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Modern portfolio diversification using iShares: correlation and return gaps

Abstract

This analysis shows that coefficient of correlation alone does not provide an intuitive indicator of diversification benefits nor do these benefits depend only on the correlation between asset returns. Using domestic, international, industry-specific, commodity and bond iShares, this study demonstrates that a return gap accounts for the effects of both correlations and standard deviation, and provides a perceptive measure of diversification benefits. It shows that relative rank of assets by diversification benefits is different when measured by correlation coefficient and by return gap. Therefore, investors seeking diversification opportunities could combine coefficient of correlation and return gap in practical asset allocation.

Keywords: diversification, correlation, return.

JEL Classification: G11, G15.

Introduction

Portfolio risk can be reduced to a substantial extent with a sensible mix of financial assets. This is what mean-variance model of portfolio selection proposed, developed, and justified by the pioneers of portfolio diversification – Harry Markowitz (1959) and James Tobin (1958). This model precisely suggests the nature of co-movement among the security returns is the important variable that influences scope of portfolio risk reduction; however, as diversification increases, risk of the portfolio decreases but not proportionally. Furthermore, portfolio risk can never be eliminated completely even with a very large number of stocks because there is a strong tendency among stocks within an economy to move more or less in unison (e.g., Bernstein and Pinkernell, 2006; 2007).

Previous empirical findings show that investors seeking diversification may benefit from being able to at least partially hedge out market exposure through investing in regions, countries (e.g., Grubel, 1968; Levy and Sarnat, 1970; Heston and Rouwenhorst, 1994; Bekaert and Harvey, 1995; Bekaert et al., 1996; Griffin and Karolyi, 1998; Cavaglia et al., 2000; Serra, 2000; Diermeier and Solnik; 2001, Li et al., 2003; Meyer and Rose, 2003; Driessen and Leaven, 2007) and across different asset classes (e.g., Bernstein and Pinkernell, 2007; Statman and Scheid, 2008).

While correlation is the common indicator of diversification benefits, Statman and Scheid (2008) point out that coefficient of correlation alone does not provide an intuitive indicator of diversification benefits nor these benefits depend only on the correlation between asset returns. Authors show that portfolio diversification also depends on the standard

deviation of asset returns and introduce return gap. A return gap is a gap between the returns of a pair of assets, whether U.S. equity and international equity or other asset categories. The return gap and the diversification benefits are lower when correlation is higher, but the return gap is higher when standard deviation is higher.

The purpose of this study is to explore the differences between correlation and the return gap as a measure of diversification benefits and show that diversification benefits across different asset classes remain considerable on example of iShares – one of the fastest-growing exchange-traded funds (ETFs) family that combines key features of traditional mutual funds and individual stocks in the financial markets since early 1990s.

The remainder of the paper is organized as follows. Section 1 summarizes the methodology and data used in this study. Section 2 presents the empirical results. The final section offers some concluding remarks.

1. Data and methodology

The return gap is associated with dispersion – standard deviation of an individual asset return around the mean return of all assets. In the case of two assets, dispersion can be defined as the difference between the return of each asset and the mean return of these two assets.

Solnik and Roulet (2000) present correlation as a function of dispersion and the standard deviation of the returns of a market portfolio. They introduce and test the concept of cross-sectional dispersion of stock market returns as an alternative and instantaneous measure of the general level of global market correlation. They demonstrate usefulness of dispersion to measure integration of global equity markets and find that equity markets become more integrated but at a slower pace than is proposed by prac-

tioners. These findings are consistent with Solnik et al. (1996) results, who stress that growth of new markets partly offsets the trend toward increasing correlation between international markets.

Statman and Scheid (2005) present dispersion as a function of correlations and standard deviation of individual assets. Statman and Scheid (2008) apply similar approach to an individual asset and global market portfolio. Their analysis shows that the benefits of diversification during down markets are higher compared to up markets between 1926 and 2007. Using Statman and Scheid (2008) approach, Realized Return Gap is calculated on the example of two assets as:

$$\text{Realized Return Gap} = 2\sigma \sqrt{\frac{(1-\rho)}{2}}, \quad (1)$$

where σ – mean standard deviation of asset returns and ρ – correlation between two assets. The return gap between the two assets is double the dispersion.

Return gap and diversification benefits are lower when correlation between assets is higher; however, return gap and diversification benefits are higher when standard deviation is higher between a pair of assets. Statman and Scheid (2008) warn against confusing a return gap and covariance. Both of them combine correlation and standard deviation; however, these two functions are different. Covariance and the return gap are higher when the standard deviation is higher. On the other hand, covariance is lower when correlation coefficient is lower but the return gap and diversification benefits are higher.

Bernstein and Pinkernell (2007) find that diversification benefits diminish over the years. However, their conclusion is challenged by Statman and Scheid (2008), who demonstrate that diversification benefits remain substantial when measured by return gap instead of coefficient of correlation only. They reveal that negative effects of an increase in correlation on the benefits of diversification are often mitigated by a simultaneous increase in standard deviation.

I collect monthly data for iShares representing 22 broad asset classes which include US broad equity market (iShares Russell 3000, iShares Russell 2000, iShares Russell Midcap, iShares S&P 1500, iShares S&P 500, iShares S&P Midcap, iShares S&P Small Cap 600), US industry-specific equity (iShares DJ US Basic Materials, iShares DJ US Consumer Goods, iShares DJ US Consumer Services, iShares DJ US Energy, iShares DJ US Financial Sector, iShares DJ US Technology Sector, iShares DJ US Telecommunications Sector), international equity (iShares MSCI EAFE, iShares MSCI Emerging Markets, iShares S&P Latin America 40), real estate

(iShares Cohen&Street Realty Majors, iShares DJ US Real Estate), US Treasury and investment grade corporate bonds (iShares Barclays US Multisector Aggregate Bond fund), and commodities (iShares S&P Goldman Sachs Commodity Index fund) between March 2001 and March 2011. Table 1 presents sample of iShares.

In 2009, US exchange-traded product assets – iShares – grew at a 46% growth rate, with net inflows of \$115 billion. As of 2010, iShares command 46% of the US ETF industry, offer more than 440 funds – \$480 billion in assets under management¹. The iShares family of ETFs is built around virtually every leading market index provider: Barclays Capital, Cohen & Steers, Dow Jones, JP Morgan, FTSE, MSCI, NASDAQ, Morningstar, NYSE, Russell and Standards and Poor's. iShares ETFs are diversified like index funds, seek to track specific market indexes; however, trade like a stock. Listed on all major stock exchanges (e.g., NYSE, AMEX, NASDAQ), they offer advantages of transparency, cost- and tax-efficiency, index exposure, and continuous pricing just like shares of publicly held company. They can be traded any time during normal trading hours, using all the trading strategies associated with stocks. Investors can pursue a variety of short-term and long-term investment strategies (e.g., equitizing, dividend investment, portfolio completion, tax-loss harvesting, investment selection through rebalancing and asset allocation, seeking "alpha") utilizing iShares. Simply put, the broad family of iShares ETFs makes diversification easy both across a variety of asset classes and across a range of geographies, sector funds, and styles, with low-cost, efficient funds tracking established indexes in virtually every asset class and category.

2. Empirical findings

Table 2 shows descriptive statistics for the sample of iShares. Over the sample period, iShares DJ US Energy Sector, iShares Cohen & Street Realty Majors, iShares DJ US Real Estate, iShares MSCI Emerging Markets, and iShares S&P Latin America 40 generated the highest average monthly rate of return (1.10%, 1.19%, 1.06%, 1.88%, and 2.17%). At the same time, these ETFs have exhibited the highest volatility of their returns (6.27%, 7.72%, 7.05%, 6.99%, and 7.93%) along with iShares S&P GSCI (7.99%) and iShares DJ US Technology sector (7.79%).

Next, I create four portfolios. Each portfolio has exposure to broad US market, international equity, real estate, US Treasury and investment grade corporate bonds, and commodities. Table 3 (Panel A

¹ <http://www.iShares.com>.

through Panel D) presents correlation coefficient between 17 (Panel A and B) and 18 (Panel C and D) asset classes. Results presented in Table 3 show that iShares DJ US Real Estate, iShares Cohen & Street Realty, iShares S&P Latin America 40, iShares S&P GSCI Commodity Indexed Trust, and iShares Barclays US Multisector Aggregate Bond Fund exhibit the lowest correlation with broad and sector-specific US equity and international equity markets. Higher correlations are undeniably associated with lower benefits of diversification, but relations between the two are far from perfect since standard deviation plays a role as well. For example, the correlation coefficient between iShares Russell 3000 and iShares Russell MidCap is 0.957 almost identical to the correlation between iShares S&P 1500 and iShares S&P MidCap (0.962). However, the benefits of diversification of two pairs of assets are quite different based on the realized return gap. The realized return gap for the first pair of assets is 7.4110% vs. 5.1444% for the later pair. Over the same period, correlation coefficient between iShares S&P 1500 and iShares S&P 500 is almost one (0.999) and realized return gap is less than one percent (0.2115%). Observation of realized return gap shows that diversification provided smaller benefits in this case. Investors should carefully consider portfolio composition when making their investment decisions. iShares S&P 1500 and iShares S&P 500 top 10 holdings are almost identical (companies and their weights in corresponding index funds).

Figure 1 (Panel A through F) shows some examples of correlation and realized monthly return gaps between asset classes for the sample period. Panels B, C, E, and F demonstrate the most striking picture.

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Results presented in Table 4 show that the benefits of diversification rank of asset pairs by correlation coefficient often differs from their rank based on realized return gap. For example, the (0.245) correlation between iShares Barclays US Multisector Aggregate Bond Fund and iShares DJ US Real Estate places this pair of assets first on benefits of diversification when ranked by correlation, but the pair's 107.7538% return gap places it only 47th when ranked by return gap. In fact, findings presented in Table 4, illustrate the importance of considering standard deviation along with coefficient of correlation when assessing diversification benefits across asset categories. Moreover, these results show that despite of increase within the US market, sector, industry and global market correlations the potential for further risk reduction through asset allocation and international diversification remains quite considerable.

