ETFs offer limited diversification benefits, the fund shares are still sensitive to US market returns.

3. Research questions and data

Despite the popularity of CEFs and ETFs, little is known about how the daily prices of these funds process information from the foreign markets. Our study explores three related issues. First, we examine the daily dynamics of how CEF and ETF prices respond to changes in underlying values, which are represented by the NAV and exchange rate.

To understand how the flow of information is processed, we calculate the cointegrating relationships among the variables and estimate a vector autoregression (VAR) model. The impulse response functions from the VAR system show how price shocks are transmitted to the fund prices. As the trading in domestic and foreign stock markets is not contemporaneous, we also estimate a regression model of the fund share prices using lagged variables. The final part of our study examines the profitability of a simple trading strategy involving the relationships uncovered in our analysis.

The second issue examined in this study is whether fund prices are sensitive to domestic and foreign stock market returns. Previous research documents that CEFs with portfolios of foreign securities are sensitive to domestic stock market returns. This lowers the diversification benefits associated with using these investment companies to get international equity exposure. Therefore, the analysis described above includes the Standard & Poor's 500 Index and the MSCI country indexes. The final goal of our study is to examine whether ETFs process information more efficiently than CEFs. As CEFs are less liquid and more difficult to arbitrage than ETFs, we expect to find differences in their price transmission dynamics.

[2] Federal Reserve, Flow of Funds Accounts of United States.

Table 1
Sample and summary statistics.

Fund name	Fund symbol	NAV symbol	Fund allocations	NAV returns	
				Mean (%)	Std. Dev. (%)
Panel A: closed-end funds					
Aberdeen Australia Equity Fund	IAF	XIAFX	At least 65% Australian equity	13.36	17.42
Brazil Fund[e]	BZF	XBZFX	At least 70% Brazilian common and preferred equity	12.99	32.59
Brazilian Equity Fund[e]	BZL	XBZLX	At least 65% Brazilian equity; up to 25% Brazilian corporate/government debt	3.91	31.66
Central European Equity[e]	CEE	XCEEX	At least 65% Central European equity	7.08	20.19
Chile Fund[e]	CH	XXCHX	At least 75% Chilean equity and debt; up to 25% U.S. securities; up to 20% unlisted Chilean equity	4.96	17.99
Emerging Markets Telecom Fund[e]	ETF	XETFX	At least 70% Emerging Market infrastructure equity; up to 30% Private Placements	−13.40	17.36
Europe Fund	EF	XEFIX	At least 65% European equity; up to 35% European debt	−6.23	22.38
First Israel Fund[e]	ISL	XISLX	At least 65% Israeli securities	−1.33	17.91
France Growth Fund	FRF	XFRFX	At least 65% French equity; up to 35% French debt	−7.15	25.12
Germany Fund	GER	XGERX	At least 65% German equity; up to 35% euro-denominated debt	−9.45	30.39
Korea Fund[e]	KF	XKFDX	At least 80% Korean equity	10.92	32.67
Latin America Equity Fund[e]	LAQ	XLAQX	At least 65% Brazilian, Chilean, Mexican securities	5.28	22.84
New Germany Fund	GF	XGFNX	At least 65% non-large cap German equity	−11.23	24.24
Scudder New Asia Fund[e]	SAF	XSAFX	At least 65% Asian equity	−3.51	20.91
Southern Africa Fund[e]	SOA	XSOAX	At least 60% South African equity; up to 40% South African debt	6.79	21.67
Spain Fund	SNF	XSNFX	At least 65% Spanish equity	−0.91	23.56
Swiss Helvetia Fund	SWZ	XSWZX	Swiss equity and debt	3.27	16.87
Templeton Dragon Fund[e]	TDF	XTDFX	At least 45% Chinese equity; up to 20% Japanese equity	15.95	18.79
Templeton Emerging Markets Fund[e]	EMF	XEMFX	At least 75% Emerging countries securities with low-, middle-income economies	4.40	14.85
Fund name	**Fund symbol**	**NAV symbol**		**NAV returns**	
				Mean (%)	Std. Dev. (%)
Panel B: exchange-traded funds					
MSCI Australia Index Fund	EWA	EWA.NV		10.47	18.16
MSCI Austria Index Fund	EWO	EWO.NV		20.81	16.72
MSCI Belgium Index Fund	EWK	EWK.NV		4.23	21.96
MSCI Canada Index Fund	EWC	EWC.NV		−2.48	23.05
MSCI France Index Fund	EWQ	EWQ.NV		−4.49	25.70
MSCI Germany Index Fund	EWG	EWG.NV		−9.31	29.05
MSCI Hong Kong Index Fund[e]	EWH	EWH.NV		−3.89	22.41
MSCI Italy Index Fund	EWI	EWI.NV		−3.12	22.50
MSCI Japan Index Fund	EWJ	EWJ.NV		−7.12	23.02
MSCI Mexico Index Fund[e]	EWW	EWW.NV		6.32	26.00
MSCI Netherlands Index Fund	EWN	EWN.NV		−6.85	25.06
MSCI Singapore Index Fund[e]	EWS	EWS.NV		−1.87	21.85
MSCI Spain Index Fund	EWP	EWP.NV		2.34	23.60
MSCI Sweden Index Fund	EWD	EWD.NV		−11.66	33.13
MSCI Switzerland Index Fund	EWL	EWL.NV		1.20	19.73
MSCI United Kingdom Index Fund	EWU	EWU.NV		−4.23	20.55

This table lists the funds analyzed in our study. All funds are classified as emerging or developed market funds. The 'e' superscript represents emerging market funds. The fund allocations represent the portfolio allocation guidelines from the fund's objectives. All ETFs are invested at least 99% in the respective country equity. The NAV return means and standard deviations are annualized for the sample period, March 31, 2000 to March 31, 2004.

To investigate the factors influencing the short-term changes in fund prices, we form a sample of CEFs and ETFs that invest in non-U.S. equities. The sample period is from March 31, 2000 to March 31, 2004.[3]

As this study investigates daily price dynamics, we require our funds to regularly release daily NAVs. While the rules promulgated under the Investment Company Act of 1940 require CEFs to calculate NAVs weekly, some funds voluntarily release portfolio values on a daily basis in a similar manner to mutual funds. This data is typically distributed over the Nasdaq Mutual Fund Quotation System.

To determine the CEFs for our study, we select all funds that are classified as world equity funds by The Wall Street Journal and release NAVs on a daily basis during our sample period. The 19 CEFs meeting these requirements are shown in Table 1. This table also contains data on fund objectives and country exposure gathered from the Morningstar Advisor website on April 16, 2004 as well as summary statistics for our sample. With one exception, our sample also includes all ETFs (16 funds) that invest exclusively in non-U.S. equities during our sample period. The MSCI Malaysia Index Fund is excluded because the fund distributor placed limits on its arbitrage. These restrictions were a consequence of the capital controls imposed by Malaysia following the Asian Financial Crisis.

