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Article

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FINANCIAL ECONOMICS | RESEARCH ARTICLE

On the informational efficiency of Saudi exchange-traded funds listed at home and away from home

Nassar S. Al-Nassar^{1*}

Abstract: This study compares the pricing efficiency of two domestic exchange-traded funds (ETFs) (i.e., Falcom 30 and HSBC 20) listed on the Saudi stock exchange (i.e., Tadawul), as well as an international ETF (i.e., iShares MSCI Saudi Arabia) listed on the NYSE, by examining the extent and properties of the deviations of their prices from their net asset values (NAVs), and whether these deviations persist and vary over time. The results show that the deviations of the market prices of all of the ETFs are significantly large and persist for at least three days. It is shown that the standard deviation of the premiums/discounts based on the *dyna* model are large, particularly for the domestic funds. The premiums/discounts appear to be exacerbated during the periods of market turbulence. The results from cointegration analysis support the existence of a long-run relationship between the prices and the NAVs of the three ETFs. However, the ETFs' prices do not fully reflect the fundamental information contained in the underlying basket of the stocks in either the long run or the short run. Furthermore, the adjustment toward the long-run relationship seems to be quite slow, albeit apparently faster in the case of iShares MSCI Saudi Arabia. The restrictions on short selling, the concentration of authorized market participants, the increased cost for the creation and redemption of the ETF



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Nassar S. Al-Nassar, PhD is an Assistant Professor at Qassim University. After graduating with a degree in Economics and Business (with 1st class honors) from Qassim University, Nassar completed a master's in Finance from the University of Adelaide and a postgraduate diploma in Economics and Commerce specializing in Finance from Monash University then a PhD in Finance from RMIT University. His research interests are mainly in the areas of Financial market efficiency, funds management, macro-finance, market integration and business education.

PUBLIC INTEREST STATEMENT

The unprecedented growth in the ETF industry has attracted the attention of investors, economists, and policy makers alike. While ETFs resembles close-ended funds and open-ended index funds in many aspects, they stand out from their rivals by providing the best of both worlds. Like close-ended funds, ETFs trade on the secondary market but with a lower possibility of experiencing severe and prolong deviations from their fair value due to the presence of the creation and redemption mechanism. ETFs also offer exposure to an index at a low cost like index funds but with intraday liquidity. Indeed, ample research is conducted on the pricing of ETFs in the US and other developed markets. Using Saudi ETFs data, we find that the international ETF is priced more accurately compared to its domestically listed counterparts although they track the same market. Policy makers maybe interested in understanding the reasons that led to the status quo if they wish to expand the local Saudi ETF industry.

shares, and the lack of an active secondary market for the ETF shares can create major limits to arbitrage, thereby impeding efficiency in the market.

Subjects: Econometrics; Corporate Finance; Investment & Securities

Keywords: exchange traded funds; pricing efficiency; Saudi market; arbitrage

GEL Codes: G12; G15; G23

1. Introduction

In their seminal paper, Elton et al. (2002, p. 471) elegantly concluded that “... exchange traded funds that offer immediacy are likely to prosper and reproduce.” The recent dramatic growth in the U.S. exchange-traded funds (ETFs) industry strongly supports this conclusion. There has been a sharp rise in the total net assets of ETFs during the last two decades, from 34 USD billion in 1999 to 3371 USD billion in 2018 (Investment Company Institute, 2019, p. 50).¹ The U.S. has the largest ETF market, representing 71% of the world’s total net assets, followed by Europe and Asia-Pacific with shares of 15% and 10%, respectively, while the remaining 4% is scattered around the rest of the world (Investment Company Institute, 2019, p. 82).

While the ETF industry has expanded globally, The ETF market is still in its early stage of development, especially in the Middle East and Africa. Only a few ETFs are listed on the national stock exchanges in the Middle East and Africa region.² The Saudi stock exchange is, to the best of our knowledge, the only regional market that has ongoing ETFs with sufficient historical data.³ The Saudi market constitutes the largest share of the underlying portfolios of international ETFs invested in the Middle Eastern and African markets. As of 30 June 2019, the largest ETF in the Middle East and Africa region was iShares MSCI Saudi Arabia with 850.53 USD million in net assets, followed by iShares MSCI South Africa with 431.17 USD million, which is about half of the size of the Saudi ETF (BlackRock, 2019a; BlackRock, 2019b).⁴ Notwithstanding the extremely small size of domestically listed ETFs of 112 USD million (Capital Market Authority (CMA) 2019, p. 168), the number of international ETFs tracking the performance of the Saudi market is growing.⁵

Among many other issues associated with ETFs, the pricing efficiency in terms of the magnitude and persistence of the departure of the ETFs’ market price from their net asset values (NAVs) has attracted much attention in the literature. This is because retail and institutional investors—other than authorized participants (APs)⁶—can only transact ETFs at the prevailing secondary-market price. DeFusco et al. (2011) and Petajisto (2017) showed that mismatches between the NAV and the secondary-market price represent an extra trading cost incurred directly by unsophisticated investors, in addition to explicit trading costs, including trading commission and the bid-ask spread. In fact, ETFs are, by design, more efficiently priced compared to close-ended funds, which usually trade at a notoriously large discount from their NAV⁷ (see, Lee et al., 1990). However, a number of studies have shown that international ETFs (listed on the U.S. stock exchange, but their constituent portfolio contains securities that trade in foreign exchanges around the world) exhibit large mispricing. Engle and Sarkar (2006), Hilliard (2014), and Petajisto (2017) attributed the mispricing in international ETFs to differences in time zones between the U.S. and the home country, in addition to regulatory and institutional settings that impede the functioning of the creation and redemption mechanism. However, only a few studies have examined the pricing efficiency of non-U.S. domestically listed and locally invested ETFs. Gallagher and Segara (2005) examined four ETFs listed on the Australian stock exchange and their results indicate that ETFs trade close to their NAVs, thereby resulting in a premium/discount that tends to disappear within one trading day. Lin et al. (2006) provided evidence on the Top 50 Tracker Fund (the first ETF in the Taiwanese stock market) to show that their resulting premiums/discounts are relatively small and statistically insignificant, averaging about 4 bps. However, the results reported by Charteris (2013), Shanmugham and Zabiulla (2012), and Jiang

et al. (2010) are in sharp contrast with these studies. These studies documented that the prices of the ETFs listed on the South African, Indian, and Chinese stock exchanges, respectively, display large and persistent deviations from their NAVs.

The objective of this paper is to compare the pricing efficiency of the two domestic ETFs (Falcom 30 and HSBC 20) listed on the Saudi stock exchange (Tadawul), as well as an international ETF (iShares MSCI Saudi Arabia) listed on the NYSE, by estimating the extent of the resulting premiums (discounts) from the fair market value (the net asset value).⁸ While a massive amount of empirical work (for example, (Ackert & Tian, 2000, 2008; Delcours & Zhong, 2007; Elton et al., 2002; Engle and Sarkar 2006; Petajisto, 2017)) has been carried out on the pricing efficiency of U.S.-domiciled ETFs and the magnitude and the dynamics of the deviations of their prices from their fundamental values, only a little work has been conducted on the pricing efficiency of the ETFs listed on the Saudi stock exchange.⁹

The availability of sufficient data on domestically listed ETFs and iShares MSCI Saudi Arabia ETF provides a unique opportunity to evaluate whether the domestic or the international ETFs are priced more efficiently. The findings of this study have important implications for ETF investors faced with two alternative choices to access to the Saudi market, by investing either in a domestically listed ETF or through an international ETF. To this end, tests were conducted to investigate the extent and the properties of the resulting deviation of the ETF prices from their fundamental NAVs, as well as whether these deviations vary over time. An attempt was also made to analyze the information transmission between the ETF prices and the NAVs, via their underlying shares, to determine the extent to which the ETF market prices reflect the fundamentals embedded in their respective NAVs.

The organization of this paper is as follows. Section 2 briefly presents a review of some of the selected studies, focusing on examining the U.S.-domiciled ETFs and those listed on other developed and emerging markets. Section 3 explains the details of the sample data, model specifications, and econometric methodology, whereas Section 4 discusses the empirical results. The concluding remarks and implications of the empirical results are presented and discussed in the final section.

2. Literature review

The literature on ETFs is vast. Andreu et al. (2013) divided the literature on ETFs into three main strands: the pricing efficiency (for example, (Ackert & Tian, 2000; Elton et al., 2002; Engle and Sarkar 2006; Petajisto, 2017)), the performance of ETFs measured in comparison to open-ended mutual index funds (for example, (Agapova 2011; Blitz et al., 2012; Elton et al., 2019; Kostovetsky 2003)) and close-ended funds (for example, (Harper et al., 2006; Hughen and Mathew 2009; Tsai & Swanson, 2009)), and the effect of the inception of ETFs on their underlying securities and their role in price discovery (for example, Dannhauser, 2017; Israeli et al., 2017; Madhavan & Sobczyk, 2016).

Most of the studies in three main strands investigated U.S.-domiciled ETFs designed to track domestic and international stock market indices. Studies conducted, inter alia, by Gallagher and Segara (2005), Lin et al. (2006), Charteris (2013), Shanmugham and Zabiulla (2012), and Jiang et al. (2010) examined ETFs listed outside the U.S. that invested domestically in the markets in which they are listed or internationally in other developed and emerging markets. Such distinction between U.S.-based ETFs, on one hand, and those listed on developed and emerging markets, on the other, shed light on the potential differences in pricing efficiency across markets. Thus, it may be important to present a review of some selected empirical studies, focusing on empirical evidence for ETFs domiciled in the U.S. and ETFs domiciled in other developed and emerging markets to evaluate the findings that emerge from these studies regarding the relative performance of these ETFs listed on domestic and international exchanges.