Conclusion

Coefficient of correlation is the frequent indicator of portfolio diversification benefits; however, correlation alone does not offer an intuitive gauge of diversification benefits nor do these benefits depend only on the correlation between asset return. Findings of this study show that relative order of assets by diversification benefits is different when measured by correlation coefficient and by return gap. Furthermore, investors seeking portfolio diversification opportunities could combine coefficient of correlation and return gap in practical asset allocation to at least partially hedge out market exposure and invest more granularly in sectors, regions, countries, and asset categories.

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Appendix

Table 1. Sample of iShares

| iShares | Ticker | iShares | Ticker |
|---|--------|---|--------|
| iShares Russell 3000 | IWV | iShares DJ US Utilities Sector | IDU |
| iShares Russell MidCap | IWR | iShares S&P 1500 | ISI |
| iShares Russell 2000 | IWM | iShares S&P MidCap | IJH |
| iShares DJ US Basic Materials Sector | IYM | iShares S&P SmallCap 600 | IJR |
| iShares DJ US Consumer Goods Sector | IYK | iShares S&P 500 | IVV |
| iShares DJ US Consumer Services Sector | IYC | iShares MSCI EAFE | EFA |
| iShares DJ US Energy Sector | IYE | iShares MSCI Emerging Markets | EEM |
| iShares DJ US Financial Sector | IYF | iShares S&P Latin America 40 | ILF |
| iShares DJ US Technology Sector | IYW | iShares Barclays US Multisector Aggregate Bond Fund | AGG |
| iShares DJ US Telecommunications Sector | IYZ | iShares S&P GSCI* Commodity-Indexed Trust | GSG |
| iShares Cohen & Street Realty Majors | ICF | iShares DJ US Real Estate | IYR |

Table 2. Descriptive statistics

| iShares ticker | Number of monthly observations | Min, % | Max, % | Mean, % | Std. dev, % |
|----------------|--------------------------------|--------|--------|---------|-------------|
| IWV | 121 | -17.69 | 10.50 | 0.38 | 4.74 |
| IWR | 116 | -22.32 | 15.32 | 0.79 | 5.39 |
| IWM | 121 | -20.76 | 15.43 | 0.76 | 6.03 |
| IYM | 121 | -25.87 | 17.89 | 1.03 | 6.93 |
| IYK | 121 | -14.87 | 9.21 | 0.59 | 3.69 |
| IYC | 121 | -16.74 | 13.06 | 0.35 | 5.25 |
| IYE | 121 | -19.27 | 16.90 | 1.10 | 6.27 |
| IYF | 121 | -23.90 | 19.90 | 0.11 | 6.29 |
| IYW | 121 | -21.71 | 22.04 | 0.39 | 7.79 |
| IYZ | 121 | -20.81 | 28.76 | 0.002 | 6.52 |
| ICF | 121 | -33.18 | 33.59 | 1.19 | 7.72 |
| IYR | 121 | -31.20 | 29.52 | 1.06 | 7.05 |
| IDU | 121 | -12.77 | 10.16 | 0.35 | 4.43 |
| ISI | 86 | -17.30 | 10.21 | 0.49 | 4.53 |
| IJH | 121 | -21.68 | 14.82 | 0.81 | 5.36 |
| IJR | 121 | -20.00 | 17.00 | 0.85 | 5.76 |
| IVV | 121 | -16.76 | 9.55 | 0.32 | 4.62 |
| EFA | 115 | -20.11 | 12.78 | 0.64 | 5.31 |
| EEM | 95 | -25.7 | 16.0 | 1.88 | 6.99 |
| ILF | 113 | -31.60 | 20.37 | 2.17 | 7.93 |
| AGG | 92 | -2.67 | 3.96 | 0.39 | 1.04 |
| GSG | 57 | -27.77 | 19.52 | 0.005 | 7.99 |

Table 3. Correlation among iShares

| Panel A | | | | | | | | | | | | | | | | | | |
|---------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-----|
| | IWV | IWR | IWM | IYM | IYK | IYC | IYE | IYF | IYW | IYZ | IDU | ICF | EFA | EEM | EZU | ILF | AGG | GSG |
| IWV | 1 | | | | | | | | | | | | | | | | | |
| IWR | 0.971 | 1 | | | | | | | | | | | | | | | | |
| IWM | 0.919 | 0.957 | 1 | | | | | | | | | | | | | | | |
| IYM | 0.866 | 0.881 | 0.802 | 1 | | | | | | | | | | | | | | |
| IYK | 0.817 | 0.800 | 0.760 | 0.694 | 1 | | | | | | | | | | | | | |
| IYC | 0.924 | 0.918 | 0.892 | 0.787 | 0.737 | 1 | | | | | | | | | | | | |
| IYE | 0.653 | 0.672 | 0.595 | 0.706 | 0.507 | 0.480 | 1 | | | | | | | | | | | |
| IYF | 0.862 | 0.831 | 0.807 | 0.704 | 0.766 | 0.808 | 0.413 | 1 | | | | | | | | | | |
| IYW | 0.865 | 0.838 | 0.801 | 0.704 | 0.565 | 0.808 | 0.500 | 0.624 | 1 | | | | | | | | | |
| IYZ | 0.764 | 0.701 | 0.627 | 0.614 | 0.571 | 0.681 | 0.485 | 0.599 | 0.663 | 1 | | | | | | | | |
| IDU | 0.653 | 0.664 | 0.600 | 0.563 | 0.586 | 0.508 | 0.666 | 0.475 | 0.481 | 0.556 | 1 | | | | | | | |
| ICF | 0.678 | 0.738 | 0.720 | 0.621 | 0.618 | 0.640 | 0.353 | 0.784 | 0.445 | 0.394 | 0.421 | 1 | | | | | | |
| EFA | 0.897 | 0.886 | 0.819 | 0.851 | 0.794 | 0.764 | 0.711 | 0.787 | 0.715 | 0.651 | 0.703 | 0.654 | 1 | | | | | |
| EEM | 0.835 | 0.839 | 0.781 | 0.857 | 0.707 | 0.690 | 0.716 | 0.667 | 0.771 | 0.678 | 0.618 | 0.610 | 0.902 | 1 | | | | |
| EZU | 0.894 | 0.872 | 0.804 | 0.819 | 0.757 | 0.773 | 0.666 | 0.772 | 0.749 | 0.689 | 0.669 | 0.611 | 0.966 | 0.861 | 1 | | | |
| ILF | 0.792 | 0.788 | 0.709 | 0.798 | 0.671 | 0.664 | 0.716 | 0.628 | 0.660 | 0.665 | 0.662 | 0.531 | 0.834 | 0.922 | 0.803 | 1 | | |
| AGG | -0.177 | -0.207 | -0.191 | -0.127 | -0.199 | -0.192 | -0.167 | -0.183 | -0.089 | -0.037 | -0.055 | -0.242 | -0.147 | -0.119 | -0.103 | -0.153 | 1 | |
| GSG | 0.352 | 0.398 | 0.295 | 0.487 | 0.259 | 0.333 | 0.333 | 0.321 | 0.292 | 0.320 | 0.233 | 0.323 | 0.378 | 0.380 | 0.331 | 0.449 | -0.233 | 1 |

Table 3 (cont.). Correlation among iShares

| Panel B | | | | | | | | | | | | | | | | | | |
|---------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-----|
| | IWV | IWR | IWM | IYM | IYK | IYC | IYE | IYF | IYW | IYZ | IDU | IYR | EFA | EEM | EZU | ILF | AGG | GSG |
| IWV | 1 | | | | | | | | | | | | | | | | | |
| IWR | 0.971 | 1 | | | | | | | | | | | | | | | | |
| IWM | 0.919 | 0.957 | 1 | | | | | | | | | | | | | | | |
| IYM | 0.866 | 0.881 | 0.802 | 1 | | | | | | | | | | | | | | |
| IYK | 0.817 | 0.800 | 0.760 | 0.694 | 1 | | | | | | | | | | | | | |
| IYC | 0.924 | 0.918 | 0.892 | 0.787 | 0.737 | 1 | | | | | | | | | | | | |
| IYE | 0.653 | 0.672 | 0.595 | 0.706 | 0.507 | 0.480 | 1 | | | | | | | | | | | |
| IYF | 0.862 | 0.831 | 0.807 | 0.704 | 0.766 | 0.808 | 0.413 | 1 | | | | | | | | | | |
| IYW | 0.865 | 0.838 | 0.801 | 0.704 | 0.565 | 0.808 | 0.500 | 0.624 | 1 | | | | | | | | | |
| IYZ | 0.764 | 0.701 | 0.627 | 0.614 | 0.571 | 0.681 | 0.485 | 0.599 | 0.663 | 1 | | | | | | | | |
| IDU | 0.653 | 0.664 | 0.600 | 0.563 | 0.586 | 0.508 | 0.666 | 0.475 | 0.481 | 0.556 | 1 | | | | | | | |
| IYR | 0.709 | 0.768 | 0.754 | 0.646 | 0.645 | 0.675 | 0.367 | 0.808 | 0.473 | 0.421 | 0.421 | 1 | | | | | | |
| EFA | 0.897 | 0.886 | 0.819 | 0.851 | 0.794 | 0.764 | 0.711 | 0.787 | 0.715 | 0.651 | 0.703 | 0.676 | 1 | | | | | |
| EEM | 0.835 | 0.839 | 0.781 | 0.857 | 0.707 | 0.690 | 0.716 | 0.667 | 0.771 | 0.678 | 0.618 | 0.633 | 0.902 | 1 | | | | |
| EZU | 0.894 | 0.872 | 0.804 | 0.819 | 0.757 | 0.773 | 0.666 | 0.772 | 0.749 | 0.689 | 0.669 | 0.632 | 0.966 | 0.861 | 1 | | | |
| ILF | 0.792 | 0.788 | 0.709 | 0.798 | 0.671 | 0.664 | 0.716 | 0.628 | 0.660 | 0.665 | 0.662 | 0.557 | 0.834 | 0.922 | 0.803 | 1 | | |
| AGG | -0.177 | -0.207 | -0.191 | -0.127 | -0.199 | -0.192 | -0.167 | -0.183 | -0.089 | -0.037 | -0.055 | -0.245 | -0.147 | -0.119 | -0.103 | -0.153 | 1 | |
| GSG | 0.352 | 0.398 | 0.295 | 0.487 | 0.259 | 0.333 | 0.333 | 0.321 | 0.292 | 0.320 | 0.233 | 0.329 | 0.378 | 0.380 | 0.331 | 0.449 | -0.233 | 1 |

