

# **Exchange Traded Funds: Pricing, Performance and Price Discovery**

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## Abstract

The Net Asset Value of international ETFs can differ from the daily closing price on exchange. Whilst these differences might appear significant, this is actually by design, and products have historically tracked their benchmarks very closely over longer time horizons. It is therefore very important that investors understand the differences between valuation methodologies and be mindful of the metric used when evaluating ETF performance.

This paper discusses the reasons behind these pricing differences and shows that they actually arise because ETFs are acting as price-discovery vehicles whilst the underlying markets they track are closed, giving investors near-constant global market access throughout the day.

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## Introduction

In order to make timely and informed investment decisions, it is important that investors understand how the pricing of Exchange Traded Funds (ETFs) is executed and which metrics are to be considered when buying or selling an ETF. Two valuation methods that are specific to ETFs are Net Asset Value (NAV) and daily closing price on exchange.

In this paper, we will explain the two different pricing methodologies, the benefits of each method and also discuss how they differ from each other. We will also discuss the appropriate metric to calculate the performance of an ETF, especially when comparing to the stated benchmark index.

A unique feature of ETFs (especially versus managed funds) is that they offer investors the ability to transact intra day, gaining access to broad market exposures at any time during market hours. We therefore extend our research to analyse the intra-day price movements of international ETFs to ascertain whether they do in fact offer investors a fair representation of the value of the underlying securities held in the fund at any point in time.

## ETF Pricing - Net Asset Value Versus Pricing on Exchange

The Net Asset Value (NAV) of an Exchange Traded Fund (ETF) is the value of each share in a fund, measured by the value of its underlying holdings. The NAV of an ETF is generally calculated in accordance with the standard formula for valuing managed fund units at the close of regular trading – in other words, the value of the fund's assets minus its liabilities, divided by the total number of shares outstanding, as outlined in Table 1.

**Table 1. NAV Calculation of an ETF**

ETF	
Fund assets	Value of the underlying securities Dividend/Coupon accruals Stock lending revenue accruals etc
Fund liabilities	Daily accruals of the management fee <sup>1</sup>
NAV	$(\text{Fund assets} - \text{Fund liabilities}) / \text{Total number of shares outstanding}$

The NAV of an equity ETF is based on the closing (or sometimes the last traded) prices of each of the fund's underlying securities on their local exchange. ETFs with international exposures, trading across multiple time zones therefore calculate their portfolio NAV using closing prices from different exchanges throughout the day.

This approach is consistent with the calculation methodologies of the indices used by ETFs, therefore allowing a meaningful comparison of ETF performance versus benchmark over time.

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<sup>1</sup> In the case of iShares ETFs, the management fee payable to BlackRock Fund Advisors. This fee excludes any other fees and expenses an ETF may incur.

ETFs themselves are also priced in live time during market hours on their local exchanges (like any other listed stock) and therefore have a daily closing (or last traded) price on their local exchange. This price is representative of the market consensus value of the underlying portfolio of securities *at that point in time* (4pm, Sydney for Australian Securities Exchange (ASX) listed ETFs).

For ETFs tracking local equities, the daily closing price on exchange should be very similar to the daily NAV of the ETF, since both are representative values of the underlying portfolio at exactly the same point in time. This relationship should hold for any ETF holding only securities with the same market closing time at the ETF itself, since any significant mispricings between the ETF and the underlying portfolio can be arbitrated away.

Importantly however, for ETFs where the closing time of the listing exchange differs to that of the underlying securities, the closing value on exchange will differ from the daily NAV. This is especially true for Australian ETFs with broad international exposures (such as the iShares S&P Global 100 (IOO.AU) or iShares MSCI Emerging Markets (IEM.AU) listed on the ASX), where the timing differences between 4pm Sydney (close of the ASX) and the market close of the underlying portfolio constituents (e.g. European or US securities) can be as much as 15 hours.

**Figure 1. Market hours of the underlying securities of international ETFs (AEST)**

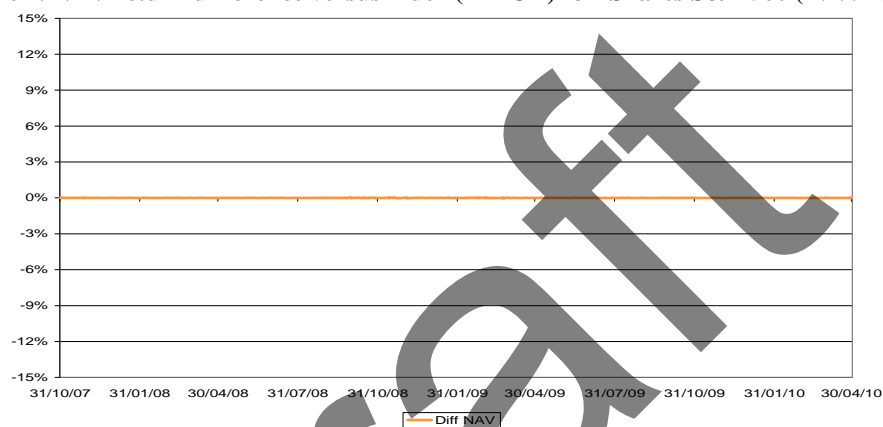


As seen in Figure 1, when the market closes in Sydney, there are still several hours of trading activity remaining in the Asian region and the trading days in Europe and North America are yet to begin. The daily closing price of any ASX listed ETF with international exposure can, and should, therefore differ from the daily NAV due to these significant timing differences.