2.1. Evidence on ETFs listed on the U.S. stock exchange

Ackert and Tian (2000) and Elton et al. (2002) were the first to investigate the pricing efficiency of U.S.-domiciled ETFs—Standard & Poor's Depository Receipt (SPDR) and the MidCap SPDR—relative to their benchmark price indices, viz., the S&P 500 and S&P 400, respectively. Using daily data over the period of January 1993 to December 1997,¹⁰ Ackert and Tian (2000) computed the premiums/discounts for the SPDR and the MidCap SPDR with reference to their respective benchmarks and evaluated the pricing efficiency of these funds by testing the hypothesis that the premium/discount equals zero for both the raw and adjusted premium/discount series.¹¹ The results show that while the raw SPDR series exhibit a statistically significant discount of -21 bps and the adjusted series produce a statistically significant premium of 6.8 bps, the MidCap SPDR raw and adjusted series both exhibit statistically significant premiums of 103 bps and 131 bps, respectively. The results indicate a considerable level of mispricing in the MidCap SPDR, as the difference between the SPDR's and MidCap SPDR's average premium/discount is statistically significant. The analysis based on absolute values produced qualitatively similar results. The results also show that the volatility of the SPDR is lower than its underlying index, whereas the volatility of the MidCap SPDR is slightly higher than its benchmark. Ackert and Tian (2000) concluded that although the premiums/discounts for the SPDR and the MidCap SPDR are significant, both funds are largely efficiently priced because the unexploited profit from them is likely to be transaction costs. These results are at odds with the findings on close-ended funds, where high discounts and excessive volatility are widely documented. Elton et al. (2002) examined the pricing efficiency and the performance of the SPDR relative to its benchmark and the rivaling investment vehicles, viz., index fund and index futures using daily data over the period of February 1993 to December 1998. The results reveal that the SPDR persistently underperforms its benchmark by an average of 28.4 bps, which is accounted for by the fund's dividends policy¹² and expenses. However, when compared to its rivals (i.e., the Vanguard index fund and index futures), the SPDR's return falls short of its rivals by 18.1 and 30.7 bps, respectively. The authors attribute the difference in the case of Vanguard index fund to the value of immediacy offered by the SPDR, whereas in the case of futures index to the large investment and expertise required to maintain a position in futures, along with restrictions on holding futures for some institutional investors. Testing the pricing efficiency of the SPDR by analyzing the size and the time path dynamics of the premiums/discounts measured with reference to the NAV, Elton et al. (2002) produced results that indicate that the premiums/discounts are small in general, averaging 1.8 bps, with discounts being more pronounced than premiums. The persistence of these deviations was examined by fitting an autoregressive model with one lag, leading to results that show that the deviations from the NAV are short-lived with a low and statistically insignificant first-order autocorrelation of 0.0620. The SPDR's trading volume is driven by broad stock market volatility and absolute deviations from the NAV, which is taken as evidence for the increased use of ETFs by both hedgers and arbitrageurs.

Engle and Sarkar (2006) investigated the pricing efficiency of a wide range of domestic and international U.S.-domiciled equity ETFs, including 21 domestic ETFs tracking broad market and sectoral indices and 16 international ETFs replicating the performance of 16 developed stock markets. Using an unbalanced sample of both daily and intradaily data, starting from the inception of the ETF and ending in September 2000, they tested for cointegration between the ETF prices and their NAVs, as well as estimated the resulting premiums/discounts to explore their magnitude and time path dynamics. The results show that domestic ETFs are fairly priced, with an extremely small and transitory departure from the NAVs, which is eliminated in a matter of minutes. The average premiums/discounts of 1.1 bps ranges between -0.1 bps (for the Russell 2000) and 4.6 bps (for DJIA), with a first-order autocorrelation of 0.10 on average. On the other hand, large and persistent premiums are observed for international ETFs lasting for several days.¹³ The average premiums/discounts of 34.8 bps range between -6 bps (for the Netherlands) and 218 bps (for Mexico), with a first-order autocorrelation of 0.30 on average, reaching as high as 0.6 in the case of Mexico. The standard deviation of the premiums/discounts generally falls below the bid-ask spread for both

domestic and international funds. The authors noted that while the premiums/discounts are substantial for some international ETFs, they remain well below those of international close-ended funds.

Subsequent studies conducted, *inter alia*, by Delcours and Zhong (2007), Tse and Martinez (2007), and Ackert and Tian (2008) examined the time-series behavior of a wide range of international equity ETFs' premiums/discounts and their determinants. Delcours and Zhong (2007) investigated 20 iShares using an unbalanced sample spanning the period of March 1996 to October 2002. They applied the approaches proposed by Goetzmann et al. (2001) and Engle and Sarkar (2006) to correct for measurement errors.¹⁴ They examined the long-run relationship between the ETF prices and their NAVs and the short-run dynamics of the resulting premiums/discounts. Using the Johansen (1988) cointegration test, Delcours and Zhong's (2007) results indicate that the ETF prices and their NAVs are cointegrated, with a cointegrating slope coefficient close to unity in all cases. They also investigated the transitory nature of the premiums/discounts by using the persistence profile analysis of Pesaran and Shin (1996), and showed that 90% of the premiums/discounts are eliminated within two days as prices and the NAVs revert to equilibrium—except for iShares Australia and Malaysia, for which these premiums and discounts are eliminated in 4 and 21 days, respectively. Delcours and Zhong (2007) reported the absolute values of the premiums/discounts, which are in contrast with those reported by Engle and Sarkar (2006) in terms of their magnitude. However, as for the persistence of these premiums/discounts, as expressed by first-order autocorrelation, it is very much similar. The average absolute value of the premiums/discounts is 100 bps, ranging from 53 bps (for France) to 377 bps (for Malaysia). The first-order autocorrelation is 0.28, on average, with a range between 0.10 (for Switzerland) and 0.88 (for Malaysia). Furthermore, the authors identified several factors, such as institutional ownership, the bid-ask spread, trading volume, conditional correlation between the U.S. and iShares, political and financial crises, and exchange rate volatility that may influence the absolute value of the premiums/discounts. The panel regression results suggest that while most of the factors have a significant impact on the magnitude of the premiums/discounts, a large portion of it remains unaccounted for. The authors conjectured that behavioral factors may explain the remaining mispricing. Tse and Martinez (2007) investigated the price discovery process and information transmission for 24 iShares over the period of January 2002 to December 2004 by regressing the ETF return on the NAV return, as well as a lagged value of the premiums/discounts to account for the speed of adjustment of the ETF prices to their NAVs. The results indicate that the ETF prices reflect all of the NAV information, as the coefficient on the NAV return is not significantly different from unity, except for in Australia, Taiwan, Germany, Italy, Austria, and Canada. The coefficient on the NAV return ranges from 0.82 (for Canada) to 1.08 (for Taiwan) and the speed of adjustment is quite high, as the coefficient on the lagged premiums/discounts is significantly negative in all cases, ranging between -0.14 (for Malaysia) and -0.85 (for Spain). These results are interpreted as being supportive of the hypothesis that the ETF prices are efficient, and they reflect the value of their underlying portfolio. The results from the price discovery analysis indicate that the ETF's price contributes to a higher share of price discovery compared to the NAV recorded in the local market, which is in line with market efficiency. Similarly, Ackert and Tian (2008) examined the pricing efficiency of 28 U.S.-listed ETFs (21 of which are international tracking MSCI single country indices and seven are domestic tracking broad U.S. market indices) using an unbalanced sample of daily data over the period of June 2002 to January 2005.¹⁵ Ackert and Tian (2008) analyzed the impact of momentum in the funds' NAVs, Amihud's square root illiquidity measure, the trading volume, and the ETF's market capitalization on the size of the premiums/discounts. Employing the raw premiums/discounts without any adjustment for a measurement error, their results show that the value of the premiums/discounts, on average, is negative but insignificant in nine cases, except for Mexico and Brazil. Overall, the average value of the premiums/discounts is positive, with 1.5 bps for the U.S. ETFs, 9.1 bps for the international ETFs, and 16.9 bps and 1.3 bps for the developed and emerging market economies, respectively. The values of the premiums/discounts, particularly of the international ETFs, are lower than those reported by Engle and Sarkar (2006).

However, the persistence of these premiums/discounts varies across markets, as the first-order autocorrelation for the U.S. ETFs (0.034, on average) is substantially lower than that for the international ETFs (i.e., 0.20 for developed markets and 0.40 for emerging market countries). The results that emerge from the regression analysis highlight the importance of liquidity and the size of the fund in enhancing pricing efficiency and the detrimental effect of momentum in the NAV.

