DISSECTING INVESTMENT STRATEGIES IN THE CROSS SECTION AND TIME SERIES

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OVERVIEW

- Fund managers either build their signals in cross section (where they are market neutral and have the same amount of long and short exposure) or time series (where they have directional exposure).
- We compare carry, momentum and value strategies in time series and cross section. While other studies look at time series or cross section, very few directly compare the two.
- We analyse risk and return of these two approaches across currencies, commodities, equities and fixed-income.
- Diversification benefits across styles and asset classes are substantial. Both the time series and cross sectional portfolios can generate attractive risk adjusted returns.
- Some styles work better in time series than in cross section, and vice versa. We investigate the differences in performance between time series and cross sectional trading for each of the strategies, and attempt to explain how and why these differences arise.
- We find that momentum works better in time series and value in cross section. Carry performs equally well in both. We conjecture this is because momentum tends to capture better the 'global' factor while value tends to capture the information coming from a wider range of other factors.

CONTENT

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Abstract:

We contrast the time series and cross sectional performance of three popular investment strategies: carry, momentum and value. While considerable research has examined the performance of these strategies in either a directional or cross-asset settings, there is little research that directly compares the two approaches. We offer some insights on the market conditions that favor the application of a particular setting.

A full version of the paper is available at: http://ssrn.com/abstract=2695101

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1. INTRODUCTION

In quantitative cash equity strategies, momentum is almost always traded across assets (relative value or cross-section) whereas in futures trading, momentum is implemented in a directional (univariate) method. Why? Our goal is to better understand the performance of three popular strategies, carry, momentum and value in time series and cross sectional implementations.

Consider the following motivating example. Suppose equity returns are driven by a set of factors and the first factor is the overall equity market return. In a cross-asset strategy that is market neutral, this first factor is effectively hedged out. If predictability is driven by the other factors, it would likely be better to implement a cross-asset investment strategy. However, if the first factor plays an important role in predictability, perhaps a time series implementation is preferred. For example, if the market factor is trending, then it is more likely time series momentum will be profitable than cross sectional momentum.

In this paper, we provide an analysis of both the time series and cross-section using a broad number of asset classes: equity, fixed income, currencies and commodities. We then try to understand the drivers of directional vs. cross-asset strategies. Lastly, we discuss the robustness of our findings.

2. DATA, SIGNALS AND PORTFOLIO CONSTRUCTION

a. Data

The sample period starts in January 1990 and ends in April 2015. All prices used in this study are mid-market prices and do not therefore account for trading costs. We consider 31 currencies (all expressed versus the USD), 26 equity index futures (across several geographic regions); 16 commodity futures and 14 interest rate swap curves.

b. Signals

The carry can be defined as the difference between spot and forward prices. However, for reasons pertaining to conventions and liquidity, we choose slightly different definitions of carry for each asset class: in FX, we use the 3 month FX-forward to imply an annualized carry; in equities, we compare the first two futures and adjust for seasonality; in commodities, we use the first future and the contract expiring one year later; in rates, we add carry and roll-down.

The momentum measure is based on three moving average crossovers, with an average holding period of around six weeks: we use the same momentum measure for all asset classes.

Value is based on the old aphorism: price is what you pay, value is what you get. Value indicators are therefore the difference between a measure of the fundamental price and the market price. In FX, the indicator is defined as the difference between the relative purchasing power parity of a currency and its market price; in commodities, the indicator is the difference between the average deflated price and the market price; in rates, the indicator is the difference between the 10Y swap rate and the GDP nominal growth rate; finally in equity, as we show in the appendix, it is convenient to express the value indicator as the dividend yield. Why the latter two relationships make sense is detailed in the appendix.

c. Portfolio Construction

The construction of the cross sectional portfolio is simple. For each combination of style and asset class, we rank all the assets according to the magnitude of the signal and take long/short positions on the six most extreme assets (three on each side). We use equal weights, meaning that the dollar notional allocated to each position does not depend on the magnitude of the signals. The portfolio is rebalanced every trading day.

The time series portfolio construction uses the same carry, momentum and value indicators as the cross sectional portfolio. The main difference is that, within every asset class, we consider the universe of N assets and take positions equal to 1/N of total asset under management. These positions will be long or short (+/-1) depending on the carry, momentum and value indicators. All details of the portfolio construction are similar otherwise in the time series and cross sectional portfolios.

3. EMPIRICAL RESULTS

a. Cross Sectional Portfolio

The first step consists of running each of the value/carry/momentum strategies on the FX/equity/commodity/interest rates asset classes. We first consider results for the cross sectional portfolios. Results are summarized in Table 1, Panel A which shows the Sharpe ratio estimates for these trading strategies, by style, by asset class and in combination. The 'All Asset' numbers refer to the Sharpe of each investment style when implemented across all asset classes, meaning that we then benefit from the diversification.

With one exception, all the Sharpe ratios are positive with an average of 0.40 per asset class. As far as styles go, Sharpe ratios across all assets vary between 0.42 to 1.27, with carry emerging as the most profitable standalone style. As shown in Panel B, maximum drawdowns per style using all assets range between 1.8 to 3.1 times the volatility. Panel C shows that the skew is positive for value and momentum and negative for carry.