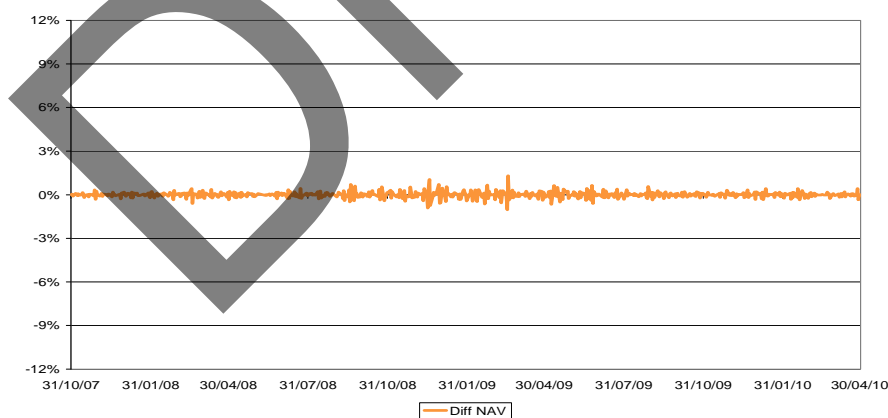
## ETF Performance Calculation – Daily Price versus Daily NAV Returns

The performance of an ETF will differ, depending on whether the closing price on exchange, or the NAV, is used to calculate the return. As mentioned previously, market indices use the same pricing methodology as NAV (i.e. daily closing values of all underlying securities) and therefore when evaluating ETF performance relative to its stated benchmark, returns must be calculated using NAV to allow a meaningful comparison to be made. Figures 2 to 5 below show the daily performance difference between the NAV return and the benchmark index return for four ASX listed iShares ETFs (since the month end following their inception).