Recent studies carried out by Hilliard (2014) and Petajisto (2017) extend the analysis to include a wide array of ETFs investing in other asset classes, in addition to equities, such as commodities, taxable bonds, municipal bonds, and currencies. Using a sample of 801 ETFs, spanning the period of April 2010 to April 2011, Hilliard (2014) found that the average premium/discount of international equity ETFs is the largest, reaching 18.18 bps and ranging from −1225 to 2790 bps, while their domestic U.S. counterpart's average is 2.87 bps, albeit ranging from as low as −4950 bps up to 2190 bps. The average first-order autocorrelation is 0.20 for international equity ETFs, which was found to be significant in 68% of the international equity ETFs compared to 0.139 for their domestic U.S. counterparts, which was significant 53.60% of the time. Using the mean-reverting Ornstein-Uhlenbeck process augmented with jumps to model the time path of the premiums/discounts, Hilliard (2014) found that while domestic U.S. ETFs are priced efficiently, higher long-term mean premiums and lower speeds of adjustment are detected for international and bond ETFs. Augmenting the mean-reverting process with jumps improves the model fit, revealing that the probability of the jumps is the highest for international equity ETFs. The author attributed the inefficiencies in the pricing of international equity and bond ETFs to arbitrage impediments.

Petajisto (2017) investigated the most representative sample of 586 U.S.-listed ETFs, covering 87% of the ETF assets over the period of January 2007 to December 2014. Using a novel approach to correct for the measurement errors based on the relative premium of an ETF (defined as the deviation of the ETF's price from the mean price of other ETFs replicating the same or a similar index),¹⁶ Petajisto's (2017) results suggest that while ETFs are efficiently priced, on average, with an overall average premium of 6 bps, the premium fluctuates within a wide range of nearly 100 bps. The results show that the deviations are considerably higher and more volatile in international equities, bonds, and illiquid U.S.-traded securities such as municipal bonds and Junk bonds, reaching a range of 600 bps. Petajisto (2017) also investigated the profitability of a trading rule based on cross-sectional mispricing, involving a long position in undervalued ETFs (i.e., selling at a discount relative to their peers) and a short position in overvalued ETFs (i.e., selling at a premium relative to their peers), and the results confirm the profitability of the trading rules, as the premiums/discounts turned out to be economically significant. Almudhaf (2019) looked into the pricing efficiency of the four international ETFs invested in four GCC markets, namely, iShares MSCI Saudi Arabia, Lyxor FTSE COAST ETF Kuwait, iShares MSCI Qatar, and iShares MSCI UAE, using an unbalanced sample spanning the period of June 2008 to April 2017. The results indicate large average premiums/discounts, ranging from −34 bps (for UAE iShares) to 178.6 bps (for Saudi iShares). The band over which the premiums/discounts fluctuate reaches as wide as −419.6 bps to 726.5 bps for Qatar iShares. Further, the premiums/discounts seem to be persistent in all markets, indicating that the divergence between the ETF price and its NAV can last for more than two days for UAE, four days for Kuwait, and one day for Saudi and Qatar. In line with this, it is shown that the lagged premium/discount can be used to predict the ETFs returns of the next day. Estimating an "in-levels" regression of the ETF price on the NAV, Almudhaf's (2019) results indicate that the coefficient of the NAV is very close to one, and the intercept is statistically significant in all cases, except for Saudi iShares. When regressing the ETF return on the NAV return and the lagged premium/discount, the results show that the ETF return exhibits a one-to-one correspondence with the NAV return only for Saudi iShares. Meanwhile, the coefficient of the NAV return is insignificantly different from unity for Saudi Arabia—it is 0.87 for Qatar and 0.96 for Kuwait. On the other hand, the coefficients on the lagged premium/discount are significantly negative, ranging between −0.49

(for Saudi Arabia) and -0.59 (for Kuwait), showing that the speed of adjustment of the ETF's price to its NAV is relatively high.

Overall, the evidence on ETFs Listed on the U.S. Stock Exchange show that while domestic U.S. ETFs are efficiently priced, their international counterparts (both that invest in developed and emerging markets) display a large and persistent departure from their fundamental value, particularly in the short run. Mispricing in international ETFs arises due to the difference in time zones between the U.S. and a home country, in addition to regulatory and institutional settings that impede the functioning of the creation and redemption mechanism.

2.2. Evidence on ETFs listed on non-U.S. stock exchanges in developed and emerging markets

Gallagher and Segara (2005) compared the performance and pricing efficiency of four equity ETFs (i.e., STW, SFY, IDX and CDF) listed on the Australian stock exchange and three passive index funds (i.e., AMP, SSgA, and MLC) over the period of January 2002 to December 2003. They found that ETFs track their benchmark indices more closely compared to index funds. Furthermore, the ETFs appear to trade closely to their NAVs, with an average premium ranging from -3.59 bps for SFY to 6.35 bps for CDF. The band over which the premiums/discounts fluctuate seems to be relatively narrow, falling between -61.1 and 90.29 bps for STW, whereas it is as wide as -373.8 to 336.1 bps for CDF. In all cases, however, the premiums/discounts disappear within one trading day (the autoregression of the premiums/discounts indicates that the AR(1) term is less than 0.1 and statistically insignificant).

Lin et al. (2006) tested the pricing efficiency of the Taiwan Top 50 Tracker Fund (TTT), the first ETF in the Taiwanese stock market, over the period of November 2002 to June 2004. Testing the relationship between the NAV of TTT and its market price, they found the estimate of the slope coefficient to be close to one (0.9982) and an R^2 of 0.99 . These results are interpreted as indicating that the price of the TTT and its NAV move together in a one-to-one correspondence in the long run, albeit no formal cointegration tests were used. Lin et al.'s (2006) results show that the average premium/discount is 4 bps, which is not only small, but also statistically insignificant. They documented that while the estimates of the premiums/discounts range from -132 to 248 bps, these deviations are insignificant when transaction costs are taken into consideration. Similar results were obtained by Kayali (2007) and Jiang et al. (2010), who examined the pricing efficiency of the ETFs listed on the Istanbul and Chinese stock exchanges, respectively. Kayali (2007) investigated the pricing efficiency of the first ETF listed on the Istanbul stock exchange (i.e., the Dow Jones Istanbul 20), tracking the Dow Jones Turkey Titans 20 Index over the period of January 2005 to December 2005. Using regression analysis, Kayali's (2007) results show that the OLS estimate of the coefficient of the NAV is equal to 0.996 and the R^2 is 1.00 . He also found that the average premium/discount is -80 bps, falling between -836 and 742 bps, and is statistically significant. The autoregression of the premiums/discounts indicates that the AR(1) term is 0.168 and is statistically significant, meaning that the deviations of the NAV of the Istanbul index from its market price last for one trading day before being eliminated in the subsequent trading day.

Jiang et al. (2010) examined the pricing efficiency of the first ETF in China, the Shanghai 50 ETF (SSE 50 ETF), using data covering the period of February 2005 to September 2008. Using Engle and Granger's (1987) cointegration test, they found supportive evidence of the long-run relationship between the NAV of the SSE 50 and its market price, with the slope coefficient estimate of 0.998 . They also estimated an error correction model (ECM) by augmenting it with a GARCH(1,1) error process, and the results show that the deviations from the long-run equilibrium are corrected rather quickly—the estimated value of the error correction term is -0.33 . The Granger causality test was performed, indicating the presence of a unidirectional causality running from the market price to the NAV. These results are interpreted as indicating that changes in the market price exert a significant spillover effect on the NAV of the SSE 50, implying the importance of ETFs in price discovery. The results also show that

the premium/discount fluctuates within a range of -207 bps to 270 bps, averaging 2 bps (statistically insignificant). The use of the AR(3)–GARCH(1,1) specification to model the premiums/discounts shows that mismatches between the NAV of the SSE 50 ETF from its market price persist for as long as three trading days. Jiang et al. (2010) emphasized that the deviations of the ETFs' prices from their NAVs are exacerbated during the outbreak of the GFC toward the end of the sample period under investigation.

Shanmugham and Zabiulla (2012) examined the performance and pricing efficiency of the Nifty BeES listed on the Indian market across different market regimes using data over the period of January 2003 to December 2008. Their results indicate that the BeES outperforms the market, generating a significantly positive estimate of the Alpha during bullish market periods and over the entire sample, but it underperforms compared to the market during downturns. The departure of BeES's price from its NAV is substantial across different market regimes, with an overall average discount of around -17.4 bps, ranging from as low as -633 bps to as high as 837 bps. The autoregression results indicate that the premium/discount persists for two days, as the estimates of the AR(1) and AR(2) terms are significant, reaching 0.15 and 0.10 , respectively.

Charteris (2013) examined the pricing efficiency of seven ETFs listed on the Johannesburg stock exchange, four of which track domestic South African broad market and sectorial indices (i.e., SATRIX 40, SATRIX FINI, SATRIX INDI, and SATRIX RESI), while the remaining three track international indices in Japan and the U.K., in addition to a world market index (i.e., DBX Japan, DBX UK, and DBX WORLD). Using data over the period of June 2008 to December 2012, Charteris's (2013) results indicate that the average premium/discount ranges from -9.4 bps for SATRIX INDI to 107.4 bps for DBX UK, and is statistically significant in all cases, except for SATRIX INDI. Furthermore, the band within which the premium/discount fluctuates is quite wide, falling between -350.1 and 251.3 bps for SATRIX 40, and -687.2 bps to 2752 bps for DBX UK. These deviations are relatively smaller for the domestic ETFs, which tend to be eliminated within one trading day, whereas those for the international ETFs tend to last for one trading day. These deviations are shown to have predictive power over the next day's return, and a profitable trading strategy can be evolved based on the information that underlies these deviations, even after transaction costs are accounted for. These findings are viewed to be at odds with the efficient market hypothesis in its weak form. Similar results were reported by Badenhorst (2017), who investigated the determinants of the premiums/discounts for the South African ETFs invested domestically over the period of January 2010 to December 2014. He found that the cross-sectional average of the absolute value of the premiums/discounts is 61 bps, involving a wide range from 0.2 to 604.4 bps, evidence that is consistent with that reported by Charteris (2013).