Fund share prices and dividend information for the sample funds are gathered from the CRSP database. The CDA/Wiesenberger FundEdge product is used to get daily NAV information. The fund share prices, NAVs, and dividends are expressed in U.S. dollars. Datastream is used to collect historical exchange rates and local stock market indexes for all countries in which the funds have more than a 10% investment. We use the MSCI country index in the local currency and the daily exchange rate return between the U.S. dollar and the local currency.

The trading activity in our funds varied significantly during the sample period. The CEFs have a median daily volume of 24,429 shares, and volume ranged from 8,450 to 146,829 shares. The median volume for the ETFs is 38,601, or 58% great than the CEFs. Daily share volume for the ETFs ranges from 12,375 to 2,000,057.

4. Results

4.1. Stationarity

In order to have a well specified analysis, we begin by conducting the Augmented Dickey-Fuller unit root tests for the fund share prices

[3] Few CEFs released daily NAVs before 2000.

Table 2
Decomposition of 5-day ahead forecast error variance.

Variables explained	By innovations in: UC index	Exchange rate	NAV	S&P 500	Close
Panel A: averages for CEFs					
UC index	93.87	3.54	1.58	0.64	0.29
Exchange rate	1.71	97.23	0.28	0.24	0.27
NAV	0.62	0.41	90.92	5.90	2.14
S&P 500	0.50	0.29	15.33	83.10	0.77
Close	0.47	0.40	54.42	8.08	36.63
Panel B: averages for ETFs					
UC index	97.05	0.80	1.32	0.56	0.26
Exchange rate	1.99	97.37	0.28	0.17	0.19
NAV	0.29	0.40	91.11	6.90	1.57
S&P 500	0.27	0.11	16.13	83.29	0.19
Close	0.30	0.15	77.75	8.55	13.24
Panel C: medians for CEFs					
UC index	95.04	2.21	1.40	0.51	0.16
Exchange rate	0.89	98.47	0.13	0.19	0.17
NAV	0.37	0.18	93.12	5.14	0.14
S&P 500	0.07	0.15	15.33	83.84	0.18
Close	0.29	0.20	59.04	7.36	31.22
Panel D: medians for ETFs					
UC index	96.81	0.71	1.41	0.49	0.12
Exchange rate	1.52	97.92	0.24	0.15	0.15
NAV	0.24	0.11	93.81	5.34	0.95
S&P 500	0.08	0.06	16.34	83.05	0.14
Close	0.18	0.08	79.73	6.04	11.49

This table provides the average and median percentage of 5-day ahead average forecast error variance that is explained by innovations in the underlying country (UC) index, exchange rate, NAV, S&P 500, and closing price. The averages and medians are provided separately for the closed-end funds and exchange-traded funds. For the funds that invest in multiple countries, the percentages under UC index and exchange rate represent a sum of the percentages for each country in which the fund invests at least 10%.

and the NAVs. The lag length for each series is selected using the Schwarz Bayesian Criterion (SBC). For 25 of the 35 fund share prices, we fail to reject the presence of a unit root for the fund shares. The results are similar for the NAVs; 27 of the 35 test statistics are not statistically significant. For the hypothesis of two unit roots, the test statistics are statistically significant at the 1% level for all of the fund share prices and NAVs.

The findings suggest that first differencing is sufficient to make the series stationary. As one would expect in the absence of market segmentation, the fund share prices and underlying portfolio values have similar time series properties. For each country in which one of our sample funds invests at least 10%, we run these tests on the MSCI country index and exchange rate with the U.S. dollar. In the test for one unit root, 89% of the test statistics for both the indexes and currencies are insignificant at the 10% level. All of the test statistics are significant at the 1% level in the test for two unit roots. Based on these results, first differencing of these time series is used when estimating the impulse response functions, which are presented later in the paper.

This first differencing may result in the loss of information on the long-run trend in prices. Therefore, we bring this information back into our analysis through Johansen's cointegration tests by incorporating the error correction term in our VAR models (resulting in vector error correction models).[4] The cointegration equation includes the fund share price, NAV, underlying country (UC) index, S&P 500 Index, and exchange rates for each country in which the fund invests a minimum of 10% of its assets.[5] The Akaike Information Criterion (AIC) is used to determine the appropriate number of lags for each test.[6] The trace test is consistent with all of the funds except EMF having at least one cointegrating vector. Twenty-three funds have at least two cointegrating vectors. Six funds have at least three cointegrating vectors, and one fund has more than three cointegrating vectors. The results from the maximal eigenvalue test are similar. EMF and CEE do not have a cointegrating vector. Eight funds have at least one cointegrating vector, and fifteen funds have at least two cointegrating vectors. The rest of the funds in the sample have at least three cointegrating vectors. The cointegrating vectors for these funds are used to estimate the restricted VAR model so that it reflects the equilibrium relationship.

4.2. Variance decomposition

The estimation of a VAR model allows us to investigate how much of the forecast error variance is caused by the different variables in our model. Table 2 provides the percentage of 5-day ahead average forecast error variance that is explained by innovations in the UC index, exchange rate, NAV, S&P 500 Index, and closing price. The variables are included in our analysis in that order, which is consistent with Kim et al. (2000). For the funds that invest in multiple countries, the percentages under UC index and exchange rate represent a sum of the percentages for each country in which the fund invests at least 10%. Panels A and B show the averages for the CEFs and ETFs while Panels C and D provide the medians.

The UC index, exchange rate, and the NAV are the most exogenous variables for the funds. On average for the CEFs (ETFs), 93.87% (97.05%) of the variance in each UC index is explained by its own innovations. The results are similar for the exchange rates and NAVs since innovations in these variables respectively explain 97% and 91% of their own variance. Also, forecast errors in the S&P 500 Index are mainly due to uncertainty in the S&P 500 Index itself; the averages and medians for the CEFs and ETFs are all at 83%.

The most interesting results are for the closing fund share prices. In an integrated and efficient market, one would expect that innovations

[4] The results of the Augmented Dickey Fuller tests and the Johansen's cointegration tests are available on request from the authors.

[5] We have performed this and subsequent analyses including all the countries' exchange rates and indexes in which a particular fund has invested. The results are qualitatively similar. In the interest of conciseness and to make the presentation of our results more appealing we have chosen to report the results including exchange rates and indexes in which a fund has invested at least 10% of their funds.

[6] Other lag length selection methods do not change our results qualitatively.

Table 3
Impulse responses of fund closing price.