**Figure 2. NAV return difference versus index (in AUD) for iShares S&P 500 (IVV.AU)<sup>2</sup>**

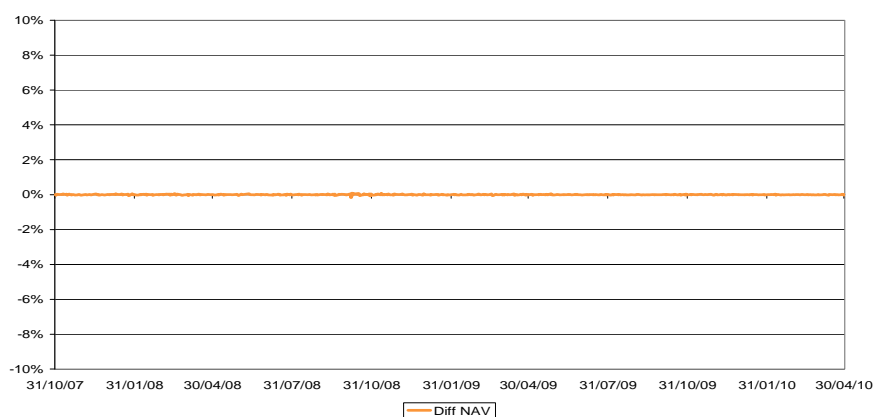


**Figure 3. NAV return difference versus index (in AUD) for iShares S&P Global 100 (IOO.AU)<sup>2</sup>**

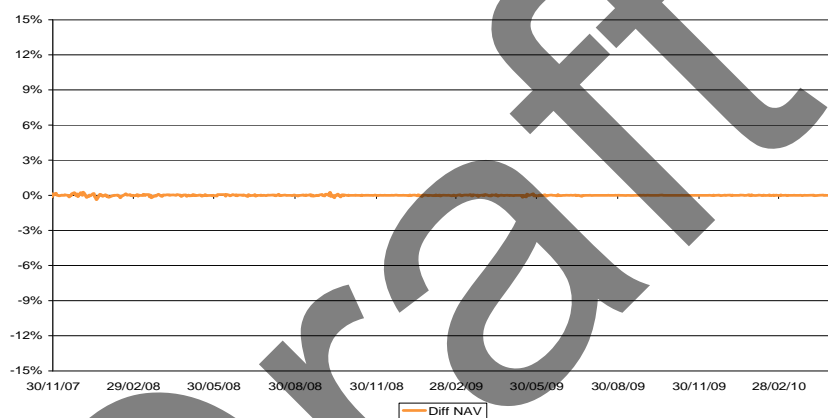


<sup>2</sup> Source: BlackRock & Bloomberg

**Figure 4. NAV return difference versus index (in AUD) for iShares MSCI EAFE (IVE.AU)<sup>3</sup>**



**Figure 5. NAV return difference versus index (in AUD) for iShares FTSE Xinhua China 25 (IZZ.AU)<sup>3</sup>**

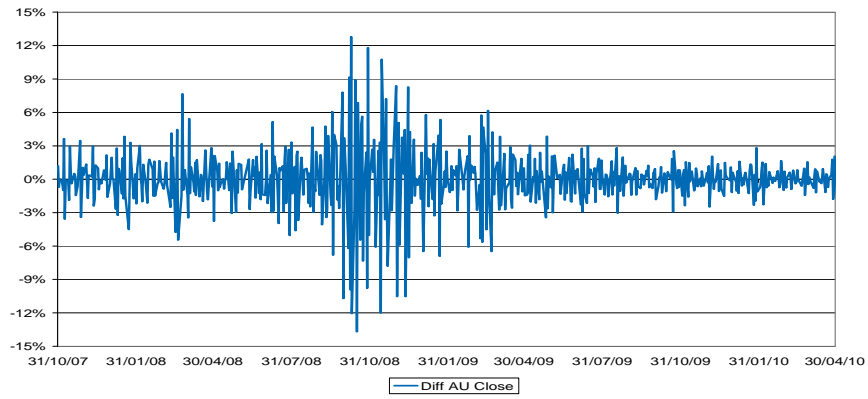


The daily NAV performance of these four international ETFs is almost identical to that of their indices, as demonstrated by the orange lines all hugging the horizontal axes of the graphs since November 2007 of the iShares products. In other words, these ETFs have performed (before transaction costs) in line with expectations, replicating the daily returns of their stated benchmarks consistently through time.

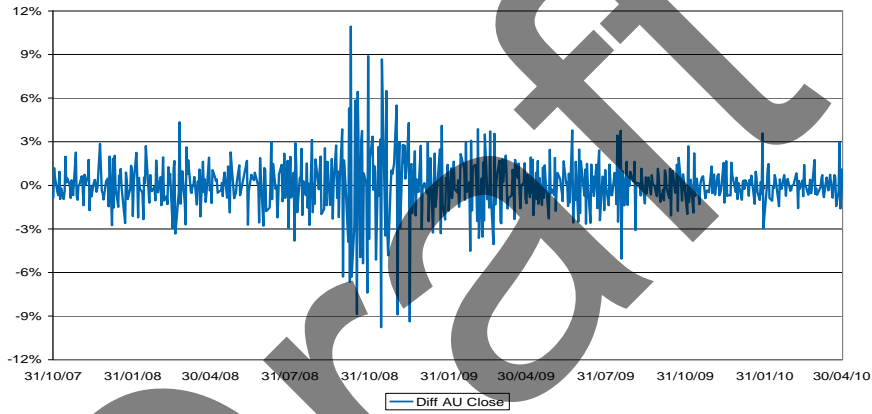
If daily performance of these Australian ETFs is instead calculated using the 4pm daily closing prices of each iShares ETF on the ASX and compared to the published index return, we see the daily performances differences, as shown in Figures 6 to 9 below - note that the graphs have the same vertical axis scale as their corresponding chart in Figures 2 to 5.

<sup>3</sup> Source: BlackRock & Bloomberg

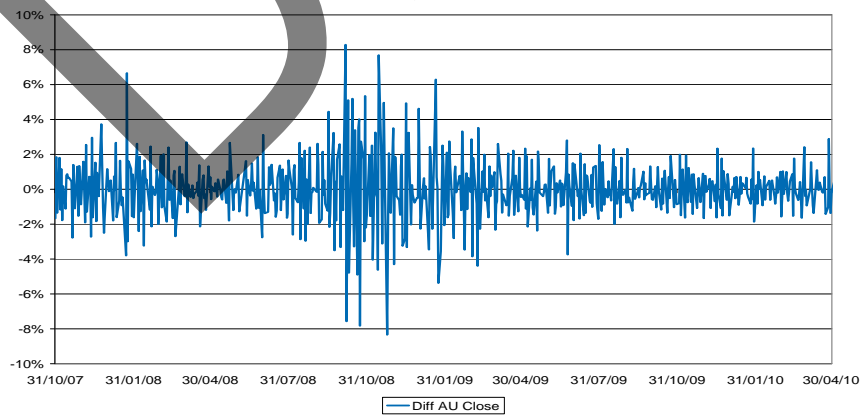
**Figure 6. Closing price return difference versus index (in AUD) for iShares S&P 500 (IVV.AU)<sup>4</sup>**



**Figure 7. Closing price return difference versus index (in AUD) for iShares S&P Global 100 (IOO.AU)<sup>4</sup>**

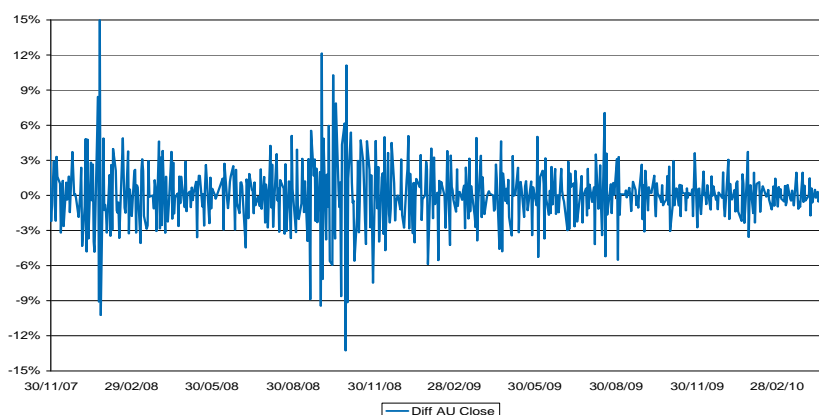


**Figure 8. Closing price return difference versus index (in AUD) for iShares MSCI EAFE (IVE.AU)<sup>4</sup>**



<sup>4</sup> Source: BlackRock & Bloomberg

**Figure 9. Closing price return difference versus index (in AUD) for iShares FTSE Xinhua China 25 (IZZ.AU)<sup>5</sup>**