In a recent study, Almudhaf and Alhashel (2020) examined the pricing efficiency of the domestic ETFs listed on the Saudi stock exchange (namely, Falcom 30, Falcom Petrochemical, and HSBC 20). Their sample spanned the period of January 2012 to May 2017. The average premiums/discounts that they documented are 6.4 bps (ranging from 946 to -592 bps), 19.4 bps (ranging from 1640 to -832 bps), and 81 bps (ranging from 2564 to -973 bps) for Falcom 30, Falcom Petrochemical, and HSBC 20, respectively. The autoregression results indicate that the premium/discount persists for at least two days, as the estimates of AR(1) are 0.403 , 0.361 , and 0.475 and of AR(2) are -0.769 , -0.550 , and -0.572 for Falcom 30, Falcom Petrochemical, and HSBC 20, respectively. When regressing the ETF return on the NAV return and the lagged premium/discount, the results show that the ETF return does not fully reflect its underlying NAV, with coefficients on the NAV return estimates of 0.585 , 0.367 , and 0.213 , while the coefficients on the lagged premium/discount are significantly negative, amounting to -0.588 , -0.350 , and -0.049 for Falcom 30, Falcom Petrochemical, and HSBC 20, respectively.

3. Data, model, and methodology

The dataset contains daily observations on the NAVs and the closing market prices for the three Saudi ETFs, namely, Falcom 30, HSBC 20, and iShares MSCI Saudi Arabia, over the period of

16 September 2015 to 9 April 2019.¹⁷ The data for Falcom 30 and HSBC 20 were obtained from Tadawul and for iShares MSCI Saudi Arabia from the Bloomberg terminal. Some key features of the funds are summarized in Table 1.

Table 1 reveals that Falcom 30 and HSBC Saudi 20 are incredibly small compared to iShares MSCI Saudi Arabia; the latter is 88 times the size of both the domestic funds in terms of net assets. However, the expense ratios are quite similar in the case of the three funds.

The pricing efficiency of the Saudi domestic and international ETFs can be evaluated by examining how close their market prices are to their NAVs. This is done by computing the premium/discount that represents the deviation of the secondary market closing price from the NAV of these funds, which is given by¹⁸:

$$PR_t = \ln \left(\frac{ETF_t}{NAV_t} \right) \quad (1)$$

where PR_t is the premium/discount on day t while ETF_t and NAV_t refer to the secondary market closing price and the net asset value recorded at the end of trading on day t , respectively. The pricing efficiency of an ETF requires the closing market price to be equal, on average, to its NAV over time.¹⁹ However, if the closing market price of the fund deviates from its NAV, it is important to investigate the extent and persistence of the deviations of the closing market price of the fund from its NAV over time. To this end, the behavior of the premium/discount can be analyzed by fitting an autoregressive model of degree five to examine whether the current premium/discount is determined by its past values,²⁰ which is given by using the following regression to examine autocorrelations of up to five lags²¹:

$$PR_t = \beta_0 + \beta_1 PR_{t-1} + \beta_2 PR_{t-2} + \beta_3 PR_{t-3} + \beta_4 PR_{t-4} + \beta_5 PR_{t-5} + \epsilon_t \quad (2)$$

Engle and Sarkar (2006) argued that the traditional measure of the premium/discount (i.e., the standard deviation) is susceptible to measurement errors that stem from two microstructural sources: (1) stale pricing in the underlying securities that misrepresents the ETF's NAV, and/or (2) inaccuracy in the closing quotes of the ETF because of infrequent trading. This phenomenon is prevalent in economic and financial data and is commonly referred to as the errors-in-variables problem. To deal with the so-called "errors-in

Table 1. Some key features

Fund Name	Underlying Index	Inception Date	Net Assets (\$) [†]	Expense Ratio (%)
Falcom 30	Falcom 30 Saudi Equity index	28 March 2010	7,308,518	1 [‡]
HSBC Saudi 20	HSBC Saudi 20 Equity Index	22 November 2011	2,605,212	0.75
iShares MSCI Saudi Arabia	MSCI Saudi Arabia IMI 25/50	16 September 2015	850,530,491	0.74

Sources: The information for Falcom 30 Saudi Equity index and iShares MSCI Saudi Arabia is obtained from the respective Fact sheet of each ETF as of 30 June 2019. HSBC Saudi 20's information was obtained from the Interim report for the six-month period ended 30 June 2019. [†] The currency of Falcom 30 and HSBC Saudi 20 is the Saudi Riyal, and it is converted at the prevailing exchange to . USD [‡] Based on the prospectus information for Falcom 30, the sum of all expenses is 0.88%, and it is stated that the maximum expense ratio to be charged is 1%.

-variables" problem, Engle and Sarkar (2006) modeled the measurement errors by exploiting the cointegration between the ETF's market price and the NAV. Engle and Sarkar (2006) estimate the premium/discount by extracting the residuals from the so-called *dyna* model, which is given by:

$$PR_t = \alpha \Delta \ln NAV_t + \beta x_t + u_t, \quad (3)$$

where x_t is a set of stationary exogenous variables that explain the true premium and α and β are the regression coefficients.²² The *dyna* model residuals can then be tested for the presence of autocorrelation and heteroskedasticity. If the residuals are autocorrelated, an ARMA(p, q) specification can be used to model the premium/discount, as well as the dynamics of the residuals. If the residuals are heteroskedastic, a GARCH(p, q) specification can be used to control for the ARCH effects in the residuals. The *dyna* regression model can, therefore, be specified as follows:

$$PR_t = \alpha_0 + \alpha_1 \Delta \ln NAV_t + \sum_{j=1}^p \rho_j PR_{t-j} + \sum_{i=1}^q m_i u_{t-i} + u_t, \quad (4)$$

where ρ_j refers to the coefficients of the autoregressive terms, m_i refers to the coefficients of the moving average terms, and u_t is the error term that follows a conditional normal process with a zero mean and a time varying variance, i.e., $u_t \sim N(0, \sigma_t^2)$. The dynamics in the variance can then be modeled as a GARCH(p, q) process as follows:

$$\sigma_t^2 = \omega + \sum_{i=1}^p \lambda_i u_{t-i}^2 + \sum_{j=1}^q \phi_j \sigma_{t-j}^2, \quad (5)$$

where ω is the mean-reverting constant and λ_i and ϕ_j are, respectively, the ARCH and GARCH coefficients, with $\omega > 0$, $\lambda_i > 0$, $\phi_j \geq 0$ and $\sum_{i=1}^p \lambda_i + \sum_{j=1}^q \phi_j < 1$.

Fama (1970) posited that if financial markets are semi-strong form efficient, then asset prices should fully reflect all information that is publicly available, and should change instantaneously to incorporate any new information that randomly arrives in the market. Consequently, neither the past nor the current information are useful to predict any change in future asset prices. There is ample evidence to suggest that changes in asset prices generally follow a random walk. Thus, if the ETFs' market prices and their NAVs follow a random walk with a drift, they can be represented, respectively, by Equations (6) and (7), as follows:

$$\ln(ETF_t) = \mu_1 + \ln(ETF_{t-1}) + v_{1,t}, \quad (6)$$

$$\ln(NAV_t) = \mu_2 + \ln(NAV_{t-1}) + v_{2,t} \quad (7)$$

where μ_1 and μ_2 are constants representing the drifts in the processes,²³ and $v_{1,t}$ and $v_{2,t}$ are white noise series. The creation and redemption mechanism via in-kind transactions ensures that the NAV and the market price of an ETF move in tandem. Thus, despite being individually unpredictable, the market price and the NAV are likely to be driven by some common (stochastic) trend due to arbitrage activities initiated via the creation and redemption mechanism, and as the underlying two series are unlikely to permanently drift too far apart from one another. Engle and Granger (1987) argued that if the two series are integrated into the same order of one, i.e., I(1), and their linear combination is generally integrated into the same order of one, then they are unlikely to

move together to form a long-run relationship. However, the two series may form a long-run relationship in a special case when their linear combination is stationary. Thus, the long-run relationship between the ETFs' market price and their NAVs can be represented by:

$$\ln(ETF_t) = \delta_0 + \delta_1 \ln(NAV_t) + \varepsilon_t \quad (8)$$

where, δ_0 is the intercept,²⁴ δ_1 is the normalized cointegration coefficient (i.e., long-run coefficient), and ε_t is the disequilibrium error that must be stationary if the ETF market prices and their NAVs were to form a relationship in the long run, that is $\varepsilon_t = \ln(ETF_t) - \delta_0 - \delta_1 \ln(NAV_t) \sim I(0)$. In this case, the long-run equilibrium relationship can be represented by the static regression between the levels of the two series. If the "no arbitrage" condition holds precisely in the long run through the creation and redemption mechanism, not only are the NAV and the secondary-market price cointegrated, but also the market price moves in a one-to-one correspondence to the NAV, such that $\delta_1 = 1$.²⁵ However, it must be noted that the "no arbitrage condition" is unlikely to hold in the short run since departures may occur in the short run from the equilibrium relationship between ETF prices and their NAVs.