	Unit shock in NAV		Unit Shock In UC Index		Unit Shock In Currency		Unit Shock In S&P 500	
	+ and significant coefficient	− and significant coefficient	+ and significant coefficient	− and significant coefficient	+ and significant coefficient	− and significant coefficient	+ and significant coefficient	− and significant coefficient
Panel A: CEFs								
IAF	60%	0%	0%	0%	0%	0%	80%	0%
BZF	40%	0%	0%	0%	0%	0%	60%	0%
BZL	60%	0%	0%	0%	0%	0%	40%	0%
CEE	60%	0%	0%	0%	0%	0%	60%	0%
CH	60%	0%	0%	0%	0%	0%	40%	20%
ETF	60%	0%	0%	20%	0%	0%	40%	0%
EF	60%	0%	0%	7%	0%	0%	60%	0%
ISL	60%	0%	0%	0%	0%	0%	20%	0%
FRF	60%	0%	0%	0%	0%	20%	40%	0%
GER	80%	0%	0%	0%	0%	0%	60%	0%
KF	20%	0%	0%	0%	0%	0%	20%	0%
LAQ	60%	20%	0%	0%	7%	0%	40%	20%
GF	100%	0%	20%	0%	20%	0%	60%	0%
SAF	60%	0%	20%	0%	0%	0%	40%	0%
SOA	60%	0%	0%	0%	10%	0%	60%	0%
SNF	40%	0%	0%	0%	20%	0%	40%	0%
SWZ	60%	20%	0%	20%	0%	0%	40%	0%
TDF	40%	0%	0%	0%	0%	27%	20%	0%
EMF	60%	0%	0%	0%	0%	0%	40%	0%
Mean	58%	2%	2%	2%	3%	2%	45%	2%
Median	60%	0%	0%	0%	0%	0%	40%	0%
Panel B: ETFs								
EWA	20%	0%	0%	0%	0%	0%	60%	20%
EWO	40%	0%	0%	0%	0%	0%	60%	0%
EWK	40%	0%	0%	20%	0%	0%	20%	0%
EWC	40%	20%	0%	0%	0%	0%	20%	0%
EWQ	20%	0%	0%	0%	0%	0%	40%	0%
EWG	20%	0%	0%	0%	20%	0%	40%	0%
EWH	20%	0%	0%	0%	0%	0%	40%	20%
EWI	40%	0%	0%	0%	0%	0%	60%	0%
EWJ	20%	0%	0%	0%	0%	0%	40%	20%
EWW	40%	0%	0%	0%	40%	0%	20%	0%
EWN	20%	0%	0%	0%	0%	0%	20%	0%
EWS	20%	0%	0%	0%	0%	0%	40%	40%
EWP	20%	0%	0%	20%	0%	0%	40%	20%
EWD	20%	0%	0%	0%	0%	0%	20%	0%
EWL	40%	20%	0%	0%	0%	0%	60%	0%
EWU	20%	20%	0%	0%	0%	0%	20%	0%
Mean	28%	4%	0%	3%	4%	0%	38%	8%
Median	20%	0%	0%	0%	0%	0%	40%	0%

Impulse responses are calculated for each of five days after a shock. The percentage that are significant at the 5% level and of a certain sign are shown above.

in the NAV explain the majority of the forecast error variance in the closing price of the fund shares. While 78% of the forecast error variance in the ETF share prices (Panel B) is explained by innovations in the NAV, only 54% (Panel A) is explained for the CEFs. The percentage explained by own innovations is 2.8 times as large for the CEFs as for the ETFs (36% versus 13%). This is consistent with the ETFs being priced more efficiently than the CEFs.

To determine the robustness of our results to the ordering of the variables, we re-estimate the VAR system using two alternative orderings of the variables.[7] Hamao, Masulis, and Ng (1990) and Bekaert, Harvey, and Ng (2005) document that stock market activity may spillover to the markets in other countries. Therefore, we estimate the VAR system with the U.S. market return as the first variable in the system. We also estimate the model with the NAV as the first variable. While the estimates presented in Table 2 change with the alternative orderings of the variables, the relative differences between the estimates for CEFs and ETFs do not significantly change. For the forecast error variance in the closing share price, innovations in the NAV for the ETFs explain at least 42% more than for the CEFs regardless of the specification. Also, the percentage explained by own innovations is about three times as large for the CEFs as for the ETFs regardless of the ordering of variables that we examined.

In a study of ADRs, Kim et al. (2000) found that the average innovations in the underlying shares and exchange rates (these variables combined are equivalent to a NAV expressed in dollars) from five countries explained between 67.22% and 75.14% of the variance in the share prices of ADRs. The average for CEFs is below this range while the average for ETFs is above it. These results are consistent with arbitrage playing an important role in how closely prices reflect their underlying values. CEFs are difficult to arbitrage and their fund prices are less connected to NAVs. ADRs are relatively easier to arbitrage and the forecast error variance of their shares is more closely connected to the underlying share values. Of the three types of securities, ETFs have less impediments to arbitrage, and innovations in the NAV explain more of the average forecast error variance of the share prices.

4.3. Estimation of the impulse response function

We further examine the price dynamics of fund share prices by estimating impulse response functions. The results quantify how a shock in a variable (NAV, UC index, exchange rate, and S&P 500 Index) impacts the fund share price over a five-day period following a shock. Table 3 shows the percentage of the five coefficients that are positive

[7] Results available on request.

Table 4
Regression analysis of CEF returns.