As discussed earlier, these differences between daily price return and NAV return are to be expected, due to the different timing methodologies adopted to calculate each price. There are also several factors which may have contributed to the magnitude of the daily differences seen in the examples above:

1. Due to Australia's extreme geographic location, when the ASX trading day ends in Sydney, the majority of the securities in these broad international portfolios still have several hours of trading remaining, and in many cases, their underlying markets have not even opened yet. Daily closing prices of Australian listed ETFs may therefore see greater divergence from NAV (compared to European or US listed), due to these more extreme timing factors.
2. The period in question (November 2007 to April 2010) was one of extraordinary market volatility. As such, intra-day tracking differences would have been magnified, relative to more "normal" market conditions. This can clearly be seen by the significant increase in daily performance difference of all products for the months following the bankruptcy of Lehman Brothers in September 2008.
3. Intra-day currency movements will also have an impact on the tracking differences. Again, this period has seen extreme moves in currency markets and heightened volatility.

Table 2 below shows the daily volatility (from October 2007 to May 2010), as measured by the standard deviation of the performance difference, using both daily NAV and price returns versus the benchmark for each ETF.

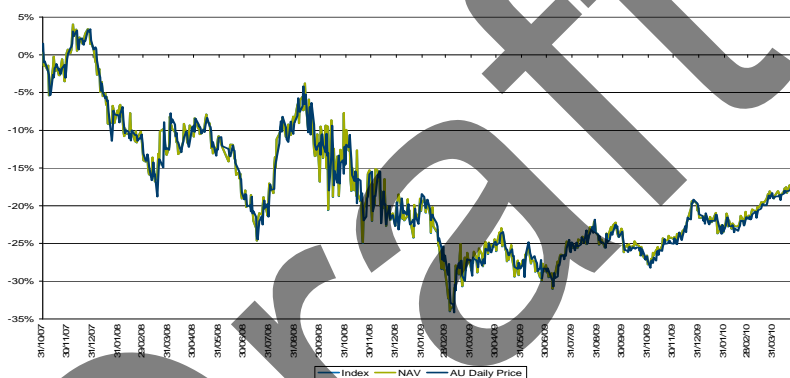
<b>ETF</b>	<b>Daily volatility of NAV return vs. index</b>	<b>Daily volatility of price return vs. index</b>
IVV.AU	0.01%	2.71%
IOO.AU	0.22%	1.98%
IVE.AU	0.02%	1.75%
IZZ.AU	0.06%	2.67%

<sup>5</sup> Source: BlackRock & Bloomberg

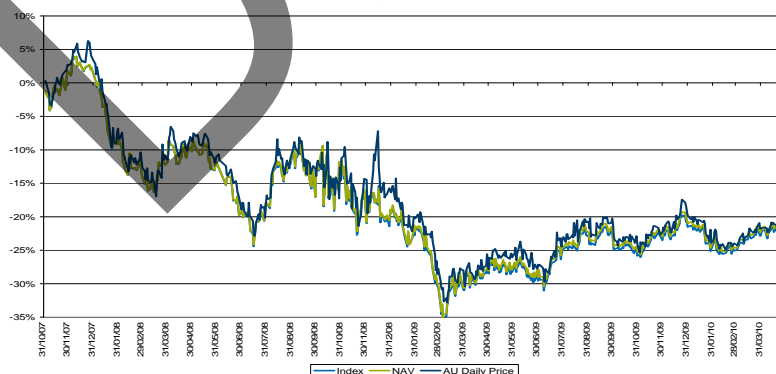
By simply calculating the daily performance of these four ETFs using a different value metric (closing price on exchange versus NAV), we might arrive at vastly different conclusions regarding the consistency of performance relative to their stated benchmarks. Measuring performance based on daily closing price on exchange would (incorrectly) suggest that the ETFs are not in fact tracking their benchmarks, but are instead exhibiting significant tracking error. This is why it is very important that investors understand the differences between valuation methodologies and be mindful of the appropriate metric to use when evaluating performance, especially for ETFs with international exposures.

Figures 10 to 13 chart the cumulative performance since inception for the same four ASX listed iShares ETFs, showing both NAV and closing market performance versus their benchmark indices.