Table 3 (cont.). Correlation among iShares

| Panel C | | | | | | | | | | | | | | | | | | | |
|---------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-----|
| | ISI | IVV | IJH | IJR | IYM | IYK | IYC | IYE | IYF | IYW | IYZ | IDU | ICF | EFA | EEM | EZU | ILF | AGG | GSG |
| ISI | 1 | | | | | | | | | | | | | | | | | | |
| IVV | 0.999 | 1 | | | | | | | | | | | | | | | | | |
| IJH | 0.962 | 0.934 | 1 | | | | | | | | | | | | | | | | |
| IJR | 0.927 | 0.876 | 0.960 | 1 | | | | | | | | | | | | | | | |
| IYM | 0.880 | 0.857 | 0.868 | 0.800 | 1 | | | | | | | | | | | | | | |
| IYK | 0.888 | 0.816 | 0.779 | 0.765 | 0.694 | 1 | | | | | | | | | | | | | |
| IYC | 0.921 | 0.915 | 0.917 | 0.890 | 0.787 | 0.737 | 1 | | | | | | | | | | | | |
| IYE | 0.667 | 0.649 | 0.669 | 0.601 | 0.706 | 0.507 | 0.480 | 1 | | | | | | | | | | | |
| IYF | 0.877 | 0.864 | 0.803 | 0.807 | 0.704 | 0.766 | 0.808 | 0.413 | 1 | | | | | | | | | | |
| IYW | 0.886 | 0.860 | 0.827 | 0.765 | 0.704 | 0.565 | 0.808 | 0.500 | 0.624 | 1 | | | | | | | | | |
| IYZ | 0.791 | 0.775 | 0.673 | 0.604 | 0.614 | 0.571 | 0.681 | 0.485 | 0.599 | 0.663 | 1 | | | | | | | | |
| IDU | 0.672 | 0.648 | 0.644 | 0.579 | 0.563 | 0.586 | 0.508 | 0.666 | 0.475 | 0.481 | 0.556 | 1 | | | | | | | |
| ICF | 0.777 | 0.656 | 0.705 | 0.730 | 0.621 | 0.618 | 0.640 | 0.353 | 0.784 | 0.445 | 0.394 | 0.421 | 1 | | | | | | |
| EFA | 0.901 | 0.895 | 0.864 | 0.808 | 0.851 | 0.794 | 0.764 | 0.711 | 0.787 | 0.715 | 0.651 | 0.703 | 0.654 | 1 | | | | | |
| EEM | 0.827 | 0.827 | 0.826 | 0.772 | 0.857 | 0.707 | 0.690 | 0.716 | 0.667 | 0.771 | 0.678 | 0.618 | 0.610 | 0.902 | 1 | | | | |
| EZU | 0.893 | 0.896 | 0.843 | 0.796 | 0.819 | 0.757 | 0.773 | 0.666 | 0.772 | 0.749 | 0.689 | 0.669 | 0.611 | 0.966 | 0.861 | 1 | | | |
| ILF | 0.801 | 0.686 | 0.738 | 0.762 | 0.646 | 0.645 | 0.675 | 0.367 | 0.628 | 0.473 | 0.421 | 0.448 | 0.531 | 0.676 | 0.922 | 0.803 | 1 | | |
| AGG | -0.193 | -0.169 | -0.206 | -0.202 | -0.127 | -0.199 | -0.192 | -0.167 | -0.183 | -0.089 | -0.037 | -0.055 | -0.242 | -0.147 | -0.119 | -0.103 | -0.153 | 1 | |
| GSG | 0.349 | 0.343 | 0.392 | 0.306 | 0.487 | 0.260 | 0.333 | 0.333 | 0.321 | 0.292 | 0.321 | 0.233 | 0.323 | 0.378 | 0.380 | 0.331 | 0.449 | -0.233 | 1 |

Table 3 (cont.). Correlation among iShares

| Panel D | | | | | | | | | | | | | | | | | | | |
|---------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-----|
| | ISI | IVV | IJH | IJR | IYM | IYK | IYC | IYE | IYF | IYW | IYZ | IDU | IYR | EFA | EEM | EZU | ILF | AGG | GSG |
| ISI | 1 | | | | | | | | | | | | | | | | | | |
| IVV | 0.999 | 1 | | | | | | | | | | | | | | | | | |
| IJH | 0.962 | 0.934 | 1 | | | | | | | | | | | | | | | | |
| IJR | 0.927 | 0.876 | 0.960 | 1 | | | | | | | | | | | | | | | |
| IYM | 0.880 | 0.857 | 0.868 | 0.800 | 1 | | | | | | | | | | | | | | |
| IYK | 0.888 | 0.816 | 0.779 | 0.765 | 0.694 | 1 | | | | | | | | | | | | | |
| IYC | 0.921 | 0.915 | 0.917 | 0.890 | 0.787 | 0.737 | 1 | | | | | | | | | | | | |
| IYE | 0.667 | 0.649 | 0.669 | 0.601 | 0.706 | 0.507 | 0.480 | 1 | | | | | | | | | | | |
| IYF | 0.877 | 0.864 | 0.803 | 0.807 | 0.704 | 0.766 | 0.808 | 0.413 | 1 | | | | | | | | | | |
| IYW | 0.886 | 0.860 | 0.827 | 0.765 | 0.704 | 0.565 | 0.808 | 0.500 | 0.624 | 1 | | | | | | | | | |
| IYZ | 0.791 | 0.775 | 0.673 | 0.604 | 0.614 | 0.571 | 0.681 | 0.485 | 0.599 | 0.663 | 1 | | | | | | | | |
| IDU | 0.672 | 0.648 | 0.644 | 0.579 | 0.563 | 0.586 | 0.508 | 0.666 | 0.475 | 0.481 | 0.556 | 1 | | | | | | | |
| IYR | 0.801 | 0.686 | 0.738 | 0.762 | 0.646 | 0.645 | 0.675 | 0.367 | 0.808 | 0.473 | 0.421 | 0.421 | 1 | | | | | | |
| EFA | 0.901 | 0.895 | 0.864 | 0.808 | 0.851 | 0.794 | 0.764 | 0.711 | 0.787 | 0.715 | 0.651 | 0.703 | 0.676 | 1 | | | | | |
| EEM | 0.827 | 0.827 | 0.826 | 0.772 | 0.857 | 0.707 | 0.690 | 0.716 | 0.667 | 0.771 | 0.678 | 0.618 | 0.633 | 0.902 | 1 | | | | |
| EZU | 0.893 | 0.896 | 0.843 | 0.796 | 0.819 | 0.757 | 0.773 | 0.666 | 0.772 | 0.749 | 0.689 | 0.669 | 0.632 | 0.966 | 0.861 | 1 | | | |
| ILF | 0.801 | 0.686 | 0.738 | 0.762 | 0.646 | 0.645 | 0.675 | 0.367 | 0.628 | 0.473 | 0.421 | 0.448 | 0.557 | 0.676 | 0.922 | 0.803 | 0.801 | | |
| AGG | -0.193 | -0.169 | -0.206 | -0.202 | -0.127 | -0.199 | -0.192 | -0.167 | -0.183 | -0.089 | -0.037 | -0.055 | -0.245 | -0.147 | -0.119 | -0.103 | -0.153 | 1 | |
| GSG | 0.349 | 0.343 | 0.392 | 0.306 | 0.487 | 0.260 | 0.333 | 0.333 | 0.321 | 0.292 | 0.321 | 0.233 | 0.329 | 0.378 | 0.380 | 0.331 | 0.449 | -0.233 | 1 |