	IAF	BZF	BZL	CEE	CH	ETF	EF	ISL	FRF	GER	KF	LAQ	GF	SAF	SOA	SNF	SWZ	TDF	EMF
a_i	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	−0.00	−0.00	0.00	0.00	−0.00	0.00	0.00	0.00	0.00	0.01	0.0
	(0.47)	(0.54)	(0.64)	(0.35)	(0.37)	(0.45)	(0.93)	(0.70)	(0.89)	(0.74)	(0.26)	(0.44)	(0.99)	(0.45)	(0.67)	(0.62)	(0.75)	(0.76)	(0.39)
NAV_0	0.32	0.67	0.32	0.46	0.55	0.81	0.63	0.84	0.61	0.51	0.75	0.52	0.42	0.68	0.43	0.40	0.60	0.63	0.58
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
NAV_{-1}	0.26	0.02	0.03	0.29	0.30	0.15	0.19	0.12	0.17	0.13	0.05	0.21	0.19	0.14	0.23	0.28	0.09	0.21	0.16
	(0.00)	(0.00)	(0.41)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.02)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)
NAV_{-2}	0.14	0.05	0.02	0.11	0.11	0.10	0.05	0.09	0.12	0.09	0.02	0.02	0.12	0.10	0.1	0.04	0.12	0.01	0.19
	(0.00)	(0.01)	(0.60)	(0.00)	(0.01)	(0.00)	(0.10)	(0.01)	(0.00)	(0.00)	(0.26)	(0.44)	(0.00)	(0.00)	(0.00)	(0.35)	(0.00)	(0.72)	(0.00)
EXG_0	0.04	−0.01	−0.12	−0.11	0.07	−0.02	0.38	−0.12	0.05	0.02	−0.09	−0.01	0.09	−0.02	0.03	0.06	−0.03	−0.35	0.08
	(0.44)	(0.80)	(0.05)	(0.42)	(0.30)	(0.50)	(0.12)	(0.14)	(0.34)	(0.79)	(0.08)	(0.61)	(0.17)	(0.78)	(0.34)	(0.49)	(0.45)	(0.57)	(0.43)
EXG_{-1}	0.02	0.01	−0.02	−0.01	−0.08	0.00	0.35	0.08	0.09	−0.00	−0.00	0.01	−0.01	0.10	0.02	0.06	0.05	0.00	0.07
	(0.73)	(0.67)	(0.75)	(0.96)	(0.22)	(0.87)	(0.20)	(0.30)	(0.10)	(0.95)	(0.97)	(0.70)	(0.91)	(0.15)	(0.63)	(0.52)	(0.29)	(0.99)	(0.49)
EXG_{-2}	0.03	−0.06	0.01	−0.09	0.03	−0.02	0.17	0.18	−0.01	0.07	0.09	0.02	−0.03	−0.09	0.05	−0.18	0.00	−0.52	−0.12
	(0.55)	(0.09)	(0.9)	(0.63)	(0.68)	(0.42)	(0.47)	(0.02)	(0.90)	(0.27)	(0.20)	(0.89)	(0.60)	(0.19)	(0.16)	(0.04)	(0.93)	(0.41)	(0.22)
IND_0	−0.01	−0.03	0.06	0.02	0.07	−0.05	0.05	0.00	0.01	0.03	0.01	−0.01	0.02	−0.04	−0.00	0.02	−0.03	−0.01	0.02
	(0.77)	(0.22)	(0.22)	(0.20)	(0.20)	(0.07)	(0.36)	(0.85)	(0.62)	(0.19)	(0.64)	(0.63)	(0.39)	(0.18)	(0.98)	(0.61)	(0.15)	(0.75)	(0.30)
IND_{-1}	−0.00	0.01	0.01	−0.01	−0.07	−0.01	0.01	−0.01	0.01	−0.01	0.00	−0.01	−0.04	−0.01	0.04	−0.05	0.01	0.06	−0.02
	(0.92)	(0.83)	(0.76)	(0.46)	(0.24)	(0.72)	(0.81)	(0.71)	(0.52)	(0.71)	(0.95)	(0.68)	(0.12)	(0.74)	(0.35)	(0.15)	(0.71)	(0.07)	(0.28)
IND_{-2}	−0.01	0.01	−0.01	0.00	0.09	0.02	−0.08	0.02	−0.01	−0.03	−0.01	0.02	0.090	0.08	0.00	0.00	−0.06	0.01	0.01
	(0.84)	(0.83)	(0.84)	(0.92)	(0.10)	(0.54)	(0.15)	(0.33)	(0.72)	(0.26)	(0.45)	(0.48)	(0.17)	(0.02)	(0.96)	(0.90)	(0.00)	(0.84)	(0.68)
SP_0	0.27	0.26	−0.03	0.37	0.23	0.31	0.33	0.12	0.28	0.45	0.66	0.15	0.68	0.43	0.12	0.27	0.24	0.49	0.47
	(0.00)	(0.00)	(0.62)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
SP_{-1}	−0.02	−0.05	−0.04	−0.06	−0.05	−0.01	−0.23	0.04	−0.15	−0.11	−0.28	0.06	−0.24	−0.15	−0.04	0.00	−0.10	−0.12	−0.04
	(0.53)	(0.13)	(0.53)	(0.05)	(0.20)	(0.66)	(0.00)	(0.16)	(0.00)	(0.00)	(0.00)	(0.05)	(0.00)	(0.00)	(0.26)	(0.94)	(0.00)	(0.00)	(0.43)
SP_{-2}	−0.08	−0.04	0.23	−0.02	−0.07	−0.10	−0.00	−0.07	−0.04	−0.03	−0.07	0.06	−0.07	−0.11	−0.01	−0.03	−0.02	−0.11	−0.06
	(0.01)	(0.17)	(0.00)	(0.57)	(0.04)	(0.00)	(0.90)	(0.01)	(0.18)	(0.45)	(0.02)	(0.04)	(0.07)	(0.00)	(0.68)	(0.62)	(0.37)	(0.00)	(0.16)

This table provides the results from estimating the following regression model using CEFs:

$$\text{Close}_{i,t} = a_i + \sum_{j=0}^{2} \text{b}_{\text{ij}}\text{NAV}_{\text{i,t}-\text{j}} + \sum_{c=1}^{n}\sum_{j=0}^{2} \text{EXG}_{\text{c,t}-\text{j}} + \sum_{k=1}^{m}\sum_{j=0}^{2} \text{IND}_{\text{k,t}-\text{j}} + \sum_{j=0}^{2} \text{SP}_{\text{t}-\text{j}} + \text{e}_{\text{i,t}},$$

where $Close_{i,t}$ represents the daily return of fund i on day t, $\text{NAV}_{i,t-j}$ is the return on the net asset value of fund i on day $t-j$, $\text{EXG}_{c,t-j}$ is the exchange rate return between the U.S. dollar and currency c on day $t-j$, $\text{IND}_{k,t-j}$ is the return on the stock index for country k on day $t-j$, and SP_{t-j} is the return on the S&P 500 Index on day $t-j$. The analysis includes the exchange rate and underlying country (UC) index for all countries in which the fund has more than a 10% investment. For the sake of brevity, the results from only one exchange rate and UC index are reported in this table.

and significant and the percentage that are negative and significant following each shock.[8]

As the fund shares are traded at different times than the underlying stocks in the fund's portfolio, changes in the NAV may take a day before impacting the fund prices, even in an efficient market. As expected, the 1-day lagged unit shock in NAV is significant for all the funds. However, shocks in the NAV that influence the fund price over multiple days are consistent with this market being slow to process information and suggest an inefficiency.

For 18 of the 19 CEFs in our sample, a shock in the NAV of the fund has a statistically significant impact on the fund share price over multiple days. The Korea Fund is the exception as shown in the first column of Table 3 by the 20% of five coefficients that are positive and significant. For the 95 coefficients estimated for the CEFs, only 2% are negative and significant. Thus, the overwhelming majority of the reactions to a shock in NAV are positive, and this effect persists (statistically significant) for at least three of the five days for 79% of the funds. These results indicate that the market for CEFs that invest in foreign equities do not quickly process information on their underlying value.

The results in Panel B for the ETFs are substantially different than for the CEFs. While most of the CEFs have positive and significant coefficients for three or more days, none of the ETF share prices were affected by a NAV shock for more than two of the five days. 63% of the ETFs had only one of the five days (shown as 20% in the table) with a positive and significant coefficient and all of these coefficients were for the first day after the shock. This is consistent with these securities quickly processing changes in the value of their portfolios of foreign securities.

Like shocks to NAV, shocks in the value of the S&P 500 Index affect fund share prices over multiple days. 84% of the CEF sample and 63% of the ETF sample have positive and significant coefficients for two or more days following a shock. Again, the ETFs seem to incorporate this information more quickly than CEFs, since 38% of the ETF sample only have one day with a positive and significant coefficient. Maybe individual investors underestimate the effects of contagion on foreign stock prices. This is consistent with previous research that indicates country fund prices are sensitive to domestic market returns. This research extends these previous studies by showing that the effect typically has an impact over multiple days even after daily changes in the NAV are taken into account.