If the two series are cointegrated, the short-run dynamics can be captured by fitting an error correction model (ECM), embedding the long-run equilibrium relationship to show the extent and the speed of adjustment toward the long-run relationship. The ECM is given by:

$$\Delta \ln(ETF_t) = \varphi + \sum_{i=1}^p \gamma_i \Delta \ln(ETF_{t-i}) + \sum_{i=0}^q \theta_i \Delta \ln(NAV_{t-i}) + \psi \widehat{\varepsilon_{t-1}} + \xi_t. \quad (9)$$

In Equation (9), the coefficient θ_0 of the contemporaneous term $\Delta \ln(NAV_{t-i})$ is of much importance, as it measures the extent to which the changes in the NAV are reflected in the secondary market price. Accordingly, one can test the hypothesis that the market price of the fund moves in a one-to-one correspondence to the NAV, that is, $H_0 : \theta_0 = 1$. The estimate of the coefficient ψ represents the error correction parameter, which captures the adjustment in the secondary market price to restore equilibrium between the price and the NAV.

4. Empirical results

The pricing efficiency of the three Saudi ETFs is compared by examining their premiums/discounts (the extent of the deviations of their market prices from NAVs) based on equation (1). The *t*-test and the Wilcoxon signed rank test²⁶ are employed to test the null hypothesis whether the premiums/discounts of the three Saudi ETFs equal zero, implying pricing efficiency and results are reported in (Table 2).²⁷ As is evident from the descriptive statistics in Panel A and frequency distribution in Panel B of the premiums/discounts of the three Saudi ETFs, the Falcom 30 and iShares MSCI Saudi Arabia appear to be trading at a premium (i.e., the secondary market price is greater than the NAV) by 101 bps and 16 bps, respectively, whereas the premium/discount from HSBC 20 seems to be close to zero, on average. The mean of the premiums/discounts from iShares MSCI Saudi Arabia is relatively high when compared with those reported in the literature for iShares tracking both developed and emerging markets, which rarely reaches the three digits territory.

It is also noteworthy that while the premiums/discounts on the domestic ETFs are quite wider ranging between 719 and -1260 bps for Falcom 30 and 2283 and -1592 bps for HSBC 20, those for the international ETF (iShares MSCI Saudi Arabia) are much smaller ranging between 684 and -382 bps. The standard deviation that measures the size of the pricing error ranges from 133 bps for iShares MSCI Saudi Arabia to 617 bps for HSBC 20, and is much higher than that reported by Engle and Sarkar (2006, p. 42).²⁸

Table 2. Descriptive statistics and frequency distribution of the premium/discount

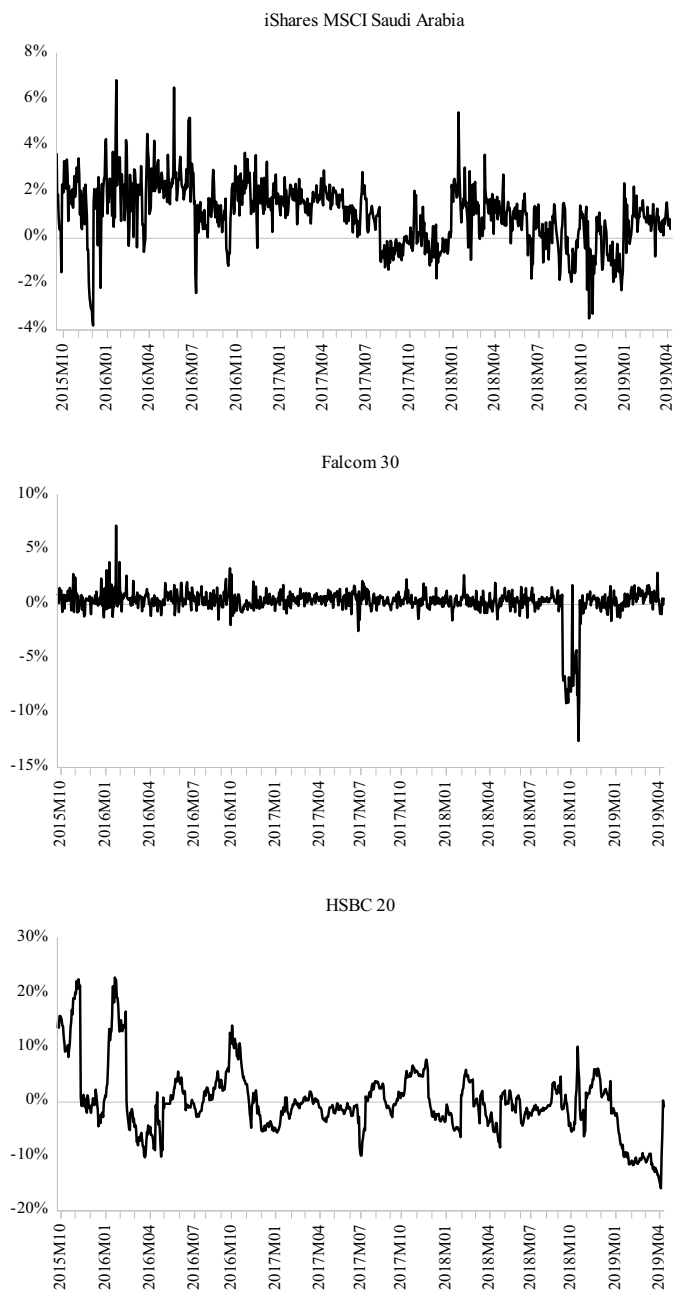
ETF	iShares MSCI Saudi Arabia	Falcom 30	HSBC 20			
Panel A: Descriptive statistics						
Mean (%)	1.01	0.16	−0.01			
Median (%)	1.12	0.32	−0.64			
Maximum (%)	6.84	7.19	22.83			
Minimum (%)	−3.82	−12.60	−15.92			
Std. Dev. (%)	1.33	1.48	6.17			
Skewness	−0.10	−3.84	0.91			
Kurtosis	4.06	25.23	5.13			
N	896	890	890			
t-Stat	22.64 ***	3.20 ***	−0.04			
Wilcoxon signed rank	18.78 ***	12.18 ***	2.71 ***			
Panel B: Frequency distribution						
Class (%)	# of days	%	# of days	%	# of days	%
−17.5 to −15					2	0.22
−15 to −12.5			1	0.11	7	0.79
−12.5 to −10			0	0.00	40	4.49
−10 to −7.5			11	1.24	31	3.48
−7.5 to −5			10	1.12	63	7.08
−5 to −2.5	8	0.89	2	0.22	113	12.70
−2.5 to 0	184	20.54	238	26.74	253	28.43
0 to 2.5	609	67.97	618	69.44	169	18.99
2.5 to 5	89	9.93	9	1.01	91	10.22
5 to 7.5	6	0.67	1	0.11	41	4.61
7.5 to 10					15	1.69
10 to 12.5					15	1.69
12.5 to 15					22	2.47
15 to 17.5					8	0.90
17.5 or more					20	2.25

Note: *** denotes significance at the 1% level.

Based on both the tests (the *t*-test and the Wilcoxon signed rank test), the null hypothesis that the premium/discount is zero is rejected significantly at the 1% level in all cases, except for HSBC 20 when the *t*-statistic is used.²⁹

Panel B of Table 2 also provides some insight into the distributional properties of the premiums/discounts. The premiums/discounts from iShares MSCI Saudi and, to a lesser extent, from Falcom 30 are tightly distributed around their respective means, lingering between 0 and 250 bps nearly 70% of the time of the sample period. However, the premiums are sparsely scattered around the mean in the case of HSBC 20. Figure 1 provides a visual insight into the time-series behavior of premium/discount over the sample period.

Figure 1. The premium/discount.



Because the deviations of the ETFs' market prices from their respective NAVs are large and statistically significant, a careful examination of the persistence of these deviations is warranted. For this purpose, Equation (2) was estimated and the results obtained are presented in Table 3. As shown in Table 3, the deviations of the ETFs' prices from their NAVs persist for three days for all the

Table 3. Estimates of the autoregressive model

ETF	iShares MSCI Saudi Arabia	Falcom 30	HSBC 20
θ_0	0.16 *** (4.07)	0.02 (0.64)	-0.02 (-0.38)
θ_1	0.58 *** (17.19)	0.37 *** (11.12)	0.99 *** (29.21)
θ_2	0.08 ** (2.11)	0.24 *** (6.68)	0.08 (1.58)
θ_3	0.08 * (1.95)	0.11 *** (3.02)	-0.12 *** (-2.60)
θ_4	0.05 (1.41)	0.02 (0.67)	-0.01 (-0.11)
θ_5	0.05 (1.60)	0.11 *** (3.21)	0.03 (0.74)
Diagnostics			
R^2	0.58	0.55	0.93
DW	2.00	2.00	2.00

Note: t-statistics in (). *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

ETFs with a notably high first order autocorrelation coefficient of 0.99 for the HSBC 20 which is indicative of non-synchronous trading.³⁰ R^2 is remarkably high, ranging from 0.55 for Falcom 30 to 0.93 for HSBC 20. These findings are at odds with those of Elton et al. (2002) and Gallagher and Segara (2005), who were not able to find evidence supporting the persistence of the deviations of the ETFs' prices from their NAVs in the US and Australian markets, respectively. These findings are, however, consistent with those of Jiang et al. (2010), Shanmugham and Zabiulla (2012), and Almudhaf (2019), who documented the presence of a strong and persistent autocorrelation in the premiums/discounts, lasting for up to four days for Lyxor FTSE COAST ETF Kuwait (Almudhaf 2019, p. 133), three days for Shanghai 50 ETF (Jiang et al., 2010, p. 46), and two days for Nifty BeES (Shanmugham & Zabiulla, 2012, p. 118).