Table 4. Realized return gap

| Panel A | | | | | | | | | | | | | | | | | |
|---------|--------------------------------|---------------------------------|----------------------------------|-----------------------------------|---------------------------------|----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|----------------------------------|---------------------------------|----------------------------------|-----|-----|-----|-----|-----|
| | IWV | IWR | IWM | IYM | IYK | IYC | IYE | IYF | IYW | IYZ | IDU | ICF | EFA | EEM | EZU | ILF | AGG |
| IWR | 7.4110 3.0888- 9.6863 | | | | | | | | | | | | | | | | |
| IWM | 33.2785 14.6822- 52.5287 | 9.9316 0.2148- 13.4794 | | | | | | | | | | | | | | | |
| IYM | 28.0253 5.5412- 36.9138 | 29.3321 0.0901- 36.8672 | 51.4209 1.2654- 64.7744 | | | | | | | | | | | | | | |
| IYK | 53.9535 0.5282- 71.3666 | 52.0363 0.6770- 61.6125 | 82.0538 45.7245- 100.1073 | 92.6885 28.3963- 130.2322 | | | | | | | | | | | | | |
| IYC | 15.0622 2.0844- 18.1319 | 22.4850 0.9386- 29.0567 | 35.3524 17.0339- 41.8977 | 56.8019 5.9190- 81.1287 | 54.3343 22.5792- 71.1979 | | | | | | | | | | | | |
| IYE | 72.2068 9.9244- 84.3830 | 71.4228 1.3511- 89.4434 | 98.1172 3.1561- 122.3225 | 94.3081 30.5023- 106.4191 | 77.4648 52.7689- 96.6829 | 117.1848 25.5692- 139.7230 | | | | | | | | | | | |
| IYF | 51.4207 55.0989- 64.7744 | 82.0537 66.7715- 100.1073 | 92.6889 97.2897- 130.2322 | 166.9254 119.4233- 413.6575 | 43.4698 34.5425- 147.7579 | 54.3082 34.7061- 465.2763 | 225.9841 175.3039- 382.6059 | | | | | | | | | | |
| IYW | 26.9081 14.2488- 36.6678 | 43.4203 6.2186- 63.6576 | 55.4638 23.6504- 74.7585 | 95.0657 71.3142- 110.4549 | 86.9695 72.7209- 111.0607 | 48.3260 23.1361- 58.6729 | 142.7629 69.4703- 161.7245 | 110.6939 114.0127- 149.7049 | | | | | | | | | |
| IYZ | 55.8117 25.4789- 93.4344 | 85.6437 27.0699- 139.7139 | 117.9592 59.1909- 156.1405 | 123.7637 50.7982- 149.9152 | 74.4621 30.2847- 86.1158 | 86.0858 35.6193- 128.3073 | 141.1386 53.9080- 161.4628 | 110.6467 149.4891- 180.1585 | 162.9143 0-330.0663 | | | | | | | | |
| IDU | 74.8547 14.2306- 93.5853 | 76.5519 1.1127- 90.6091 | 96.4652 52.4147- 120.6058 | 135.5838 41.4684- 152.1857 | 67.2584 54.5926- 77.5583 | 114.0601 36.9701- 129.0545 | 78.0297 12.9489- 105.7459 | 98.1944 48.8213- 353.9545 | 232.6611 0-310.2598 | 171.1116 52.1590- 261.7410 | | | | | | | |
| ICF | 21.2305 1.3906- 53.5318 | 28.8655 2.5029- 46.7925 | 91.2534 38.2099- 108.8179 | 104.9919 46.9478- 142.1934 | 62.1117 25.0509- 78.6967 | 112.1022 76.2361- 139.3048 | 157.1419 87.6188- 202.7063 | 65.7883 44.7030- 108.7183 | 89.6323 64.5891- 130.6269 | 177.5101 27.1495- 253.1782 | 104.7553 4.8976- 128.0261 | | | | | | |
| EFA | 19.3870 0.1119- 24.5299 | 22.8881 16.5488- 30.6008 | 39.5640 26.5017- 54.4830 | 41.6368 29.4029- 51.7889 | 32.6694 24.3639- 41.2203 | 49.8145 35.7290- 61.8111 | 78.6977 51.3727- 92.6924 | 97.5132 58.9751- 58.9751 | 116.2368 102.9572- 134.5021 | 72.0333 23.3265- 85.0217 | 54.3709 4.9750- 65.8142 | 108.1047 30.7785- 133.8215 | | | | | |

Table 4 (cont.). Realized return gap

| Panel A | | | | | | | | | | | | | | | | | | |
|---------|----------------------------------|----------------------------------|-----------------------------------|----------------------------------|----------------------------------|----------------------------------|-----------------------------------|-----------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|-----------------------------------|----------------------------------|-------------------------------|--|
| | IWV | IWR | IWM | IYM | IYK | IYC | IYE | IYF | IYW | IYZ | IDU | ICF | EFA | EEM | EZU | ILF | AGG | |
| EEM | 23.2347 0.3216- 39.1638 | 27.3930 0.7387- 43.4067 | 39.7636 1.1229- 66.0672 | 37.9887 0.6228- 51.9318 | 42.4069 0.0532- 60.2351 | 55.2185 1.7601- 89.8306 | 66.7314 2.4819- 88.9454 | 128.5426 123.1668- 184.0022 | 94.5290 24.4179- 126.9217 | 103.9949 32.7154- 137.2559 | 68.4548 9.8727- 86.6328 | 98.4105 17.7898- 150.4181 | 15.55414 0.1926- 26.0168 | | | | | |
| EZU | 19.1477 0.5982- 25.7654 | 22.7598 0.3751- 34.4539 | 33.0403 0.3726- 49.2326 | 48.3609 23.8809- 62.6287 | 44.8015 39.2955- 51.5986 | 47.3379 34.4550- 59.4519 | 82.9204 26.4930- 104.7309 | 90.4294 86.94111- 141.3458 | 48.1109 33.1630- 71.7215 | 102.7643 34.6096- 151.0517 | 61.7184 6.3350- 73.1611 | 140.9614 37.2296- 158.9277 | 7.9759 0.6114- 10.2967 | 33.8307 1.3715- 48.5310 | | | | |
| ILF | 33.6184 4.3998- 49.2362 | 38.5484 2.4225- 57.2114 | 65.8488 50.0948- 87.8009 | 69.0813 60.2432- 77.8677 | 49.9407 27.7793- 61.7253 | 67.4973 41.2304- 88.1441 | 85.6349 73.5974- 95.6748 | 133.5921 153.665- 194.061 | 65.6531 28.1553- 117.0281 | 140.9614 37.2296- 158.9277 | 108.9012 67.8255- 165.6879 | 130.0650 29.8455- 181.2096 | 35.9564 16.7873- 44.0529 | 21.6003 10.1084- 27.3160 | 430.5784 317.0454- 878.9722 | | | |
| AGG | 140.6272 23.5198- 279.7326 | 165.7637 21.9564- 325.8627 | 240.2194 151.0416- 360.5800 | 248.2695 144.0997- 391.613 | 149.4700 93.2685- 222.1035 | 202.6546 118.5225- 312.980 | 266.6204 190.6336- 365.8344 | 372.2469 34.4343- 589.4079 | 228.6318 96.6310- 372.1252 | 165.4610 5.2342- 339.3807 | 145.1863 41.7016- 233.6003 | 228.4187 23.7487- 479.5056 | 171.0606 40.6226- 304.3016 | 234.6373 53.4689- 393.0374 | 195.1662 32.6570- 373.9336 | 271.3859 56.4555- 458.2154 | | |
| GSG | 77.3979 0.4579- 153.6993 | 81.1138 0.2751- 162.2123 | 103.3058 0.0079- 213.0720 | 85.5512 0.2092- 177.4597 | 71.6668 0.3247- 136.7178 | 86.8600 0.0641- 174.9604 | 115.2068 0.4874- 209.0054 | 211.5994 204.2859- 292.1392 | 107.7538 0.7716- 213.5523 | 121.2909 22.8212- 222.2250 | 94.6438 16.4103- 169.8725 | 137.555 18.1501- 259.5064 | 85.1943 17.5814- 165.1549 | 15.1215 0.4582- 289.2652 | 115.1605 23.3369- 226.7626 | 117.0571 16.7565- 218.8531 | 28.8226 4.1316- 54.4938 | |

Table 4 (cont.). Realized return gap

| Panel B | | | | | | | | | | | | | | | | | |
|---------|--------------------------------|---------------------------------|----------------------------------|-----------------------------------|---------------------------------|----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|----------------------------------|-----------------------------------|--------------------------------|-----|-----|-----|-----|-----|
| | IWV | IWR | IWM | IYM | IYK | IYC | IYE | IYF | IYW | IYZ | IDU | IYR | EFA | EEM | EZU | ILF | AGG |
| IWR | 7.4110 3.0888- 9.6863 | | | | | | | | | | | | | | | | |
| IWM | 33.2785 14.6822- 52.5287 | 9.9316 0.2148- 13.4794 | | | | | | | | | | | | | | | |
| IYM | 28.0253 5.5412- 36.9138 | 29.3321 0.0901- 36.8672 | 51.4209 1.2654- 64.7744 | | | | | | | | | | | | | | |
| IYK | 53.9535 0.5282- 71.3666 | 52.0363 0.6770- 61.6125 | 82.0538 45.7245- 100.1073 | 92.6885 28.3963- 130.2322 | | | | | | | | | | | | | |
| IYC | 15.0622 2.0844- 18.1319 | 22.4850 0.9386- 29.0567 | 35.3524 17.0339- 41.8977 | 56.8019 5.9190- 81.1287 | 54.3343 22.5792- 71.1979 | | | | | | | | | | | | |
| IYE | 72.2068 9.9244- 84.3830 | 71.4228 1.3511- 89.4434 | 98.1172 3.1561- 122.3225 | 94.3081 30.5023- 106.4191 | 77.4648 52.7689- 96.6829 | 117.1848 25.5692- 139.7230 | | | | | | | | | | | |
| IYF | 51.4207 55.0989- 64.7744 | 82.0537 66.7715- 100.1073 | 92.6889 97.2897- 130.2322 | 166.9254 119.4233- 413.6575 | 43.4698 34.5425- 147.7579 | 54.3082 34.7061- 465.2763 | 225.9841 175.3039- 382.6059 | | | | | | | | | | |
| IYW | 26.9081 14.2488- 36.6678 | 43.4203 6.2186- 63.6576 | 55.4638 23.6504- 74.7585 | 95.0657 71.3142- 110.4549 | 86.9695 72.7209- 111.0607 | 48.3260 23.1361- 58.6729 | 142.7629 69.4703- 161.7245 | 110.6939 114.0127- 149.7049 | | | | | | | | | |
| IYZ | 55.8117 25.4789- 93.4344 | 85.6437 27.0699- 139.7139 | 117.9592 59.1909- 156.1405 | 123.7637 50.7982- 149.9152 | 74.4621 30.2847- 86.1158 | 86.0858 35.6193- 128.3073 | 141.1386 53.9080- 161.4628 | 110.6467 149.4891- 180.1585 | 162.9143 0-330.0663 | | | | | | | | |
| IDU | 74.8547 14.2306- 93.5853 | 76.5519 1.1127- 90.6091 | 96.4652 52.4147- 120.6058 | 135.5838 41.4684- 152.1857 | 67.2584 54.5926- 77.5583 | 114.0601 36.9701- 129.0545 | 78.0297 12.9489- 105.7459 | 98.1944 48.8213- 353.9545 | 232.6611 0-310.2598 | 171.1116 52.1590- 261.7410 | | | | | | | |
| IYR | 26.1322 30.0264- 33.3687 | 71.2305 61.2088- 83.5318 | 47.8032 52.2669- 59.1661 | 64.7655 93.8188- 116.6804 | 37.8686 38.9142- 46.0912 | 43.3688 44.3527- 53.2693 | 134.8137 167.8892- 200.2954 | 65.7883 44.7030- 108.7183 | 89.6326 111.5095- 130.6269 | 73.557 113.9247- 126.0332 | 249.6953 193.7375- 355.6550 | | | | | | |
| EFA | 19.3870 0.1119- 24.5299 | 22.8881 16.5488- 30.6008 | 39.5640 26.5017- 54.4830 | 41.6368 29.4029- 51.7889 | 32.6694 24.3639- 41.2203 | 49.8145 35.7290- 61.8111 | 78.6977 51.3727- 92.6924 | 97.5132 58.9751- 58.9751 | 116.2368 102.9572- 134.5021 | 72.0333 23.3265- 85.0217 | 54.3709 4.9750- 65.8142 | 42.3020 62.2595- 66.9734 | | | | | |