Table 3 also provides the results for shocks in the UC indexes and currencies. None of the Day 1 unit shocks in the UC index are significant for the CEFs. Both of the negative and significant coefficients in Panel B are for Day 1. In contrast to the results for NAV and the S&P 500, few coefficients are found to be significant for the shocks associated with the UC indexes and currencies.

4.4. Regression analysis

The impulse response functions from the VAR system show that innovations in the NAV and S&P 500 Index are not immediately reflected in the fund share price. However, the fund shares are not priced at the same time as some of the factors determining the price. In light of this nonsynchronous pricing, we investigate the determinants of the fund share returns through the following regression model:

$$\text{Close}_{i,t} = a_i + \sum_{j=0}^{2} \text{b}_{\text{ij}}\text{NAV}_{\text{i,t}-\text{j}} + \sum_{c=1}^{n}\sum_{j=0}^{2} \text{EXG}_{\text{c,t}-\text{j}} + \sum_{k=1}^{m}\sum_{j=0}^{2} \text{IND}_{\text{k,t}-\text{j}} + \sum_{j=0}^{2} \text{SP}_{\text{t}-\text{j}} + \text{e}_{\text{i,t}},$$

where $\text{Close}_{i,t}$ represents the daily return of fund i on day t, $\text{NAV}_{i,t-j}$ is the return on the net asset value of fund i on day $t-j$, $\text{EXG}_{c,t-j}$ is the

[8] 5-day ahead average forecast error variance decomposition and impulse response function results for individual funds are available on request from the authors.

Table 5
Regression analysis of ETF returns.

	EWA	EWO	EWK	EWC	EWQ	EWG	EWH	EWI	EWJ	EWW	EWN	EWS	EWP	EWD	EWL	EWU
a_i	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	−0.00	0.00	0.00	0.00	0.00	0.00
	(0.76)	(0.75)	(0.72)	(0.87)	(0.93)	(0.99)	(0.76)	(0.81)	(0.93)	(0.82)	(0.38)	(0.66)	(0.83)	(0.89)	(0.82)	(0.94)
NAV_0	0.88	0.84	0.84	0.85	0.81	0.75	0.81	0.83	0.76	0.83	0.77	0.82	0.84	0.86	0.79	0.68
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
NAV_{-1}	0.02	0.14	0.10	0.09	0.07	0.14	0.08	0.04	0.06	0.13	0.08	0.12	0.05	0.11	0.06	0.09
	(0.53)	(0.00)	(0.09)	(0.00)	(0.00)	(0.00)	(0.00)	(0.21)	(0.00)	(0.00)	(0.33)	(0.00)	(0.01)	(0.00)	(0.06)	(0.00)
NAV_{-2}	−0.01	−0.02	−0.00	0.00	0.02	0.02	0.03	0.05	0.03	−0.01	0.00	−0.02	0.05	−0.05	−0.03	0.00
	(0.84)	(0.60)	(0.98)	(0.92)	(0.28)	(0.33)	(0.17)	(0.14)	(0.09)	(0.76)	(0.97)	(0.83)	(0.06)	(0.05)	(0.42)	(0.92)
EXG_0	−0.10	0.05	−0.04	−0.16	0.03	−0.01	−0.89	0.02	−0.04	0.02	−0.14	0.22	−0.05	−0.04	−0.01	−0.00
	(0.04)	(0.34)	(0.74)	(0.17)	(0.47)	(0.76)	(0.37)	(0.81)	(0.37)	(0.28)	(0.37)	(0.15)	(0.21)	(0.57)	(0.83)	(0.99)
EXG_{-1}	0.04	−0.00	−0.02	−0.05	−0.06	−0.04	0.92	−0.15	0.06	0.02	0.12	−0.26	−0.01	0.01	−0.06	0.01
	(0.43)	(0.98)	(0.84)	(0.68)	(0.12)	(0.34)	(0.35)	(0.02)	(0.21)	(0.22)	(0.47)	(0.09)	(0.88)	(0.88)	(0.27)	(0.85)
EXG_{-2}	0.05	−0.10	0.11	0.03	0.05	−0.06	−0.89	0.09	0.00	0.01	0.11	0.13	0.05	0.09	0.04	0.01
	(0.32)	(0.04)	(0.38)	(0.80)	(0.21)	(0.15)	(0.37)	(0.15)	(0.99)	(0.59)	(0.49)	(0.38)	(0.21)	(0.16)	(0.47)	(0.88)
IND_0	−0.10	0.04	−0.08	−0.01	−0.02	−0.03	−0.04	−0.02	0.00	0.01	0.05	0.02	−0.03	0.01	0.02	−0.02
	(0.02)	(0.26)	(0.11)	(0.63)	(0.29)	(0.03)	(0.09)	(0.56)	(0.98)	(0.68)	(0.43)	(0.57)	(0.12)	(0.68)	(0.40)	(0.42)
IND_{-1}	0.08	0.03	0.04	−0.03	0.02	0.00	−0.03	−0.04	0.03	0.01	−0.02	−0.07	0.02	−0.01	−0.03	−0.02
	(0.06)	(0.47)	(0.48)	(0.30)	(0.30)	(0.85)	(0.23)	(0.21)	(0.14)	(0.84)	(0.77)	(0.04)	(0.17)	(0.79)	(0.23)	(0.28)
IND_{-2}	−0.06	−0.00	−0.01	0.08	0.02	−0.02	−0.01	0.02	−0.01	0.02	0.01	0.05	−0.01	0.00	0.04	0.02
	(0.17)	(0.98)	(0.91)	(0.00)	(0.22)	(0.15)	(0.69)	(0.45)	(0.62)	(0.41)	(0.83)	(0.12)	(0.70)	(0.97)	(0.12)	(0.42)
SP_0	0.33	0.13	0.21	0.04	0.30	0.34	0.75	0.25	0.59	0.22	0.41	0.64	0.28	0.46	0.32	0.40
	(0.00)	(0.00)	(0.00)	(0.18)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
SP_{-1}	−0.25	−0.01	−0.11	0.01	−0.17	−0.21	−0.55	−0.08	−0.37	−0.17	−0.21	−0.32	−0.12	−0.38	−0.11	−0.16
	(0.00)	(0.76)	(0.07)	(0.83)	(0.00)	(0.00)	(0.00)	(0.04)	(0.00)	(0.00)	(0.03)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
SP_{-2}	0.04	−0.07	0.04	0.04	−0.05	−0.03	−0.09	−0.01	−0.07	0.02	−0.06	−0.10	−0.03	0.03	−0.07	−0.04
	(0.15)	(0.01)	(0.45)	(0.17)	(0.02)	(0.23)	(0.00)	(0.90)	(0.00)	(0.51)	(0.58)	(0.00)	(0.29)	(0.43)	(0.02)	(0.15)

This table provides the results from estimating the following regression model using ETFs:

$$\mathrm{Close}_{i,t} = a_i + \sum_{j=0}^{2} \mathrm{b_{ij}NAV_{i,t-j}} + \sum_{c=1}^{n}\sum_{j=0}^{2} \mathrm{EXG_{c,t-j}} + \sum_{k=1}^{m}\sum_{j=0}^{2} \mathrm{IND_{k,t-j}} + \sum_{j=0}^{2} \mathrm{SP_{t-j}} + \mathrm{e_{i,t}},$$

where $\mathrm{Close}_{i,t}$ represents the daily return of fund i on day t, $\mathrm{NAV}_{i,t-j}$ is the return on the net asset value of fund i on day $t-j$, $\mathrm{EXG}_{c,t-j}$ is the exchange rate return between the U.S. dollar and currency c on day $t-j$, $\mathrm{IND}_{k,t-j}$ is the return on the stock index for country k on day $t-j$, and SP_{t-j} is the return on the S&P 500 Index on day $t-j$.

exchange rate return between the U.S. dollar and currency c on day $t-j$, $IND_{k,t-j}$ is the return on the stock index for country k on day $t-j$, and SP_{t-j} is the return on the S&P 500 index value on day $t-j$. Some CEFs invest in multiple countries, and the regression analysis includes the exchange rate and UC index for all countries in which the fund has more than a 10% investment.