**Figure 10. Cumulative performance (in AUD) of iShares S&P 500 (IVV.AU)<sup>6</sup>**



**Figure 11. Cumulative performance (in AUD) of iShares S&P Global 100 (IOO.AU)<sup>6</sup>**



<sup>6</sup> Source: BlackRock & Bloomberg



Figure 12. Cumulative performance (in AUD) of iShares MSCI EAFE (IVE.AU)<sup>7</sup>

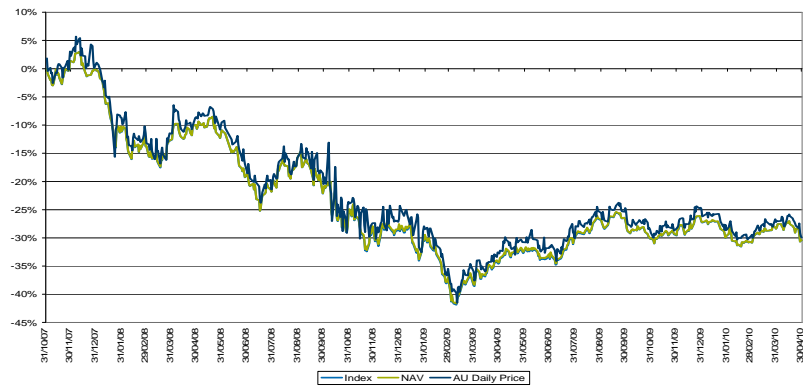
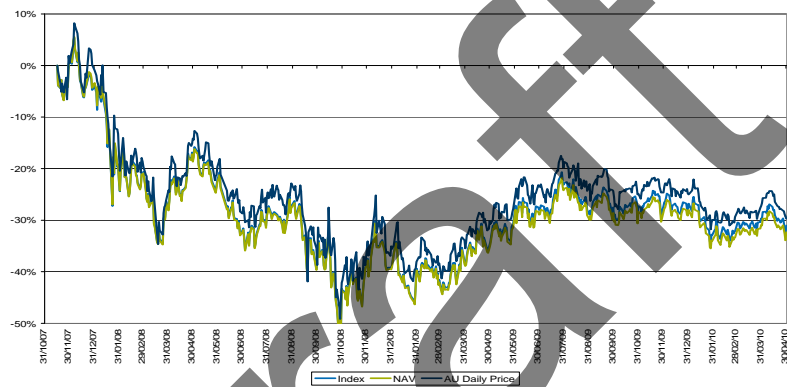


Figure 13. Cumulative performance (in AUD) of iShares FTSE Xinhua China 25 (IZZ.AU)<sup>7</sup>



Interestingly, over longer periods, the choice of metric upon which to base performance calculations becomes much less significant. Whilst the differences in value on any given day might appear to be a source of tracking error, this does not translate to high volatility versus the index over longer horizons. All four ETFs above have historically tracked their benchmarks very closely since inception, regardless of the daily valuation methodology used.

The examples above highlight that the NAV of an ETF is the most appropriate measure of performance calculation versus an index, since the pricing methodologies used are the same and hence the two metrics are directly comparable. This is particularly the case when evaluating ETFs over shorter time periods, where the timing differences between closing market price and NAV can cause quite significant differences in value, and hence performance.

<sup>7</sup> Source: BlackRock & Bloomberg

## Are these differences just noise, or price discovery?

An interesting question that arises from the above analysis is whether these differences in daily performance are just noise (and thus a source of uncompensated risk to Australian ETF investors), or whether these international ETFs are actually acting as price discovery vehicles, representing consensus valuations of their underlying international markets during Australian trading hours.

If the Australian ETF is indeed acting as a price-discovery instrument whilst the US market is closed, we might expect that when an S&P 500 ETF moves higher (lower) during the Australian trading day, then the S&P 500 market will follow suit and open higher (lower) when tomorrow's trading session begins.

A simple test investigates the broad relationship between historical daily movements of the iShares S&P 500 (IVV.AU) during the ASX trading day and the corresponding overnight movement of the S&P 500 market in the US. The graph below plots the intra-day returns of IVV.AU on the ASX, versus the corresponding overnight return of the S&P 500 Index, daily from 12 November 2009 to 2 May 2010 - this was the longest period for which intra-day historical foreign exchange rate data is available in Bloomberg.

Figure 14. Intra-day performance of IVV.AU vs. overnight performance of S&P 500 (in USD)<sup>8</sup>