The results based on the *dyna* model, as represented by Equation (3), together with those from an AR(1) error specification, are reported in Panel A of Table 4. The coefficients of the changes in the NAV are significantly negative in all cases, implying that the NAV is measured with a large error. These findings are consistent with those of Engle and Sarkar (2006, p. 42), who reported that the estimated coefficients of the changes in the NAV are significantly negative for all iShares, with only a few exceptions. Furthermore, the estimated autocorrelation coefficients are very large and statistically significant in all cases. The autocorrelation coefficients are 0.76 and 0.78 for iShares MSCI Saudi Arabia and Falcom 30, respectively, and 0.97 for HSBC 20. These autocorrelation coefficients are markedly higher than those reported by Engle and Sarkar (2006, p. 42).

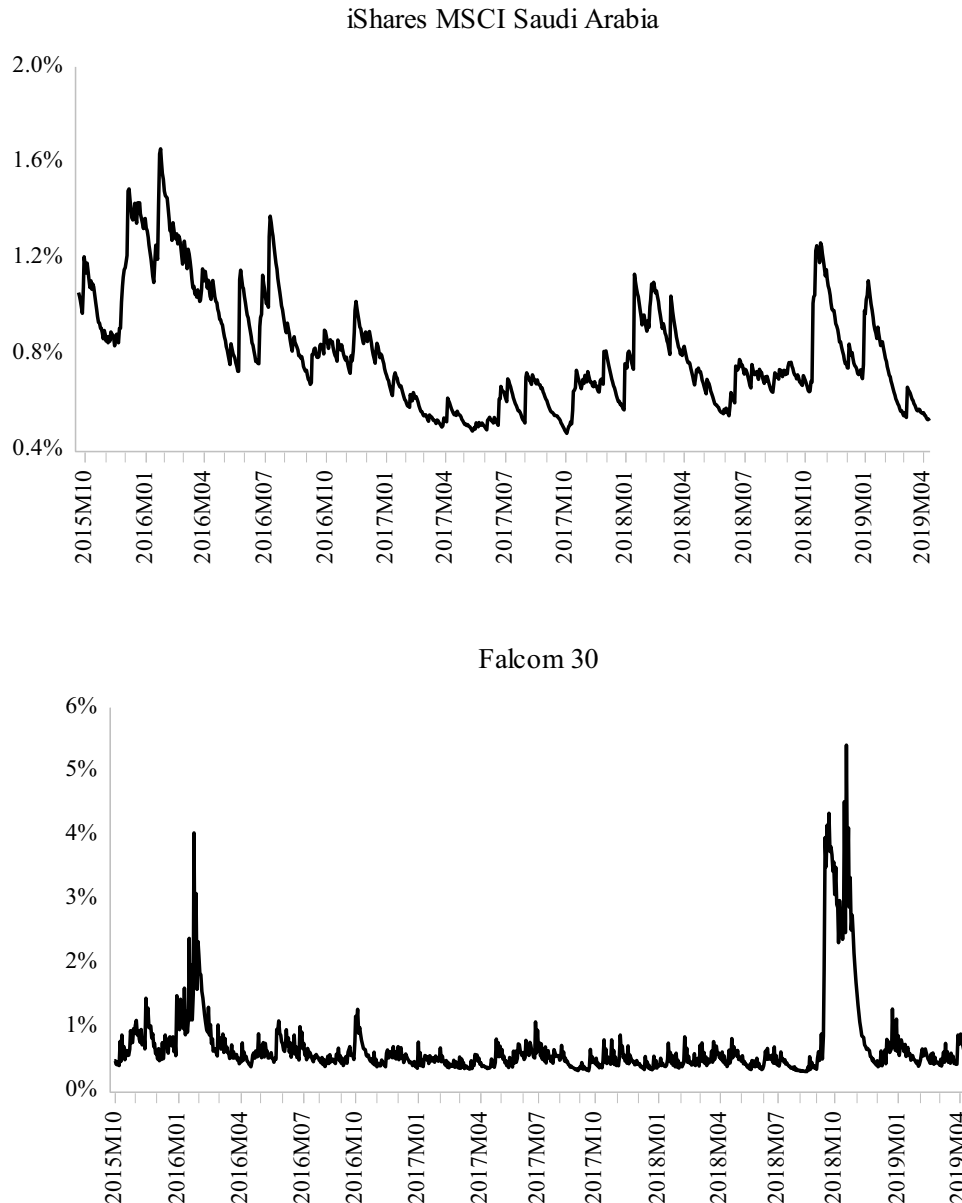
The results based on the diagnostic tests are also reported in Panel A of Table 4. Clearly, the AR(1) specification does not adequately capture the underlying dynamics in the errors, as the Ljung-Box Q-test indicates that the first five and ten days' residual autocorrelations are jointly significantly different from zero at the 1% significance level in all cases. The LM-ARCH test also rejects, at the 1% significance level, the null hypothesis, i.e., that the errors are homoscedastic, for iShares MSCI Saudi Arabia and Falcom 30 up to lag 5 and 10 days, whereas there is no sufficient evidence to reject the

Table 4. The estimates of the *dyna* model

ETF	iShares MSCI Saudi Arabia		Falcom 30		HSBC 20	
Panel A: AR(1) error specification						
α_0	1.01 ***	(8.37)	0.17	(1.30)	−0.53	(−0.35)
α_1	−0.15 ***	(−6.14)	−0.44 ***	(−22.11)	−0.51***	(−14.96)
AR(1)	0.76 ***	(34.54)	0.78 ***	(36.72)	0.97 ***	(119.99)
Diagnostics						
R^2	0.57		0.65		0.94	
Q(5)	21.73	[0.00]	73.42	[0.00]	32.58	[0.00]
Q(10)	33.89	[0.00]	107.04	[0.00]	35.29	[0.00]
ARCH(5)	11.87	[0.00]	31.88	[0.00]	0.22	[0.95]
ARCH(10)	6.69	[0.00]	16.50	[0.00]	0.18	[0.99]
Std. Dev. (true premium)	1.33		1.39		6.06	
S.E. of regression	0.87		0.88		1.46	
Panel B: ARMA–GARCH estimates						
α_0	0.65	(1.63)	0.33 ***	(7.68)	−0.37	−(0.29)
α_1	−0.10 ***	(−6.18)	−0.49 ***	(−41.52)	−0.52***	−(16.46)
ρ_1	1.46 ***	(30.95)	0.07	(0.96)	0.95 ***	(88.71)
ρ_2	−0.47 ***	(−10.43)	−0.17 **	(−2.20)		
ρ_3			0.75 ***	(11.59)		
m_1	−0.88 ***	(−33.33)	0.16 *	(1.93)	0.19 ***	(5.43)
m_2			0.29 ***	(3.04)	0.09 **	(2.52)
m_3			−0.57 ***	(−8.91)		
ω	0.01 ***	(3.11)	0.03 ***	(5.20)		
λ_1	0.06 ***	(6.28)	0.32 ***	(9.08)		
Φ_1	0.93 ***	(87.64)	0.09 **	(2.36)		
Φ_2			0.54 ***	(11.49)		
$\sum_{i=1}^p \lambda_i + \sum_{j=1}^q \Phi_j$	0.99		0.95			
Diagnostics						
R^2	0.59		0.60		0.95	
Q(5)	4.62	[0.10]	2.58		2.39	[0.30]
Q(10)	7.23	[0.41]	6.49	[0.17]	3.75	[0.81]
ARCH(5)	0.82	[0.53]	0.78	[0.56]	0.17	[0.97]
ARCH(10)	1.28	[0.23]	0.89	[0.54]	0.17	[1.00]
S.E. of regression	0.85		0.93		1.43	

Note: t-statistics in (). Std. Dev. (true premium) is the standard deviation of the true premium, which was obtained by ignoring the dynamic structure of the true premium u_t in Equation (4). Q(5) and Q(10) are the Ljung-Box Q-statistics up to lag 5 and 10 with degrees of freedom given by the number of lags less the number of AR and MA terms previously estimated and their p-values in []. ARCH(5) and ARCH(10) are Lagrange multiplier tests for autoregressive conditional heteroskedasticity in the residuals with $F(5, 882)$ and $F(10, 872)$, $F(5, 875)$ and $F(10, 865)$, and $F(5, 877)$ and $F(10, 867)$. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Figure 2. The conditional standard deviations of the premium/discount.



null of homoskedasticity for HSBC 20. Therefore, ARMA–GARCH specification was estimated by using Hendry’s general-to-specific approach, starting with 20 lags and then deleting the lags with insignificant coefficients. The conditional variance specification, as represented by Equation (5), was modeled by starting with a GARCH(1, 1) specification and higher-order ARCH and GARCH terms were included only if the GARCH(1,1) specification failed to capture the ARCH effect in the residuals. Panel B of Table 4 reports the results of the *dyna* model with an ARMA–GARCH specification. The results show that the null hypothesis of homoskedasticity in the residuals is not rejected for iShares MSCI Saudi Arabia and Falcom 30, and that conditional variances are better represented by GARCH(1, 1) and GARCH(1, 2) specifications. The estimated (G)ARCH coefficients sum to just under unity, implying the presence of strong persistence in the conditional variance. The conditional standard