Tables 4 and 5 provide the results of the regression analyses of the CEF and ETF prices. For the CEFs that invest in multiple countries, the results from only one exchange rate and UC index are reported in this table for the sake of brevity. As expected, Table 4 shows that the coefficients for the contemporaneous NAV are positive and statistically significant for all the CEFs. However, the prices of most of the CEFs do not quickly reflect changes in the NAV, and this is seen in the coefficients for the NAV lags. The coefficients for the one-day and two-day lagged NAVs are positive and statistically significant for 95% and 74% (respectively) of the CEFs. Even though the daily NAVs are publicly released for these funds at the end of the trading day, this information on the underlying value of the fund typically takes at least two days to be fully incorporated into the share price for almost three-fourths of the funds. These results show that the CEFs share prices underreact to NAV changes.

In contrast to the NAV results, the contemporaneous and lagged values of the exchange rates and UC indexes generally do not have any explanatory power for the closing fund share price in the presence of the other variables in the regression. Only 11% of the coefficients for the exchange rates are statistically significant. Thus, the price-relevant information from changes in the exchange rate is largely subsumed in NAV returns, which are expressed in dollars and already reflect the exchange rate. The situation is similar for the UC index returns. Only 5% of the coefficients are statistically significant; half of these are positive and half are negative.

The domestic stock market return, which is represented by the S&P 500 Index, surprisingly provides unique and price-relevant information. A positive relation exists between 95% of the CEF returns and the contemporaneous S&P 500 return. Even though these investment companies do not invest in the U.S. market, the domestic return influences the price of country funds. While the relation between contemporaneous returns is positive, over two-thirds of CEF returns have a negative and statistically significant relation with either the one-day or two-day lagged domestic return. These results suggest that CEF investors overreact to the domestic stock returns. Investors may overestimate the correlation between domestic and international markets.

Table 5 shows the results of the regression analysis for the ETFs. Like the CEF prices, all of the ETF prices are positively and significantly related to the contemporaneous NAV return. The one-day lagged NAV return has a positive influence on the price for 81% of the ETF sample. While the prices of 74% of the CEFs are sensitive to the two-day lagged NAV return, only 13% of the ETFs have a positive and statistically significant relation to this variable. These results are consistent with the market for ETFs being faster at processing changes in the underlying portfolio value than the market for CEFs. Similar to the results for the CEFs, the coefficients for changes in the exchange rates and UC indexes are generally not statistically significant.

For all but one of the ETFs in the sample, the analysis reveals that the fund return is positively related to the contemporaneous S&P 500 Index return. Surprisingly, more of the ETFs overreact to domestic stock market returns than CEFs. The coefficient for the one-day lagged S&P 500 Index return is negative and statistically significant for 88% of the ETFs but only 47% of the CEFs. The coefficient for the two-day lagged S&P 500 Index return is negative and significant for 38% of the ETFs and 42% of the CEFs. The prices for all but one of the ETFs (94% of the sample) have a negative relation to at least one of the lagged S&P 500 Index returns. Thus, ETFs overreact to domestic stock market returns despite the ease with which these securities can be arbitraged.

Our regression analysis provides three main findings. First, the prices of CEFs (and ETFs to a lesser extent) are slow to reflect changes

Table 6
CEF trading rule analysis.

CEF	TRret	ACTret	Nin	Nout	Ntot	Ntrans	Trdcost	*X*	*t*-statistic		*X*-adj	*t*-statistic		RTC
IAF	0.0013	0.0004	265	736	1001	183	0.0005	0.0012	(6.86)	***	0.0011	(6.36)	***	0.0137
BZF	0.0020	0.0005	270	731	1001	257	0.0005	0.0018	(6.54)	***	0.0017	(6.09)	***	0.0143
BZL	0.0017	0.0004	270	730	1000	250	0.0005	0.0015	(4.83)	***	0.0014	(4.45)	***	0.0126
CEE	0.0019	0.0005	266	735	1001	266	0.0005	0.0018	(8.72)	***	0.0016	(8.08)	***	0.0135
CH	0.0018	0.0003	258	743	1001	218	0.0005	0.0017	(7.69)	***	0.0016	(7.21)	***	0.0161
ETF	0.0013	−0.0005	209	792	1001	221	0.0005	0.0014	(6.34)	***	0.0013	(5.87)	***	0.0133
EF	0.0011	−0.0004	209	792	1001	229	0.0005	0.0012	(5.68)	***	0.0011	(5.15)	***	0.0106
ISL	0.0014	−0.0001	236	765	1001	252	0.0005	0.0015	(7.03)	***	0.0013	(6.44)	***	0.0119
FRF	0.0010	−0.0005	206	795	1001	178	0.0005	0.0012	(5.90)	***	0.0011	(5.46)	***	0.0136
GER	0.0006	−0.0005	188	813	1001	161	0.0005	0.0007	(3.14)	***	0.0007	(2.82)	***	0.0097
KF	0.0010	0.0007	330	671	1001	282	0.0005	0.0007	(2.32)	**	0.0006	(1.89)	*	0.0054
LAQ	0.0021	0.0002	267	734	1001	200	0.0005	0.0021	(10.54)	***	0.0020	(10.00)	***	0.0211
GF	0.0014	−0.0004	223	778	1001	185	0.0005	0.0015	(5.96)	***	0.0014	(5.60)	***	0.0163
SAF	0.0018	−0.0000	231	770	1001	237	0.0005	0.0018	(8.27)	***	0.0017	(7.74)	***	0.0154
SOA	0.0019	0.0002	269	732	1001	177	0.0005	0.0018	(8.92)	***	0.0017	(8.49)	***	0.0206
SNF	0.0014	−0.0001	242	759	1001	211	0.0005	0.0014	(5.14)	***	0.0013	(4.78)	***	0.0140
SWZ	0.0008	0.0000	257	744	1001	174	0.0005	0.0008	(4.79)	***	0.0007	(4.28)	***	0.0093
TDF	0.0019	0.0007	297	704	1001	226	0.0005	0.0017	(6.49)	***	0.0016	(6.07)	***	0.0152
EMF	0.0018	0.0004	290	711	1001	206	0.0005	0.0016	(6.21)	***	0.0015	(5.83)	***	0.0163