Table 4 (cont.). Realized return gap

| Panel B | | | | | | | | | | | | | | | | | | |
|---------|----------------------------------|----------------------------------|-----------------------------------|----------------------------------|----------------------------------|----------------------------------|-----------------------------------|-----------------------------------|----------------------------------|----------------------------------|----------------------------------|-----------------------------------|----------------------------------|----------------------------------|-----------------------------------|----------------------------------|-------------------------------|--|
| | IWV | IWR | IWM | IYM | IYK | IYC | IYE | IYF | IYW | IYZ | IDU | IYR | EFA | EEM | EZU | ILF | AGG | |
| EEM | 23.2347 0.3216- 39.1638 | 27.3930 0.7387- 43.4067 | 39.7636 1.1229- 66.0672 | 37.9887 0.6228- 51.9318 | 42.4069 0.0532- 60.2351 | 55.2185 1.7601- 89.8306 | 66.7314 2.4819- 88.9454 | 128.5426 123.1668- 184.0022 | 94.5290 24.4179- 126.9217 | 103.9949 32.7154- 137.2559 | 68.4548 9.8727- 86.6328 | 59.1611 91.4361- 104.6749 | 15.5541 0.1926- 26.0168 | | | | | |
| EZU | 19.1477 0.5982- 25.7654 | 22.7598 0.3751- 34.4539 | 33.0403 0.3726- 49.2326 | 48.3609 23.8809- 62.6287 | 44.8015 39.2955- 51.5986 | 47.3379 34.4550- 59.4519 | 82.9204 26.4930- 104.7309 | 90.4294 86.94111- 141.3458 | 48.1109 33.1630- 71.7215 | 102.7643 34.6096- 151.0517 | 61.7184 6.3350- 73.1611 | 48.1109 65.3274- 71.7215 | 7.9759 0.6114- 10.2967 | 33.8307 1.3715- 48.5310 | | | | |
| ILF | 33.6184 4.3998- 49.2362 | 38.5484 2.4225- 57.2114 | 65.8488 50.0948- 87.8009 | 69.0813 60.2432- 77.8677 | 49.9407 27.7793- 61.7253 | 67.4973 41.2304- 88.1441 | 85.6349 73.5974- 95.6748 | 133.5921 153.665- 194.061 | 65.6531 28.1553- 117.0281 | 140.9614 37.2296- 158.9277 | 108.9012 67.8255- 165.6879 | 65.6531 103.9520- 117.0281 | 35.9564 16.7873- 44.0529 | 21.6003 10.1084- 27.3160 | 430.5784 317.0454- 878.9722 | | | |
| AGG | 140.6272 23.5198- 279.7326 | 165.7637 21.9564- 325.8627 | 240.2194 151.0416- 360.5800 | 248.2695 144.0997- 391.613 | 149.4700 93.2685- 222.1035 | 202.6546 118.5225- 312.980 | 266.6204 190.6336- 365.8344 | 372.2469 34.4343- 589.4079 | 228.6318 96.6310- 372.1252 | 165.4610 5.2342- 339.3807 | 145.1863 41.7016- 233.6003 | 107.7538 163.5971- 213.5523 | 171.0606 40.6226- 304.3016 | 234.6373 53.4689- 393.0374 | 195.1662 32.6570- 373.9336 | 271.3859 56.4555- 458.2154 | | |
| GSG | 77.3979 0.4579- 153.6993 | 81.1138 0.2751- 162.2123 | 103.3058 0.0079- 213.0720 | 85.5512 0.2092- 177.4597 | 71.6668 0.3247- 136.7178 | 86.8600 0.0641- 174.9604 | 115.2068 0.4874- 209.0054 | 211.5994 204.2859- 292.1392 | 107.7538 0.7716- 213.5523 | 121.2909 22.8212- 222.2250 | 94.6438 16.4103- 169.8725 | 81.1138 115.4916- 162.2123 | 85.1943 17.5814- 165.1549 | 15.1215 0.4582- 289.2652 | 115.1605 23.3369- 226.7626 | 117.0571 16.7565- 218.8531 | 28.8226 4.1316- 54.4938 | |

Table 4 (cont.). Realized return gap

| Panel C | | | | | | | | | | | | | | | | | | |
|---------|--------------------------------|-----------------------------------|----------------------------------|-----------------------------------|-----------------------------------|---------------------------------|----------------------------------|-----------------------------------|-----------------------------------|---------------------------------|----------------------------------|---------------------------------|-----|-----|-----|-----|-----|-----|
| | ISI | IVV | IJH | IJR | IYM | IYK | IYC | IYE | IYF | IYW | IYZ | IDU | ICF | EFA | EEM | EZU | ILF | AGG |
| IVV | 0.2115 0.1236- 0.2761 | | | | | | | | | | | | | | | | | |
| IJH | 5.1444 1.7250- 9.3283 | 19.1441 7.6884- 87.6509 | | | | | | | | | | | | | | | | |
| IJR | 12.0589 6.1560- 18.0029 | 84.4853 64.9751- 109.8982 | 12.5102 13.5962- 22.8415 | | | | | | | | | | | | | | | |
| IYM | 19.1939 2.6156- 32.5682 | 57.6338 26.0085- 156.5087 | 24.5593 49.3101 | 45.4283 48.1709- 106.6294 | | | | | | | | | | | | | | |
| IYK | 22.0786 9.4926- 28.7126 | 37.5315 17.5046- 211.4267 | 50.5490 43.5883- 93.3685 | 120.4523 95.1182- 232.4245 | 92.6885 28.3963- 130.2322 | | | | | | | | | | | | | |
| IYC | 13.6609 2.3191- 19.7214 | 29.5738 17.7202- 78.7826 | 24.8417 19.043- 37.1484 | 27.9734 16.7859- 62.7313 | 56.8019 5.9190- 81.1287 | 54.3343 22.5792- 71.1979 | | | | | | | | | | | | |
| IYE | 59.3512 4.2806- 82.7974 | 121.4813 61.1474- 452.6779 | 100.3933 85.6907- 334.4615 | 150.7819 109.1977- 490.6122 | 94.3081 30.5023- 106.4191 | 77.4648 52.7689- 96.6829 | 117.1848 25.5692- 139.7230 | | | | | | | | | | | |
| IYF | 19.1441 6.1877- 30.4325 | 52.8125 24.9968- 452.6779 | 70.0115 48.9017- 334.4615 | 89.3429 38.3694- 490.6122 | 166.9254 119.4233- 413.6575 | 43.4698 34.5425- 147.7579 | 54.3082 34.7061- 465.2763 | 225.9841 175.3039- 382.6059 | | | | | | | | | | |
| IYW | 20.6627 15.7624- 28.0372 | 33.0794 21.2974- 74.0273 | 26.1002 25.9731- 40.4039 | 46.5097 36.0669- 80.4434 | 95.0657 71.3142- 110.4549 | 86.9695 72.7209- 111.0607 | 48.3260 23.1361- 58.6729 | 142.7629 69.4703- 161.7245 | 110.6939 114.0127- 149.7049 | | | | | | | | | |
| IYZ | 37.3920 25.3811- 51.5680 | 58.6059 43.6270- 186.4502 | 61.8640 57.1983- 145.1727 | 91.4308 69.6486- 254.8720 | 123.7637 50.7982- 149.9152 | 74.4621 30.2847- 86.1158 | 86.0858 35.6193- 128.3073 | 141.1386 53.9080- 161.4628 | 110.6467 149.4891- 180.1585 | 162.9143 0-330.0663 | | | | | | | | |
| IDU | 49.2460 8.2404- 81.3917 | 115.2213 63.6778- 452.6779 | 97.5252 93.1865- 334.4615 | 145.1323 109.8449- 490.6122 | 135.5838 41.4684- 152.1857 | 67.2584 54.5926- 77.5583 | 114.0601 36.9701- 105.0545 | 78.0297 12.9489- 105.7459 | 98.1944 48.8213- 353.9545 | 232.6611 0-310.2598 | 171.1116 52.1590- 261.7410 | | | | | | | |
| ICF | 25.8966 26.3273- 55.2016 | 177.5101 172.3753- 253.1782 | 65.3916 49.9394- 334.4615 | 82.3667 32.3569- 490.6122 | 104.9919 46.9478- 142.1934 | 62.1117 25.0509- 78.6967 | 112.1022 76.2361- 139.3048 | 157.1419 87.6188- 202.7063 | 65.7883 44.7030- 108.7183 | 89.6323 64.5891- 130.6269 | 177.5101 27.1495- 253.1782 | 104.7553 4.8976- 128.0261 | | | | | | |