Table 5. Unit root tests

ETF	ADF	PP	KPSS
	t-Statistic	Adj. t-Statistic	LM-Statistic
iShares MSCI Saudi Arabia			
$\ln(P)$	-0.60	-0.62	3.07 ***
$\Delta \ln(P)$	-29.84 ***	-29.84 ***	0.18
$\ln(\text{NAV})$	-0.46	-0.46	3.15 ***
$\Delta \ln(\text{NAV})$	-19.10 ***	-27.91 ***	0.17
Falcom 30			
$\ln(P)$	-0.76	-0.82	3.09 ***
$\Delta \ln(P)$	-30.00 ***	-30.00 ***	0.13
$\ln(\text{NAV})$	-0.71	-0.82	3.14 ***
$\Delta \ln(\text{NAV})$	-7.95 ***	-29.73 ***	0.12
HSBC 20			
$\ln(P)$	-1.27	-1.07	2.88 ***
$\Delta \ln(P)$	-28.43 ***	-28.44 ***	0.22
$\ln(\text{NAV})$	-0.72	-0.64	3.30 ***
$\Delta \ln(\text{NAV})$	-15.62 ***	-28.03 ***	0.11

Note: ADF = Augmented Dickey and Fuller (1981); PP = Phillips and Perron (1988); KPSS = Kwiatkowski et al. (1992); the auxiliary regressions for the unit root tests are generated by $\Delta y_t = f(\text{drift}, y_{t-1}, \Delta y_{t-1}, \Delta y_{t-2}, \dots, \Delta y_{t-p})$, and the lag lengths for the ADF test are based on the Akaike Information Criterion (AIC). *** denotes significance at the 1% level.

deviations of the premium/discount for both ETFs are plotted in Figure 2. The results pertaining to the coefficient of the change in the NAV and S.E. of the regression are qualitatively the same. However, the insights obtained by plotting the conditional standard deviation are valuable. The conditional standard deviation jumped to extremely high levels during January 2016, coinciding with the breaking of Saudi Arabia's diplomatic ties with Iran and the introduction of value added tax (VAT) in January 2018. These findings are consistent with those of several studies, indicating that the premiums/discounts are exacerbated during extreme market turbulence (Ben-David et al., 2017; Petajisto, 2017). Huguen (2003) documented the presence of extended large departures of the prices of iShares Malaysia from the NAVs during the Asian crisis; Hilliard (2014) reported a similar pattern for the Egypt Index ETF (EGPT) during the so-called Arab Spring uprisings in Egypt.

Prior to testing the secondary market price and the NAV for cointegration, unit root tests were conducted to determine whether the underlying series are integrated into the same order of unity. To that end, three unit root tests are applied: The Dickey and Fuller (1981), Phillips-Perron (Phillips and Perron (1988)) and Kwiatkowski et al. (1992) tests. The results are reported in Table 5. All three tests consistently confirmed that both the NAV and the secondary market price are $I(1)$ in level and $I(0)$ in first difference.

Having established that both the series are $I(1)$, we then proceeded to test for cointegration. The two residual-based cointegration tests of Engle and Granger (1987) and P. C. B. Phillips and Ouliaris (1990) were applied for this purpose. The results of both cointegration tests, together with those of the diagnostic tests, are reported in Panel A of Table 6.

Table 6. Cointegration and error correction models

ETF	iShares MSCI Saudi Arabia	Falcom 30	HSBC 20
Panel A: potentially cointegrating regression, cointegration tests, and coefficient restrictions			
δ_0	0.15 *** (7.31)	0.09 *** (3.14)	0.74 *** (6.73)
δ_1	0.96 *** (148.66)	0.97 *** (108.68)	0.78 *** (23.51)
Diagnostics			
R^2	0.99	0.98	0.78
EG_t	-8.56 ***	-6.87 ***	-4.53 ***
EG_z	-159.96 ***	-100.50 ***	-37.97 ***
PO_t	-12.96 ***	-13.63 ***	-4.77 ***
PO_z	-283.85 ***	-315.58 ***	-42.39 ***
$F_{(\delta_0=0, \delta_1=1)}$	96.08 ***	6.06 ***	22.64 ***
$F_{(\delta_1=1)}$	46.74 ***	9.50 ***	45.24 ***
Panel B: Error Correction Model (ECM)			
φ	0.00 (0.14)	0.00 (0.13)	0.01 (0.25)
γ_1	-0.16 *** (-4.54)	-0.38 *** (-11.02)	
γ_2	-0.11 *** (-3.26)	-0.24 *** (-7.26)	
θ_0	0.83 *** (28.65)	0.52 *** (22.61)	0.08 * (1.90)
θ_1	0.19 *** (4.67)	0.51 *** (15.61)	
θ_2	0.09 ** (2.28)	0.23 *** (6.89)	
θ_3	0.06 ** (2.30)	0.19 *** (7.55)	
ψ	-0.22 *** (-8.25)	-0.12 *** (-5.59)	-0.05 *** (-5.98)
Diagnostics			
R^2	0.50	0.52	0.04
$F_{(\theta_0=1)}$	35.97 ***	425.02	487.11 ***
$Q(5)$	2.85 [0.72]	0.69 [0.98]	5.58 [0.35]
$Q(10)$	6.43 [0.78]	11.88 [0.29]	12.18 [0.27]

Note: The cointegrating regression was estimated by the fully-modified OLS (FMOLS) estimator of Phillips and Hansen (1990); t-statistics in (). EG_t and EG_z are the Engle-Granger test statistics; PO_t and PO_z are the Phillips-Ouliaris test statistics; the critical values are from MacKinnon (1996); $F_{(\delta_0=0, \delta_1=1)}$ and $F_{(\delta_1=1)}$ are classical F tests for linear restrictions on the coefficients in the potentially cointegrating regression model. The degrees of freedom for the former restrictions are $F(2, 893)$ for iShares MSCI Saudi Arabia and $F(2, 887)$ for both Falcom 30 and HSBC 20, while the degrees of freedom of the latter restriction are $F(1, 893)$ and $F(1, 887)$, respectively. $F_{(\theta_0=1)}$ is a classical F test for linear restrictions on the coefficients in the ECM model with degrees of freedom $F(1, 884)$, $F(1, 878)$, and $F(1, 885)$ for iShares MSCI Saudi Arabia, Falcom 30, and HSBC 20, respectively. $Q(5)$ and $Q(10)$ are the Ljung-Box Q-statistics up to lag 5 and 10 with degrees of freedom $\chi^2(5)$ and $\chi^2(10)$ and their p-values in []. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

The results based on the EG_t and EG_z and on the PO_t and PO_z test statistics confirm the existence of cointegration between the ETFs' secondary market price and the NAV at the 1% significance level. Notwithstanding the existence of cointegration between the secondary market price and the NAV, the hypothesis that the two series move in a one-to-one correspondence in the long run (that is, $\delta_1 = 1$) is strongly rejected for all ETFs at the 1% level. In fact, the estimated cointegration coefficient δ_1 is 0.97 for Falcom 30, 0.96 for iShare MSCI Saudi Arabia, and 0.78 for HSBC 20. Besides, the estimated intercept coefficient, δ_0 , is quite large and significant, ranging from 0.09 for Falcom 30 to 0.74 for HSBC 20, reflecting the presence of limits to arbitrage. Also, the restrictions that $\delta_0 = 0$ and $\delta_1 = 1$ are strongly rejected at the 1% level.

The estimated ECM shows that the short-run relationship between the first differences of the secondary market price and the NAV is not perfect, as the hypothesis that $\theta_0 = 1$ is strongly rejected in all cases. The short-run coefficient θ_0 ranges from 0.83 for iShares MSCI Saudi Arabia to 0.08 for HSBC 20. This evidence is at odds with that of Tse and Martinez (2007), who were able to reject the hypothesis only in a few cases. These findings indicate that the secondary market price of ETFs does not fully reflect their fundamental values.

Furthermore, the error correction term ψ is significantly negative in all cases, ranging from -0.22 for iShares MSCI Saudi Arabia to -0.05 for HSBC 20. These results imply that the speed of adjustment toward equilibrium is rather slow, especially for the domestic ETFs when compared to the findings of Tse and Martinez (2007) and Jiang et al. (2010). The estimates of the error correction terms fall below -0.20 in only three instances in the former study while averaging -0.28 across the 24 iShares they examined, whereas the latter study reported that the domestic Shanghai SSE 50 ETF error correction terms is -0.33 .

Taken altogether, these findings suggest that arbitrage opportunities are not rapidly exploited, possibly due to short selling restrictions, the concentration of APs,³¹ the increased cost of creations and redemptions, and the lack of an active market of an ETF's shares or its constituents, which can all create severe limits to arbitrage in the stock market that impede market efficiency.

5. Concluding remarks and implications

This paper examined the pricing efficiency of domestic ETFs (i.e., Falcom 30 and HSBC 20) listed on the Saudi stock exchange and their international counterpart (i.e., iShares MSCI Saudi Arabia) listed on the NYSE. An attempt was also made to explore for the features of the deviation of the ETFs' prices from their underlying NAVs, and whether these deviations vary over time. The results show that not only are the deviations of the ETFs' prices from their respective NAVs significantly large, but they also persist over time, tending to be eliminated over the subsequent three days. Furthermore, the standard deviation of the premiums/discounts from the *dyna* model developed by Engle and Sarkar (2006) were large, particularly for the domestic funds. When the *dyna* model was augmented with GARCH, the premiums/discounts appeared to be exacerbated during events that induce extreme market turbulence.