In this table we analyze a simple trading rule strategy where an investor takes a long position in a CEF if the predicted return in that CEF is positive and a neutral position (i.e., invests in the risk-free asset) if the predicted return is zero or negative based on the regression models in Table 4, which uses lagged independent variables only. The *X*-statistic (*X*) is calculated as

$$\text{TRret} - \text{ACTret} + (\text{Nout}/\text{Ntot})^*\text{ACTret},$$

where TRret is the mean trading rule return, ACTret is the buy and hold strategy mean return, Nout is the number of days when a neutral position is taken and Ntot is the total number of days. The adjusted *X*-statistic (*X*-adj) accounts for transaction costs by subtracting from the *X*-statistic the cost of the trading rule strategy. One-way transaction costs are assumed to be 0.05% and *X*-adj is calculated as

$$X - \text{Trdcost}^*(\text{Ntrans}/\text{Ntot}).$$

Ntrans is the total number of trades initiated by the trading rule. This statistic is from Sweeney (1988). RTC represents the round-trip transaction costs that would drive the *X*-statistic to zero and is calculated as

$$X/0.5^*(\text{Ntrans}/\text{Ntot})$$

and is from Kim et al. (2000). The *t*-statistics associated with the *X*-statistic and adjusted *X*-statistic are presented immediately to the left of their respective values.
***, **, * indicate significance at the 1% 5%, and 10% levels, respectively.

in their underlying value. This extends the research of Kim et al. (2000), who document that the prices of ADRs underreact to NAV changes. Our second major finding is that both CEFs and ETFs (like ADRs) overreact to domestic market returns. While Chang et al. (1995) and Bodurtha et al. (1995) show that weekly CEF prices are sensitive to domestic returns, our analysis reveals that this also extends to ETFs and that the relation between fund returns and domestic returns is more complex than previously documented. The contemporaneous relation between the returns on fund shares and the domestic stock market is positive but the vast majority of the funds share prices have a negative relation with one of the lagged domestic returns. This pattern is similar to that observed by Kim et al. (2000) in the market for ADRs. As this phenomenon exists in three types of securities in which the ease of arbitrage is vastly different, this result is not consistent with impediments to arbitrage being the sole cause.

A final conclusion from our analysis relates to the visibility of information and its impact on fund prices. While changes in the exchange rates and UC indexes are more widely reported, these variables are not generally significantly related to fund returns because they are subsumed in NAV returns. Therefore, investors can focus on just the NAV and domestic return when examining factors that affect the value of funds that invest in foreign stocks.

4.5. Trading rule profitability analysis

While the regression analysis shows which variables have a statistically significant impact on fund returns, it does not directly address whether their economic impact is large enough for a trading strategy to be profitable. We analyze a simple trading rule where an investor takes a long position in a fund if the predicted return is positive and a neutral position (i.e., invests in the risk-free asset) if the predicted return is zero or negative. The predicted return is calculated using the coefficients estimated in the regression models in Tables 4 and 5 for only the lagged independent variables.

The profitability of the trading rule is measured using the X-statistic (Sweeney, 1988). It is calculated as

$$X = \text{TRret} - \text{ACTret} + (\text{Nout}/\text{Ntot})^*\text{ACTret},$$

where TRret is the mean trading rule return, ACTret is the buy and hold strategy mean return, Nout is the number of days when a neutral position is taken, and Ntot is the total number of days. The adjusted *X*-statistic (*X*-adj) accounts for transaction costs by subtracting from the *X*-statistic the cost of the trading rule strategy. One-way transaction costs are assumed to be 0.05%, and X-adj is calculated as

$$X - \text{adj} = X - \text{Trdcost} \times (\text{Ntrans}/\text{Ntot}),$$

where Ntrans is the total number of trades initiated by the trading rule.

An alternative way of evaluating a trading strategy is to determine how large transaction costs would need to be to eliminate profitability. RTC represents the round-trip transaction costs that would drive the *X*-statistic to zero and is calculated as

$$\text{RTC} = X/0.5^*(\text{Ntrans}/\text{Ntot})$$

(Kim et al., 2000).

Tables 6 and 7 describe the profitability of the trading rule as applied to the CEF and ETF samples. As shown in Table 6, the adjusted

Table 7
ETF trading rule analysis.

ETF	TRret	ACTret	Nin	Nout	Ntot	Ntrans	Trdcost	X	t-statistic		X-adj	t-statistic		RTC
EWA	0.0011	0.0004	280	721	1001	190	0.0005	0.0010	(4.69)	***	0.0000	(4.23)	***	0.0102
EWD	0.0008	−0.0004	197	804	1001	245	0.0005	0.0009	(2.97)	***	0.0008	(2.58)	***	0.0075
EWG	0.0005	−0.0004	184	817	1001	191	0.0005	0.0005	(2.32)	**	0.0004	(1.90)	*	0.0055
EWH	0.0015	0.0000	251	750	1001	230	0.0005	0.0015	(5.80)	***	0.0014	(5.36)	***	0.0134
EWI	0.0006	0.0000	237	764	1001	179	0.0005	0.0006	(5.80)	***	0.0005	(5.36)	***	0.0068
EWJ	0.0007	−0.0003	215	786	1001	201	0.0005	0.0008	(3.84)	***	0.0007	(3.35)	***	0.0079
EWL	0.0005	0.0001	253	748	1001	289	0.0005	0.0004	(1.95)	*	0.0003	(1.31)		0.0030
EWN	0.0004	−0.0012	239	762	1001	195	0.0005	0.0007	(1.30)		0.0006	(1.11)		0.0067
EWO	0.0015	0.0008	314	687	1001	246	0.0005	0.0012	(5.91)	***	0.0011	(5.30)	***	0.0098
EWP	0.0007	0.0001	255	746	1001	230	0.0005	0.0007	(3.11)	***	0.0006	(2.61)	***	0.0062
EWQ	0.0003	−0.0001	231	770	1001	231	0.0005	0.0004	(1.58)		0.0002	(1.07)		0.0031
EWS	0.0006	0.0001	280	721	1001	212	0.0005	0.0006	(2.08)	**	0.0005	(1.71)	*	0.0056
EWU	0.0003	−0.0001	216	785	1001	244	0.0005	0.0004	(1.81)	*	0.0002	(1.19)		0.0029
EWW	0.0009	0.0004	291	710	1001	232	0.0005	0.0008	(2.71)	***	0.0006	(2.29)	**	0.0065
EWC	0.0008	0.0000	241	760	1001	221	0.0005	0.0008	(3.55)	***	0.0007	(3.06)	***	0.0073
EWK	0.0012	0.0004	281	720	1001	191	0.0005	0.0011	(3.01)	***	0.0010	(2.75)	***	0.0116