Table 4 (cont.). Realized return gap

| Panel C | | | | | | | | | | | | | | | | | | | |
|---------|----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|----------------------------------|----------------------------------|----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|-----------------------------------|----------------------------------|-------------------------------|--|
| | ISI | IVV | IJH | IJR | IYM | IYK | IYC | IYE | IYF | IYW | IYZ | IDU | ICF | EFA | EEM | EZU | ILF | AGG | |
| EFA | 13.3351 1.1154- 24.4274 | 43.9298 18.6655- 194.2416 | 34.9624 30.6339- 81.2836 | 65.0366 49.4729- 154.7494 | 41.6368 29.4029- 51.7889 | 32.6694 24.3639- 41.2203 | 49.8145 35.7290- 61.8111 | 78.6977 51.3727- 92.6924 | 97.5132 58.9751- 58.9751 | 116.2368 102.9572 -134.5021 | 72.0333 23.3265- 85.0217 | 54.3709 4.9750- 65.8142 | 108.1047 30.7785- 133.8215 | | | | | | |
| EEM | 25.2106 8.4735- 42.7160 | 79.7497 32.1660 452.6779 | 62.5853 42.8625- 334.4615 | 101.9875 62.4399- 490.6122 | 39.7636 1.1229- 60.0672 | 42.4069 0.0532- 60.2351 | 55.2185 1.7601- 89.8306 | 66.7314 2.4819- 88.9454 | 128.5426 123.1668 -184.0022 | 94.5290 24.4179- 126.9217 | 103.9949 32.7154- 137.2559 | 68.4548 9.8727- 86.6328 | 98.4105 17.7898- 150.4181 | 15.5541 0.1926- 26.0168 | | | | | |
| EZU | 11.2209 2.1144- 26.5443 | 33.1766 20.3665- 108.4794 | 33.1373 34.5767- 63.2156 | 59.5305 48.0191- 124.8853 | 48.3609 23.8809- 62.6287 | 44.8015 39.2955- 51.5986 | 47.3389 34.4550- 59.4519 | 82.9204 26.4930- 104.7309 | 90.4294 86.94111 -141.3458 | 48.1109 33.1630- 71.7215 | 102.7643 34.6096- 151.0517 | 61.7184 6.3350- 73.1611 | 140.9614 37.2296- 158.9277 | 7.9759 0.6114- 10.2967 | 33.8307 1.3715- 48.5310 | | | | |
| ILF | 30.2856 7.3175- 55.3688 | 75.2572 40.7213- 452.6779 | 65.7701 54.5389- 334.4615 | 104.3083 82.6549- 490.6122 | 69.0813 60.2432- 77.8677 | 49.9407 27.7793- 61.7253 | 67.4973 41.2304- 88.1441 | 85.6349 73.5974- 95.6748 | 133.5921 153.665- 194.061 | 65.6531 28.1553- 117.0281 | 140.9614 37.2296- 158.9277 | 108.9012 67.8255- 165.6879 | 130.0650 29.8455- 181.2096 | 35.9564 16.7873- 44.0529 | 21.6003 10.1084- 27.3160 | 430.5784 317.0454 -878.9722 | | | |
| AGG | 141.7542 62.3846- 296.2941 | 283.0904 291.0142 -452.6779 | 311.8966 408.2221 -459.7737 | 341.4941 369.6964 -409.6022 | 248.2695 144.0997 -391.613 | 149.4700 93.2685- 222.1035 | 202.6546 118.5225 -312.980 | 266.6204 190.6336 -365.8344 | 372.2469 34.4343- 589.4079 | 228.6318 96.6310- 372.1252 | 165.4610 5.2342- 339.3807 | 145.1863 41.7016- 233.6003 | 228.4187 23.7487- 479.5056 | 171.0606 40.6226- 304.3016 | 234.6373 53.4689- 393.0374 | 195.1662 32.6570- 373.9336 | 271.3859 56.4555- 458.2154 | | |
| GSG | 77.5304 16.1759- 161.3771 | 149.6696 0.1041- 245.9771 | 153.8369 175.3210- 254.6429 | 186.6486 182.0787- 486.8832 | 85.5512 0.2092- 177.4597 | 71.6668 0.3247- 136.7178 | 86.8600 0.0641- 174.9604 | 115.2068 0.4874- 209.0054 | 211.5994 204.2859 -292.1392 | 107.7538 0.7716- 213.5523 | 121.2909 22.8212- 222.2250 | 94.6438 16.4103- 169.8725 | 137.555 18.1501- 259.5064 | 85.1943 17.5814- 165.1549 | 15.1215 0.4582- 289.2652 | 115.1605 23.3369- 226.7626 | 117.0571 16.7565- 218.8531 | 28.8226 4.1316- 54.4938 | |

Table 4 (cont.). Realized return gap

| Panel D | | | | | | | | | | | | | | | | | | |
|---------|--------------------------------|----------------------------------|----------------------------------|-----------------------------------|-----------------------------------|---------------------------------|----------------------------------|-----------------------------------|-----------------------------------|----------------------------------|----------------------------------|-----------------------------------|-----|-----|-----|-----|-----|-----|
| | ISI | IVV | IJH | IJR | IYM | IYK | IYC | IYE | IYF | IYW | IYZ | IDU | IYR | EFA | EEM | EZU | ILF | AGG |
| IVV | 0.2115 0.1236- 0.2761 | | | | | | | | | | | | | | | | | |
| IJH | 5.1444 1.7250- 9.3283 | 19.1441 7.6884- 87.6509 | | | | | | | | | | | | | | | | |
| IJR | 12.0589 6.1560- 18.0029 | 84.4853 64.9751- 109.8982 | 12.5102 13.5962- 22.8415 | | | | | | | | | | | | | | | |
| IYM | 19.1939 2.6156- 32.5682 | 57.6338 26.0085- 156.5087 | 24.5593 25.2894- 49.3101 | 45.4283 48.1709- 106.6294 | | | | | | | | | | | | | | |
| IYK | 22.0786 9.4926- 28.7126 | 37.5315 17.5046- 211.4267 | 50.5490 43.5883- 93.3685 | 120.4523 95.1182- 232.4245 | 92.6885 28.3963- 130.2322 | | | | | | | | | | | | | |
| IYC | 13.6609 2.3191- 19.7214 | 29.5738 17.7202- 78.7826 | 24.8417 19.043- 37.1484 | 27.9734 16.7859- 62.7313 | 56.8019 5.9190- 81.1287 | 54.3343 22.5792- 71.1979 | | | | | | | | | | | | |
| IYE | 59.3512 4.2806- 82.7974 | 121.4813 61.1474- 452.6779 | 100.3933 85.6907- 334.4615 | 150.7819 109.1977- 490.6122 | 94.3081 30.5023- 106.4191 | 77.4648 52.7689- 96.6829 | 117.1848 25.5692- 139.7230 | | | | | | | | | | | |
| IYF | 19.1441 6.1877- 30.4325 | 52.8125 24.9968- 452.6779 | 70.0115 48.9017- 334.4615 | 89.3429 38.3694- 490.6122 | 166.9254 119.4233- 413.6575 | 43.4698 34.5425- 147.7579 | 54.3082 34.7061- 465.2763 | 225.9841 175.3039- 382.6059 | | | | | | | | | | |
| IYW | 20.6627 15.7624- 28.0372 | 33.0794 21.2974- 74.0273 | 26.1002 25.9731- 40.4039 | 46.5097 36.0669- 80.4434 | 95.0657 71.3142- 110.4549 | 86.9695 72.7209- 111.0607 | 48.3260 23.1361- 58.6729 | 142.7629 69.4703- 161.7245 | 110.6939 114.0127- 149.7049 | | | | | | | | | |
| IYZ | 37.3920 25.3811- 51.5680 | 58.6059 43.6270- 186.4502 | 61.8640 57.1983- 145.1727 | 91.4308 69.6486- 254.8720 | 123.7637 50.7982- 149.9152 | 74.4621 30.2847- 86.1158 | 86.0858 35.6193- 128.3073 | 141.1386 53.9080- 161.4628 | 110.6467 149.4891- 180.1585 | 162.9143 0-330.0663 | | | | | | | | |
| IDU | 49.2460 8.2404- 81.3917 | 115.2213 63.6778- 452.6779 | 97.5252 93.1865- 334.4615 | 145.1323 109.8449- 490.6122 | 135.5838 41.4684- 152.1857 | 67.2584 54.5926- 77.5583 | 114.0601 36.9701- 129.0545 | 78.0297 12.9489- 105.7459 | 98.1944 48.8213- 353.9545 | 232.6611 0-310.2598 | 171.1116 52.1590- 261.7410 | | | | | | | |
| IYR | 30.2856 7.3175- 55.3688 | 51.8138 24.4368- 136.9478 | 70.047 36.0936- 172.3884 | 122.6423 61.9932- 232.4245 | 64.7655 93.8188- 116.6804 | 37.8686 38.9142- 46.0912 | 43.3688 44.3527- 53.2693 | 134.8137 167.8892- 200.2954 | 65.7883 44.7030- 108.7183 | 89.6326 111.5095- 130.6269 | 73.557 113.9247- 126.0332 | 249.6953 193.7375- 355.6550 | | | | | | |