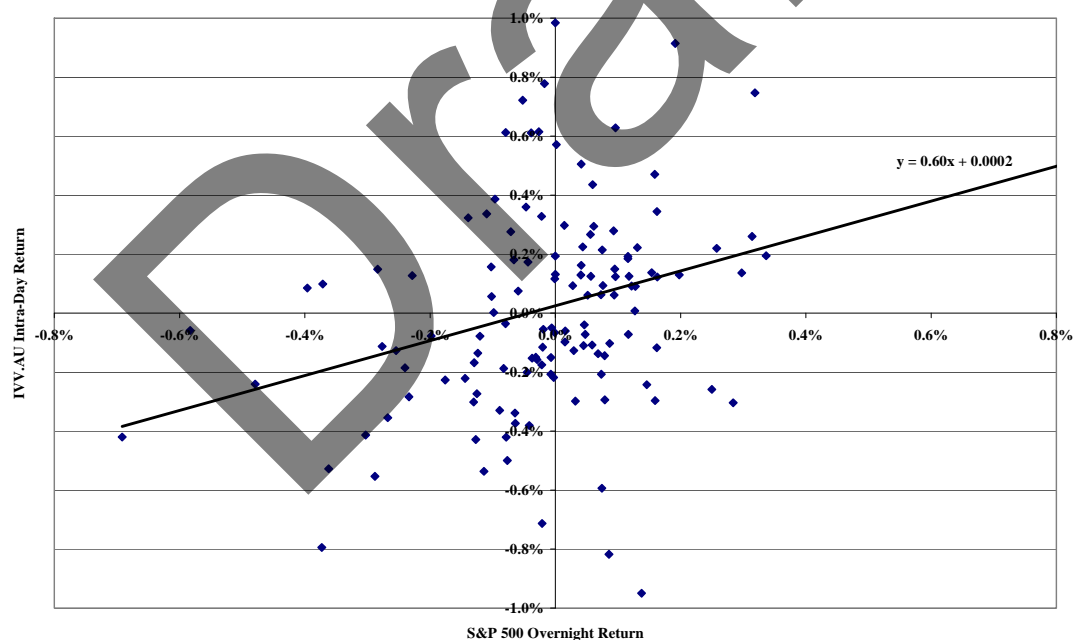


Figure 14 includes a line of best fit, giving an estimate of the linear relationship between these two variables for the sample period in question. The positive sloping line (gradient +0.60), passing very close to the origin suggests that there is indeed a statistically significant (t-stat of 2.7) positive relationship between the movement of the ASX-listed iShares S&P 500 on any given trading day and the corresponding overnight movement of the actual S&P Index on the same day. This is encouraging

<sup>8</sup> Source: BlackRock & Bloomberg

and broadly supportive of our ETF price discovery theory.

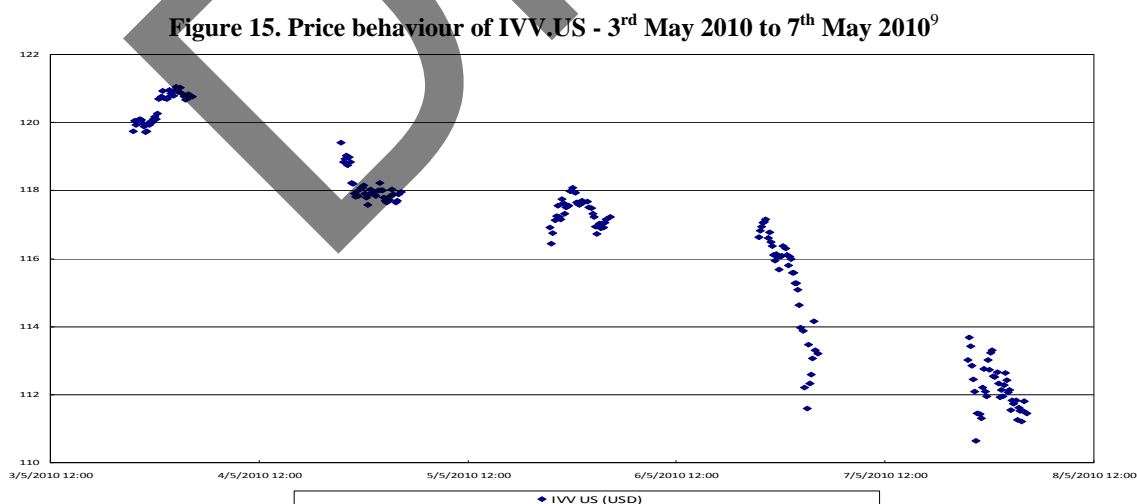
Upon closer inspection of the results however, the coefficient of determination (or  $R^2$ ) of this regression is only 0.05. Put simply, this implies that just 5% of the variability in our data set is accounted for by this simple model and it is therefore unlikely to be a reliable predictor of future outcomes. This can also be implied by visual inspection of the chart, as the points are widely scattered either side of the line.

While the general results here are directionally encouraging, it is perhaps unsurprising that this simple test does not yield a more robust conclusion, simply because of the large differences between the two time windows being compared. The ASX market hours represent just six of the 17.5 hours during which the S&P 500 is closed each day. To better test our price discovery theory, we need to not only look at ETFs trading during Australian market hours, but also during the remaining seven and a half hours between ASX close and US market open.

### ETFs allow (almost) continuous market access

Figure 15 below shows Bloomberg historical trade data (at ten minute increments in USD) across a full trading week (3rd to 7th May 2010) for the US-listed iShares S&P 500 Index Fund (IVV.US). This particular week was one of significant volatility, both during market hours (particularly on 6th May 2010) and also overnight. It therefore gives us a good test environment to analyse ETF price behaviour across different trading regions.

If ETFs trading in other markets are indeed acting as price discovery instruments while the US market is closed, then we would expect their relative trade data history to “fill in the gaps” on the graph below between each daily market closing price in the US and the following market opening price.