In this table we analyze a simple trading rule strategy where an investor takes a long position in an ETF if the predicted return in that ETF is positive and a neutral position (i.e., invests in the risk-free asset) if the predicted return is zero or negative based on the regression models in Table 5, which uses lagged independent variables only. The *X*-statistic (*X*) is calculated as

$$\text{TRret} - \text{ACTret} + (\text{Nout} / \text{Ntot})*\text{ACTret},$$

where TRret is the mean trading rule return, ACTret is the buy and hold strategy mean return, Nout is the number of days when a neutral position is taken and Ntot is the total number of days. The adjusted *X*-statistic (*X*-adj) accounts for transaction costs by subtracting from the *X*-statistic the cost of the trading rule strategy. One-way transaction costs are assumed to be 0.05% and *X*-adj is calculated as

$$X - \text{Trdcost}*(\text{Ntrans} / \text{Ntot}).$$

Ntrans is the total number of trades initiated by the trading rule. This statistic is from Sweeney (1988). RTC represents the round-trip transaction costs that would drive the *X*-statistic to zero and is calculated as

$$X / 0.5*(\text{Ntrans} / \text{Ntot})$$

and is from Kim et al. (2000). The *t*-statistics associated with the *X*-statistic and adjusted *X*-statistic are presented immediately to the left of their respective values.
***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

X-statistic is positive and statistically significant for all of the CEFs. The minimum RTC is 0.54% but the average is substantially higher at 1.38%. These results suggest that a CEF trading strategy would be profitable with moderate trading costs. Table 7 shows that the adjusted X-statistic is positive and statistically significant for 75% of the ETFs. The average RTC is 0.71% or about half the average for the CEFs.

Chou and Chung (2006) examine the relative effective spread for ETFs in the post-decimalization environment and find the following costs: S&P 500 ETFs, 0.0881%; Nasdaq 100 ETFs, 0.1541%; and DJIA ETFs, 0.11%.[9] Assuming that the spread is the only transaction cost, the spread for the foreign stock ETFs would need to be over four times as large as the spread for these domestic ETFs to make the trading strategy unprofitable. The RTC for the CEFs and ETFs is substantially higher than the average RTC of 0.27% that Kim et al. (2000) found for ADRs.

4.6. Differences between developed and emerging markets

The stock markets in countries with emerging economies tend to have higher transaction costs and lower liquidity than markets in developed economies. As shown in Table 1, the funds that invest in emerging markets are not distributed evenly between the ETFs and CEFs in our sample. Out of the 19 CEFs, 12 (63%) invest primarily in emerging markets while only three (19%) of the 16 ETFs invest outside of developed economies. It is possible that the characteristics of the ETFs and CEFs in our sample are causing the differences we observe in their pricing dynamics. To investigate this situation, we review our major findings by market status.

The decomposition of the 5-day ahead forecast error variance reveals that ETF returns are more closely related to their portfolio returns than are CEF returns. Innovations in the NAV explain 78% of the variance for ETF share prices but only 54% of the variance for CEFs. The substantial differences between ETFs and CEFs remain when comparing funds in the same market category. For the funds investing in developed markets, the innovations explain 79% of the variance for ETFs and 58% for CEFs. For the funds with portfolios in emerging markets, the NAV innovations explain 73% of the variance for ETFs and 52% for CEFs.

Another major finding in our study is that the two-day lagged NAV returns are a positive influence on 74% of CEFs and 13% of the ETFs. This statistic is 86% for the developed market CEFs and 67% for the emerging market CEFs. This compares to 23% for the developed market ETFs and 0% for those ETFs investing in emerging markets. Therefore, a substantial difference between ETFs and CEFs remains even when comparing those in similar markets.

Another of our more interesting findings is uncovered by investigating the profitability of a simple trading strategy using the lagged variables in our regression analysis. To make this strategy unprofitable, the trading cost would need to be 1.38% for CEFs and 0.71% for ETFs. For just those funds that invest in developed markets, the trading costs would need to be 1.28% for CEFs and 0.68% for ETFs. The CEFs and ETFs in emerging markets need to have average trading costs of 1.46% and 0.85%, respectively. The major conclusions of our paper are not affected by a separating the analysis by market type.

[9] All of the funds in our sample trade on either the New York Stock Exchange or American Stock Exchange, and these exchanges switched to decimal pricing on January 29, 2001. The relative effective spread equals two times the absolute value of the difference between the trade price and the bid-ask midpoint divided by the bid-ask midpoint.

5. Conclusions

Many investors desire exposure to a diversified portfolio of foreign stocks while limiting their trading to products on a domestic stock exchange. The two main vehicles for achieving this goal are CEFs and ETFs, but these investment products differ in their liquidity and ability to be arbitraged. Trading in ETFs is generally more active than in CEFs, so the trading costs of CEFs are likely higher. In contrast to CEFs, institutional investors can easily arbitrage ETF shares and minimize any differences between share prices and NAVs. To see how these differences affect the market for these funds, this study investigates the transmission dynamics between fund prices and the underlying portfolio values, exchange rates, and index returns in the foreign and domestic markets.

The first conclusion from our analysis is that ETF returns are more closely related to their portfolio returns than are CEF returns. Innovations in the NAV explain 78% of the 5-day ahead forecast error variance for ETF share prices but only 54% of the forecast error variance for CEFs. The impulse response functions show that shocks to the NAV have a positive effect on fund prices and persist for at least three of the five days following the shock for 79% of the CEFs. The impulse response functions for the ETFs reveal that none of the ETF fund prices are affected by a NAV shock for more than two of the five days following the shock. The discrepancy in the way that ETFs and CEFs process information may be due to differences in the ease of arbitrage, market liquidity, or even ownership clienteles.

Our second insight into the dynamics of fund prices is revealed from our regression analysis of fund prices. Both CEF and ETF prices underreact to NAV returns but overreact to domestic stock market returns. For 95% of the CEFs and 81% of the ETFs, share prices are positively related to the one-day lagged NAV returns. The two-day lagged NAV returns are a positive influence on 74% of the CEF prices and 13% of the ETF prices. As the prices are slow to reflect changes in NAV, we conclude the shares underreact to changes in underlying value. Both the CEFs and ETFs have a positive relation with the contemporaneous return on the S&P 500 Index. However, over two-thirds of CEF returns and 94% of the ETF returns have a negative relation with either the one-day or two-day lagged domestic return. This result is consistent with previous findings for the ADR market.

As fund prices take days to fully reflect changes in NAV and the domestic stock market, we examine the profitability of a simple trading strategy and provide a third contribution to the literature. Using coefficients from only the lagged variables in our regression analysis, the strategy would be unprofitable with roundtrip trading costs of at least 1.38% for CEFs and 0.71% for ETFs. In the ADR market, roundtrip trading costs need to be 0.27% to eliminate the profit from a simple trading strategy (Kim et al., 2000). By some measures, the market for CEFs and ETFs that invest in foreign stocks is less efficient than the market for ADRs. Such inefficiencies may be particularly costly since these funds attract short-term investors who do not want to be restricted by the limited trading opportunities associated with mutual funds.

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