Table 4 (cont.). Realized return gap

| Panel D | | | | | | | | | | | | | | | | | | | | |
|---------|----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|----------------------------------|----------------------------------|----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|----------------------------------|----------------------------------|-----------------------------------|----------------------------------|----------------------------------|-----------------------------------|----------------------------------|-------------------------------|--|--|
| | ISI | IVV | IJH | IJR | IYM | IYK | IYC | IYE | IYF | IYW | IYZ | IDU | IYR | EFA | EEM | EZU | ILF | AGG | | |
| EFA | 13.3351 1.1154- 24.4274 | 43.9298 18.6655- 194.2416 | 34.9624 30.6339- 81.2836 | 65.0366 49.4729- 154.7494 | 41.6368 29.4029- 51.7889 | 32.6694 24.3639- 41.2203 | 49.8145 35.7290- 61.8111 | 78.6977 51.3727- 92.6924 | 97.5132 58.9751- 58.9751 | 116.2368 102.9572- 134.5021 | 72.0333 23.3265- 85.0217 | 54.3709 4.9750- 65.8142 | 42.3020 62.2595- 66.9734 | | | | | | | |
| EEM | 25.2106 8.4735- 42.7160 | 79.7497 32.1660 452.6779 | 62.5853 42.8625- 334.4615 | 101.9875 62.4399- 490.6122 | 39.7636 1.1229- 60.0672 | 42.4069 0.0532- 60.2351 | 55.2185 1.7601- 89.8306 | 66.7314 2.4819- 88.9454 | 128.5426 123.1668- 184.0022 | 94.5290 24.4179- 126.9217 | 103.9949 32.7154- 137.2559 | 68.4548 9.8727- 86.6328 | 59.1611 91.4361- 104.6749 | 15.5541 0.1926- 26.0168 | | | | | | |
| EZU | 11.2209 2.1144- 26.5443 | 33.1766 20.3665- 108.4794 | 33.1373 34.5767- 63.2156 | 59.5305 48.0191- 124.8853 | 48.3609 23.8809- 62.6287 | 44.8015 39.2955- 51.5986 | 47.3389 34.4550- 59.4519 | 82.9204 26.4930- 104.7309 | 90.4294 86.94111- 141.3458 | 48.1109 33.1630- 71.7215 | 102.7643 34.6096- 151.0517 | 61.7184 6.3350- 73.1611 | 48.1109 65.3274- 71.7215 | 7.9759 0.6114- 10.2967 | 33.8307 1.3715- 48.5310 | | | | | |
| ILF | 30.2856 7.3175- 55.3688 | 75.2572 40.7213- 452.6779 | 65.7701 54.5389- 334.4615 | 104.3083 82.6549- 490.6122 | 69.0813 60.2432- 77.8677 | 49.9407 27.7793- 61.7253 | 67.4973 41.2304- 88.1441 | 85.6349 73.5974- 95.6748 | 133.5921 153.665- 194.061 | 65.6531 28.1553- 117.0281 | 140.9614 37.2296- 158.9277 | 108.9012 67.8255- 165.6879 | 65.6531 103.9520- 117.0281 | 35.9564 16.7873- 44.0529 | 21.6003 10.1084- 27.3160 | 430.5784 317.0454- 878.9722 | | | | |
| AGG | 141.7542 62.3846- 296.2941 | 283.0904 291.0142- 452.6779 | 311.8966 408.2221- 459.7737 | 341.4941 369.6964- 409.6022 | 248.2695 144.0997- 391.613 | 149.4700 93.2685- 222.1035 | 202.6546 118.5225- 312.980 | 266.6204 190.6336- 365.8344 | 372.2469 34.4343- 589.4079 | 228.6318 96.6310- 372.1252 | 165.4610 5.2342- 339.3807 | 145.1863 41.7016- 233.6003 | 107.7538 163.5971- 213.5523 | 171.0606 40.6226- 304.3016 | 234.6373 53.4689- 393.0374 | 195.1662 32.6570- 373.9336 | 271.3859 56.4555- 458.2154 | | | |
| GSG | 77.5304 16.1759- 161.3771 | 149.6696 0.1041- 245.9771 | 153.8369 175.3210- 254.6429 | 186.6486 182.0787- 486.8832 | 85.5512 0.2092- 177.4597 | 71.6668 0.3247- 136.7178 | 86.8600 0.0641- 174.9604 | 115.2068 0.4874- 209.0054 | 211.5994 204.2859- 292.1392 | 107.7538 0.7716- 213.5523 | 121.2909 22.8212- 222.2250 | 94.6438 16.4103- 169.8725 | 81.1138 115.4916- 162.2123 | 85.1943 17.5814- 165.1549 | 15.1215 0.4582- 289.2652 | 115.1605 23.3369- 226.7626 | 117.0571 16.7565- 218.8531 | 28.8226 4.1316- 54.4938 | | |

Note: The top number in each cell is the mean return gap of a pair of assets, the bottom number is the range of realized return gaps.

Panel A

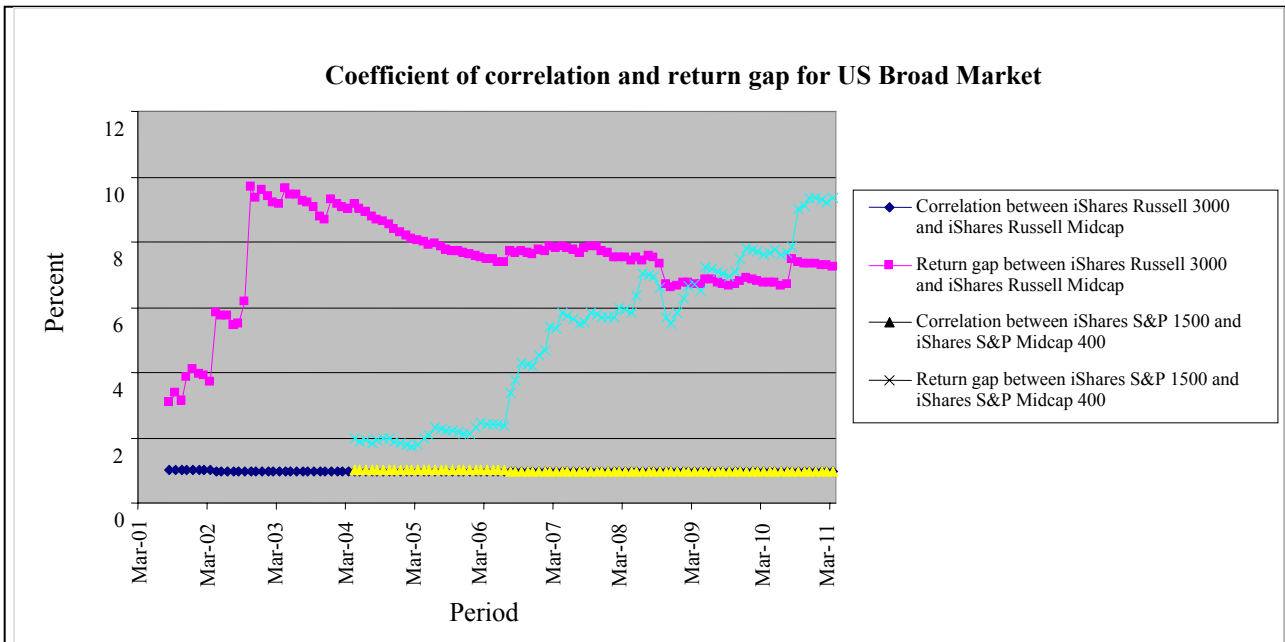


Fig. 1(a). Coefficient of correlation and return gap for US Broad Market

Panel B

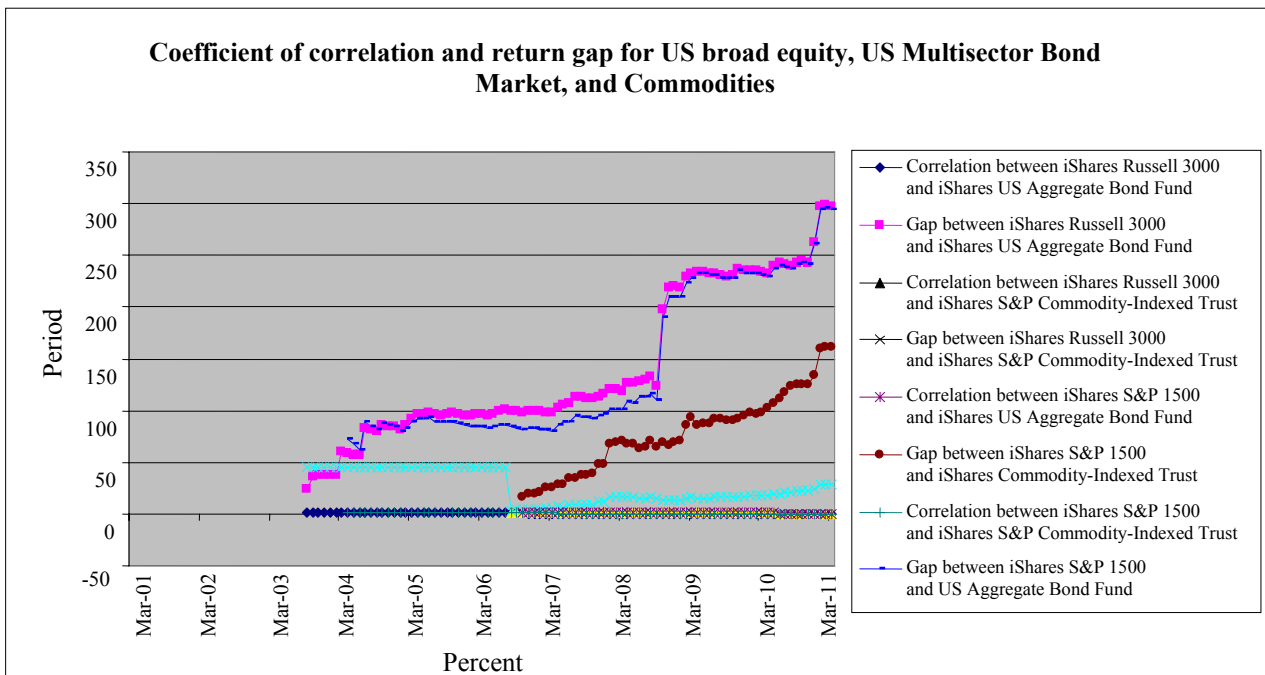


Fig. 1(b). Coefficient of correlation gap for US broad equity, US Multisector Bond Market, and Commodities