<sup>9</sup> Source: BlackRock & Bloomberg

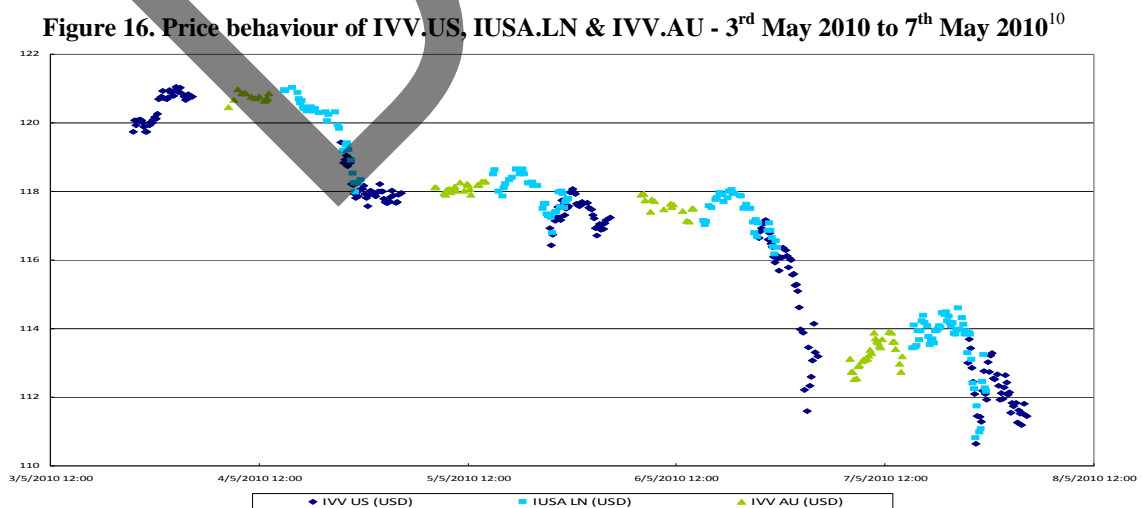
We therefore extended our pricing analysis, using continuous trade data (also at ten minute increments) for the following three ETFs, all tracking the S&P 500 Index across different trading jurisdictions:

- IVV.AU – iShares S&P 500 (Australia)
- IUSA.LN – iShares S&P 500 (UK)
- IVV.US – iShares S&P 500 Index Fund (US)

Continuous trade price data for the entire week beginning 3rd May 2010 was sourced from Bloomberg for all three ETFs and each price series converted to US dollars using continuous foreign exchange rates (also from Bloomberg), thereby neutralising any currency impact on relative pricing. As discussed earlier (and shown in Figure 1), by analysing three products trading in Sydney, London and New York, we can track the price behaviour of ETFs during 19 of the 20 continuous hours each day between Australian market open and US market close.

Since the Australian ETF (IVV.AU) is a cross list of the US fund (IVV.US), price per share of these two products (in a common currency) is directly comparable, since they both represent equal economic exposure to exactly the same underlying portfolio of securities. The UK listed ETF (IUSA.LN) however is a different product altogether and hence the price per share is not absolutely comparable to that of the US & Australian ETFs. This price series is therefore adjusted by a constant scaling factor (1 share IVV.US = 20.2 shares IUSA.LN), creating a price series that is now directly comparable to the other two ETFs.

Figure 16 plots this scaled continuous trade price data for all three ETFs throughout the entire trading week beginning 3rd May 2010.



<sup>10</sup> Source: BlackRock & Bloomberg

The price data points for the Australian and European ETFs trading outside US market hours do indeed “join the dots” between each US trading day, creating a near-continuous price profile across the entire week. This suggests that international ETFs outside of the US are indeed trading at values representative of consensus expectations of their underlying portfolios, even whilst their underlying markets are themselves closed. This evidence supports our theory that the (sometimes significant) daily tracking differences between price performance of ETFs versus benchmarks priced outside their local time zones actually arise because these instruments are providing market access at fair prices to global markets throughout the entire day.

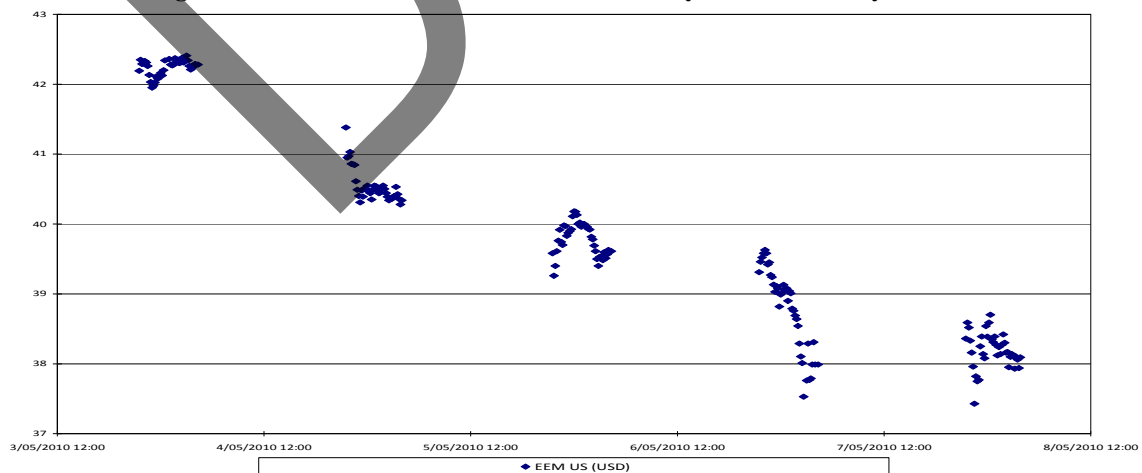
Not wanting to draw too much significance from a single product over one week, the exercise was repeated using the same three ETFs over several different weekly trading windows, with similar results – these two Australian and European ETFs appear to be providing continuous price discovery, giving investors access to the US equity market throughout the day, offering prices that are representative of the market consensus while the underlying market is closed.