The results from the cointegration analysis support the presence of a common stochastic trend binding the ETFs' prices and their NAVs. However, the ETFs' prices do not fully reflect the fundamental information contained in their underlying basket of stocks, neither in the long run nor the short run. Furthermore, the adjustment toward the long-run equilibrium relationship between the market price and the NAV is quite slow, albeit apparently faster for the international ETF. The restrictions on short selling, the concentration of APs, the increased cost of creations and redemptions, and the lack of an active market for an ETF's share or its constituent shares can all create major limits to arbitrage in the stock market, thus impeding market efficiency. A caveat of this study is that it lacks a more elaborate analysis of the determinants of the premiums/discounts due to data limitations.

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Notes

1. The Toronto Index Participation unit (TIP) is the first ETF that was introduced by the Toronto Stock Exchange (TSE) in March 1990 to track the performance of the Toronto 35 index. State Street launched the Standard & Poor's Depository Receipt (SPDR), or spiders, in January 1993 to track the performance of the S&P 500 index. Notably, in 2015, assets under management in the global ETF industry first overtook those managed by the elitists and the sophisticated hedge fund industry (The Economist, 2015). Lettau and Madhavan

- (2018, p. 151) attributed the proliferation of ETFs to three main reasons. First, the traditional advantages of ETFs include liquidity, low fees, transparency, and potential tax advantages. Second, the expansion of the universe of ETFs, in terms of the asset classes in which they invest and the emergence of ETFs that adopt an active management style. Third, the expansion of the investor base of ETFs for retail investors to include institutional investors who employ ETFs for sophisticated uses in lieu of a derivative contract for hedging and arbitrage.
2. The exceptions are Israeli and South African ETFs; see Hill et al. (2015, pp. 178–81) for details on the size and architecture of in the Middle Eastern and African ETF industry.
 3. The board of the Capital Market Authority (CMA) issued the mechanism of ETFs on 16 March 2010, enabling non-resident foreign investors to trade their units on the Saudi stock exchange (Tadawul), and the first ETF was launched and started trading at the end of same month (CMA, 2010, p. 14). This step came after introducing swap agreements as a means for non-resident foreign investors to participate in the Saudi stock market on 18 August 2008 (CMA, 2008, p. 23).
 4. The interest in the Saudi market stems from recent economic reforms mandated by Saudi Arabia's vision 2030, which has attracted the attention of the media and investment circles. One of these reforms was permitting direct foreign ownership of shares listed on the Saudi stock exchange, which came into effect on 15 June 2015. Soon after the announcement, BlackRock launched iShares MSCI Saudi Arabia ETF in the NYSE Arca exchange, being the first Western-listed ETF to track Saudi Arabia's stock market. In 2019, the Saudi stock market obtained an Emerging-Market Status in MSCI in addition to inclusion in the FTSE Russel and S&P Dow Jones emerging market benchmarks, leading to an unprecedented increase in foreign investment in the Saudi stock market to \$4.8 billion from \$356 million at the start of 2019 (Henderson, 2019). The net inflows to ETFs tracking the Saudi market reached \$2.2 billion, ranking second behind Indian ETFs, which stand at \$2.8 billion (Pacheco, 2019a) after outpacing inflows to their Turkish counterpart as destination for U.S. ETF investment (Pacheco, 2019b).
 5. Three ETFs listed on the London stock exchange, namely, iShares MSCI Saudi Arabia Capp (inception date: 30 April 2019), HSBC MSCI Saudi Arabia Capped (inception date: 30 April 2019), and Invesco MSCI Saudi Arabia UCIT (inception date: 18 June 2018), as well as two listed in the NYSE Arca, namely, Franklin FTSE Saudi Arabia ETF (9 October 2018) in addition to the iShares MSCI Saudi Arabia ETF, the first international Saudi ETF that was launched on 16 September 2015.
 6. An authorized participant (AP) is a financial intermediary that enters into a legal contract with an ETF manager that gives the AP the right (but not the obligation) to create and redeem shares of the fund in the primary market, typically via in-kind transactions. The process by which the creation of new shares and the destruction of existing ones takes place is commonly referred to as the creation/redemption mechanism.
 7. What differentiates an ETF from its counterpart, a closed-ended fund, is that it is an open-ended fund in the sense that if there is demand for its shares in excess of the supply in the secondary market, the AP can create new shares in the primary market, usually via in-kind transactions. The law of one price comes into play via the creation/redemption mechanism, ensuring that the market value of the ETF remains in sync with its NAV—the value of the underlying securities that comprises the ETF's fundamental value. However, Hugen (2003) shows that while iShares Malaysia have long traded on par with its NAV, the capital controls imposed by the Malaysian Government during the Asian crises resulted in the managers of iShares Malaysia suspending in-kind transactions, which manifested in extended large departures of the price of iShares Malaysia from its NAV, resembling those documents for close-ended fund tracking of the Malaysian market. Hilliard (2014) reports a similar pattern for the Egypt Index ETF (EGPT) during the so-called Arab Spring uprisings in Egypt.
 8. HSBC 20 and Falcom 30 aim to track the investment results of 20 and 30 shariah-compliant stocks listed on Tadawul, respectively. On the other hand, iShares MSCI Saudi Arabia ETF, which is an international fund, seeks to track the investment results of the MSCI Saudi Arabia Investable Market Index (IMI) 25/50 (the “Underlying Index”), which consists of stocks traded primarily on Tadawul. The underlying index is a free float-adjusted market capitalization-weighted index with a capping methodology applied to issuer weights so that no single issuer of a component exceeds 25% of the underlying index weight, and that all issuers with a weight above 5% do not cumulatively exceed 50% of the underlying index weight.
 9. Among the few studies are Alassane (2019) and Almudhaf and Alhashel (2020), who focus exclusively on the domestically listed Saudi ETFs
 10. The data for the Midcap SPDR start from April 1993.
 11. Ackert and Tian (2000) documented a clear quarterly seasonal pattern; therefore, they adjusted the price series to reflect the accumulation of dividends and the distribution of capital gains.
 12. Due to its organizational form, dividends that the trust receives from the underlying stock are held in a noninterest-bearing account between the time they are received and the time they are distributed.
 13. The exceptions are the Netherlands and Austria, for which small discounts are observed.
 14. The three methods yield similar results.
 15. Ackert and Tian (2008) excluded the early periods from their sample to reflect changes in the construction policy of the international indices.
 16. This approach disentangles whether the measurement errors stem from stale NAV estimates or an inefficiency in the ETF prices. However, this approach requires a large cross-sectional sample of ETFs.
 17. To maintain comparability of the results across ETFs, we did not analyze the entire trading history of each ETF. The trading history differs based on the inception date of the relevant fund, as reported in Table 1.
 18. See, for example, Engle and Sarkar (2006), Delcours and Zhong (2007), Tse and Martinez (2007), and Ackert and Tian (2008).
 19. An ETF is said to be trading at a premium when the market price is greater than the NAV, or at

- a discount if the opposite occurs. Elton et al. (2002, p. 461) indicated that the premium constitutes a cost for an investor, while a discount represents an opportunity.
20. See Elton et al. (2002).
 21. While Elton et al. (2002), Gallagher and Segara (2005), and Almudhaf (2019) used the difference between the levels of the ETF price and the NAV, we used the fractuural difference given by Equation (1) to maintain the cohesiveness of the analysis. Indeed, the results are qualitatively the same and will be made available upon request.
 22. Engle and Sarkar (2006) included the future-based cash adjustment and the futures return as exogenous variables, while Delcours and Zhong (2007) used the currency exchange rate and the S&P 500 index return. Because no future contracts are traded on the ETFs under consideration and because the currency exchange rate is irrelevant as the Saudi Riyal is pegged to the U.S. dollar, no exogenous variables were included in our analysis.
 23. If the constant μ is equal to zero, then the process follows the pure random walk model.
 24. The magnitude of δ_0 may differ from zero due to "limits to arbitrage."
 25. If $\delta_0 = 0$ and $\delta_1 = 1$, u_t is the premium.
 26. Sheskin (2011, p. 261) posited that "some statisticians believe that if one or more of the assumptions of a parametric test ... are saliently violated, the test results will be unreliable; because of this, under such conditions, it is more prudent to employ the analogous nonparametric test."
 27. It is worth noting that if the ETFs' premium/discount is significantly different from zero but does not exceed the transaction cost, the ETFs will still be priced efficiently, as unexploited opportunities of profitable arbitrage are unlikely to exist.
 28. The highest standard deviation reported in the work of Engle and Sarkar (2006, p. 42) is 117 bps for iShares MSCI Mexico.
 29. The results based on both tests using the absolute values show that the hypothesis is rejected in all cases. These results are not reported here for the sake of brevity, but can be made available upon request.
 30. Although the large AR (1) coefficient of 0.99 implies that there is a near unit root process in premiums/discounts series, the null of a unit root is unequivocally reject at the 1% level when the The Dickey and Fuller (1981), Phillips-Perron (Phillips and Perron (1988)) unit root tests are used. Results are available upon request.
 31. Antoniewicz and Heinrichs (2014, p. 8) reported that "... about 50 members of the [national securities clearing corporation] and [depository trust company] have entered into AP agreements with ETFs." In a subsequent report, Antoniewicz and Heinrichs (2015) found that U.S.-listed ETFs have, on average, 34 AP agreements, only five of which have been engaged at least once in a creation/redemption transaction in the six months preceding the report. The number of APs is Saudi is three based on the prospectus information for Falcom 30 and HSPC 20, and each fund has an agreement with its sponsoring company, in addition to Fransi Capital.

Author Contributions

Main text.

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