Panel C

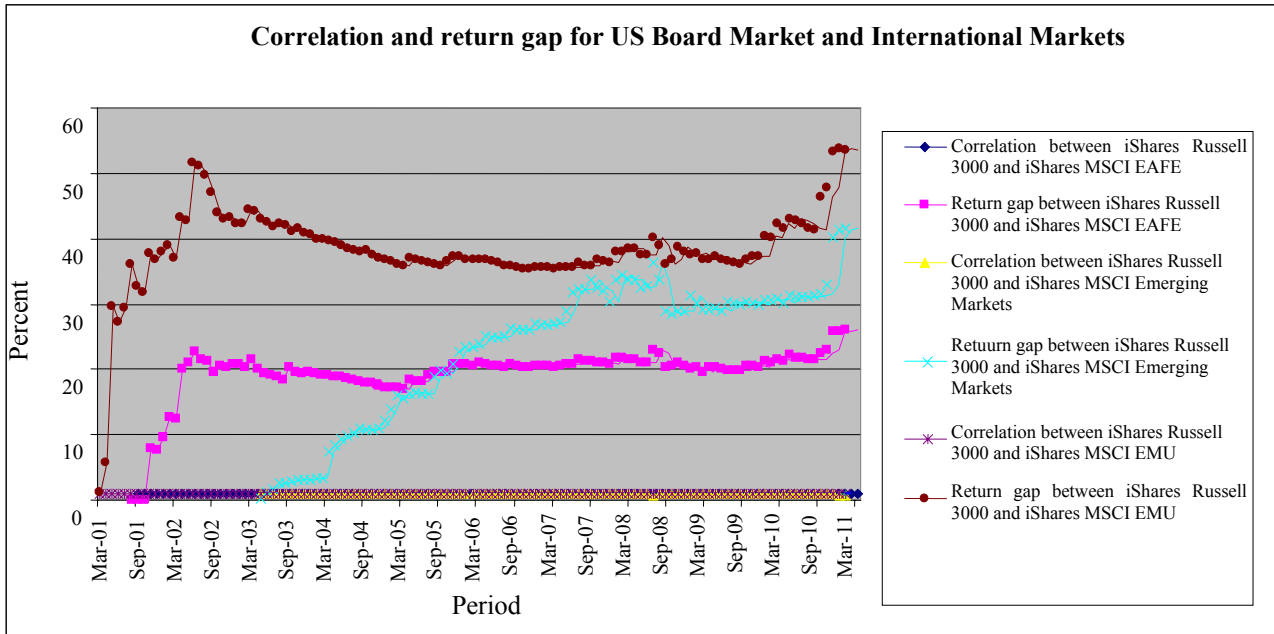


Fig. 1(c). Correlation and return gap for US Board Market and International Markets

Panel D

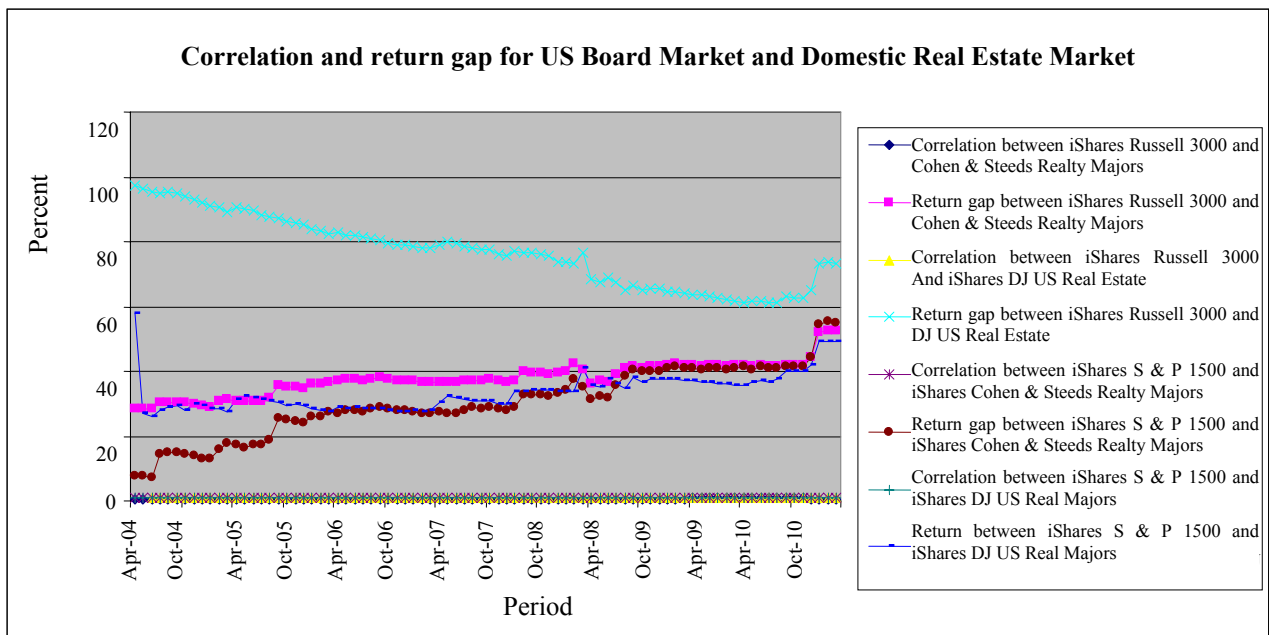


Fig. 1(d). Correlation and return gap for US Board Market and Domestic Real Estate Market

Panel E

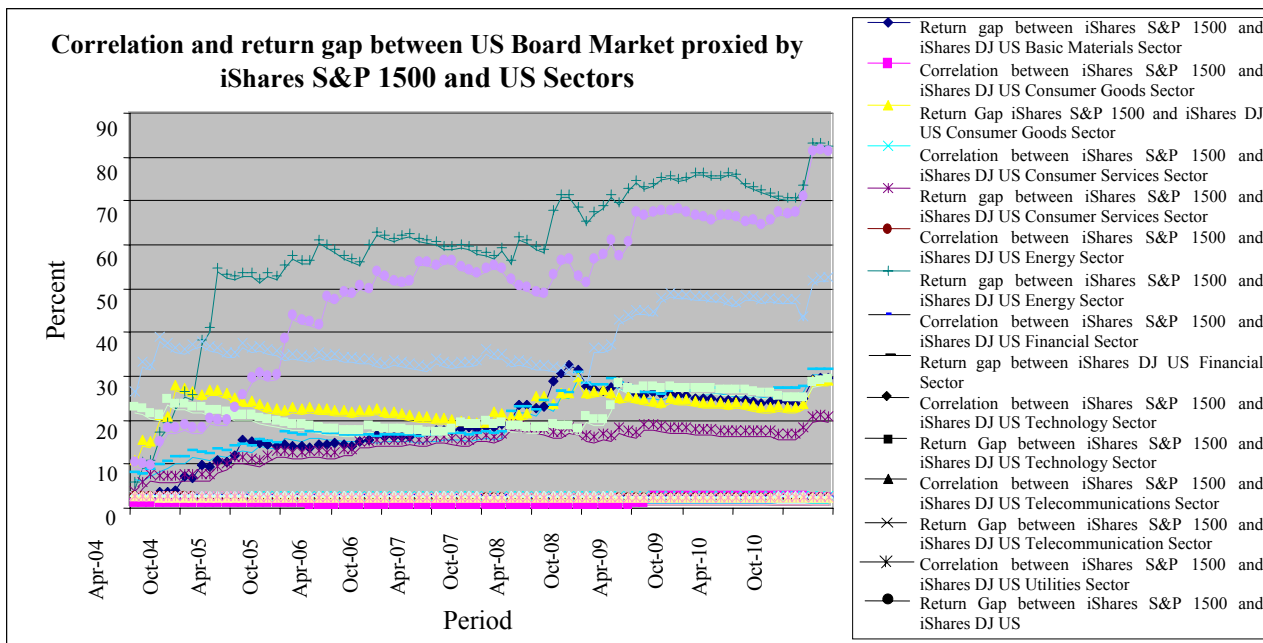


Fig. 1(e). Correlation and return gap between US Broad Market proxied by iShares S&P 1500 and US Sectors

Panel F

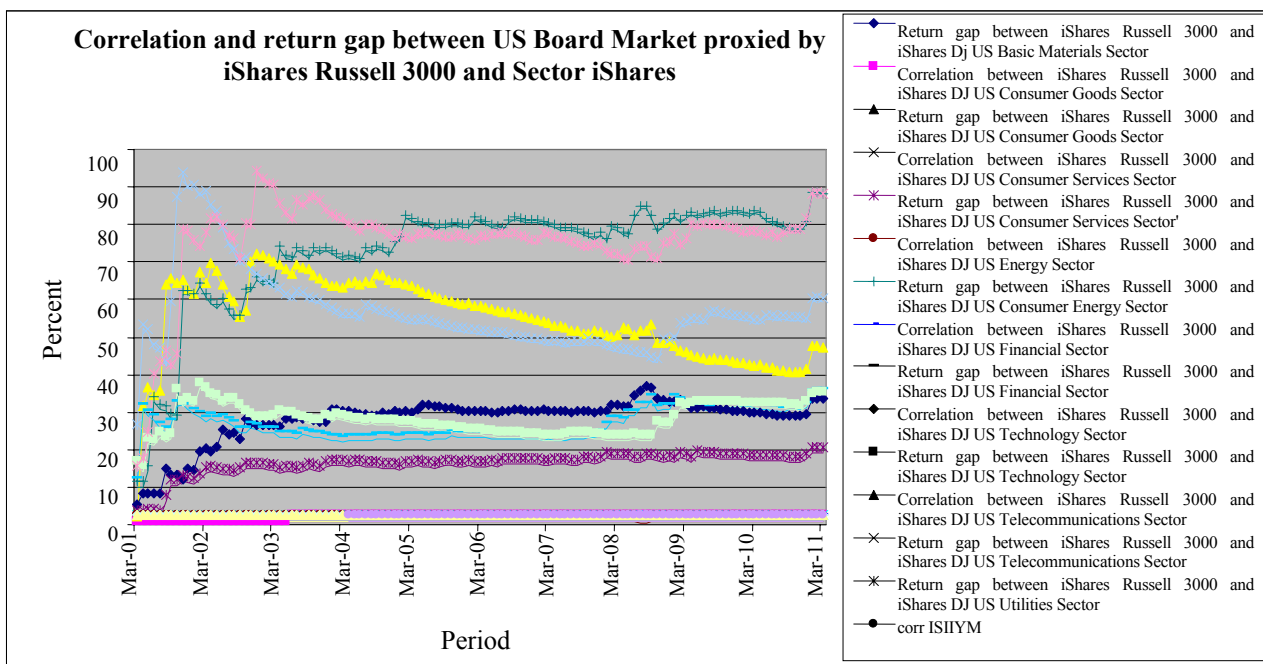


Fig. 1(f). Correlation and return gap between US Board Market proxied by iShares Russell 3000 and Sector iShares