To further test this theory, the same exercise was then repeated using three ETFs tracking the MSCI Emerging Markets Index, again listed in Australia, Europe and London:

- IEM.AU – iShares MSCI Emerging Markets (Australia)
- IEEM.LN – iShares MSCI Emerging Markets (UK)
- EEM.US – iShares MSCI Emerging Markets Index Fund (US)

The volatility, both intra-day and overnight, was very large for this benchmark also during this week, as shown below in Figure 17, with significant price moves both intra day and overnight.

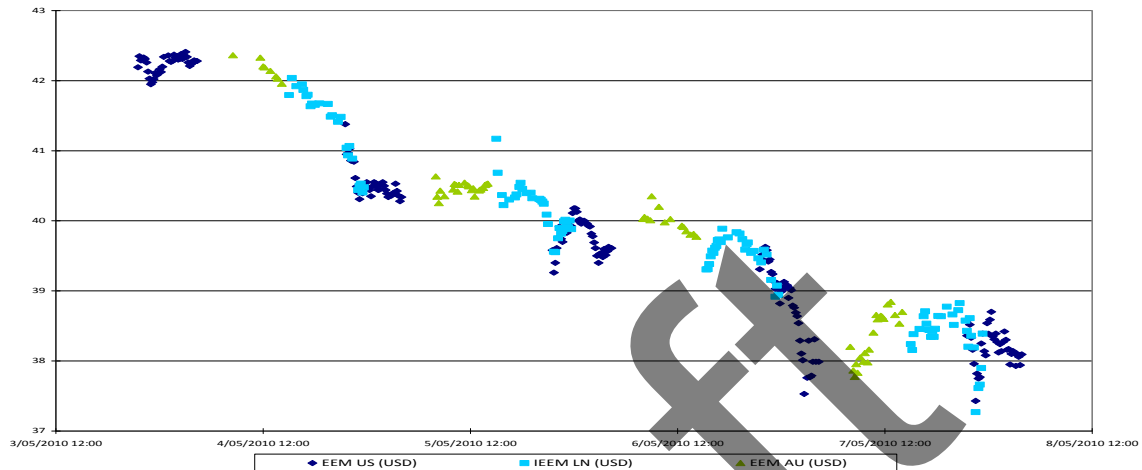
**Figure 17. Price behaviour of EEM.US - 3rd May 2010 to 7th May 2010<sup>11</sup>**



<sup>11</sup> Source: BlackRock & Bloomberg

Adding the additional trading windows to the time series again yields very convincing results, as the overnight moves in the MSCI Emerging Markets Index are tracked by the price movements of the Australian and European ETFs. Figure 18 below shows the three ETFs making a near-continuous price profile throughout the week from 3rd May to 7th May 2010.

**Figure 18. Price behaviour of EEM.US, IEEM.LN & IEM.AU - 3<sup>rd</sup> May 2010 to 7<sup>th</sup> May 2010<sup>12</sup>**



Whilst the continuous price profile for the MSCI Emerging Markets Index example above is perhaps not quite as “clean” as the earlier S&P 500 Index example, there are several reasons why we might expect a more volatile price profile for any index with multiple country exposures:

- The index includes multiple countries across different geographical regions. As such none of these three ETFs trades at the same time as all of the underlying countries.
- For many of the underlying countries there are limited, or no, derivatives available upon which to base estimates of underlying market values outside of market hours.
- Multiple currency exposures must also be factored into pricing at any point in time, as well as the underlying security values.

This evidence again very much suggests that ETFs across different trading jurisdictions are providing investors with access to the underlying markets at fair prices throughout the entire day. This exercise of comparing the MSCI Emerging Markets Index in different jurisdictions was also repeated over multiple time periods, again with similar results and continuous pricing across the entire period.

<sup>12</sup> Source: BlackRock & Bloomberg

## **Conclusion**

One of the unique features of ETFs is that they offer investors the ability to transact intra-day, gaining access to broad market exposures at any time during market hours. This is of course only a benefit to investors if the ETF price at any point during the trading day is a fair representation of the actual value of the underlying securities held in the fund.

Over the longer term, the ASX-listed iShares ETFs studied all offered investors price returns on exchange almost identical to those of their underlying benchmarks, all tracking index performance very closely since inception. When considering shorter time periods however, differences between the daily ETF price return on exchange, relative to the underlying international index were often exhibited.

Upon closer inspection, it appears that these differences between the daily return of ETFs and their benchmark indices actually arise because these instruments are providing price discovery and offering investors access to markets, at what appear to be fair prices, even when the underlying securities are not themselves trading.

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