Table 1: Cross Sectional Strategies using Individual Signals

Panel A: Sharpe Ratios

Asset Class	Value	Carry	Mom.	Avg
FX	0.42	0.67	0.74	0.61
EQ	0.39	0.33	0.01	0.24
Commo	0.07	0.77	0.45	0.43
IR	0.56	0.76	-0.31	0.34
Avg	0.36	0.63	0.22	
All Asset	**0.75**	**1.27**	**0.42**	

Panel B: Maximum Drawdowns divided by Volatility

Asset Class	Value	Carry	Mom.	Avg
FX	-3.3	-3.1	-2.5	-3.0
EQ	-3.2	-3.9	-4.1	-3.7
Commo	-3.1	-1.7	-1.9	-2.2
IR	-1.5	-1.9	-9.1	-4.2
Avg	-2.8	-2.6	-4.4	
All Asset	**-1.8**	**-3.1**	**-2.6**	

Panel C: Monthly Returns Skew

Asset Class	Value	Carry	Mom.	Avg
FX	0.59	-1.03	-0.17	-0.20
EQ	0.03	0.23	0.25	0.17
Commo	-0.27	0.22	0.38	0.11
IR	0.15	0.36	-0.50	0.01
Avg	0.13	-0.06	-0.01	
All Asset	**0.09**	**-0.39**	**0.10**	

The correlations in Table 2 show that – value is negatively correlated with both carry and momentum. As expected, value and momentum covary negatively in line with the proverbial battle between fundamental and technical traders.

Table 2: Correlation of Cross Sectional Strategies

Panel A: Overall

	Value	Carry	Mom.
Value	1		
Carry	-9.0%	1	
Mom.	-9.2%	15.0%	1

All strategies are run at a standardised 15% volatility target, to be comparable with S&P historical volatility. With the possible exception of FX carry, which has shown significant pro-cyclical behaviour, each combination of strategy and assets class displays low to negligible beta with the market, as shown in Table 3. Indeed carry in both equity and rates is somewhat counter-cyclical.

Table 3: Assessing the Market Risk of Cross Sectional Strategies

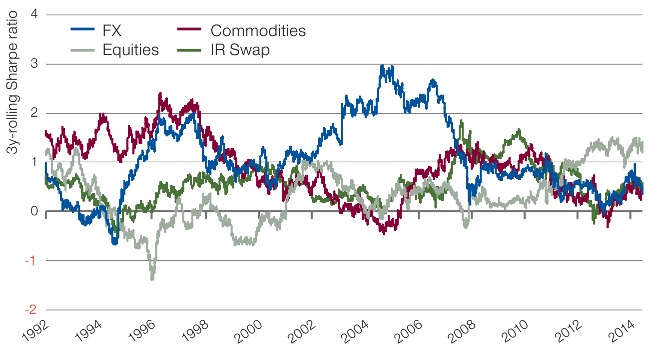
Panel A: Beta Coefficients and T-Statistics in Parenthesis

Asset Class	Value	Carry	Mom.	Avg
FX	-1 % (-1.2)	36% (30.0)	-8% (-7.13)	9%
EQ	-15% (-12.3)	-17% (-14.7)	1% (0.5)	-10%
Commo	-1% (-0.6)	-3% (-2.3)	-3% (-2.6)	-2%
IR	3% (1.9)	-11% (-8.8)	-5% (-3.4)	-4%
Avg	-4%	1%	-4%	
All Asset	**-4% (-5.9)**	**2% (2.6)**	**-4% (-6.1)**	

As we explore Sharpe ratios and correlations, the central question is: how consistent are they over time? Figure 1 exhibits Sharpe ratio three year moving averages over time per asset class and investment style. Remarkably, performance is consistently positive for value. It is also uniformly positive for carry except for a brief episode in the middle of the 90s. In contrast, cross sectional momentum has suffered over the last few years.

Figure 1: Cross Sectional: 3Y Rolling Sharpe per Asset Class (top) and per Investment Style (bottom)

16 November 1992 to 29 April 2015



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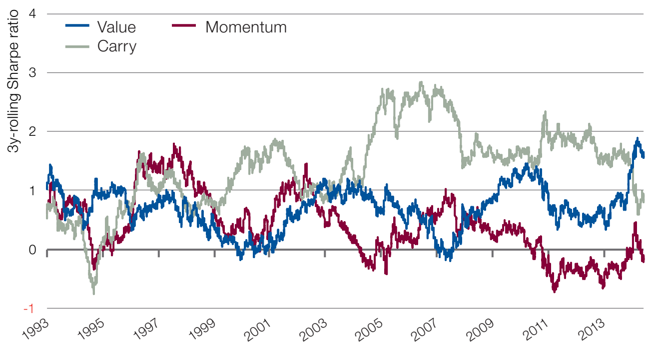

Last but not least, figures 2 and 3 show the cumulative P&L, the 3-year rolling Sharpe ratio and its distribution when all strategy pairs are aggregated into a single portfolio. The overall Sharpe ratio is 1.4, with corresponding return and volatility of 6.88% and 4.92% respectively. The reader should be reminded however that these results do not account for transaction costs. Figure 3 shows that the portfolio was never in the red on a 3-year rolling basis with a Sharpe ratio moving between 0 and 2.3 and hovering around 1.35 recently.

Figure 2: Cross Sectional: Value + Carry + Momentum Compounded P&L

1 January 1991 to 29 April 2015

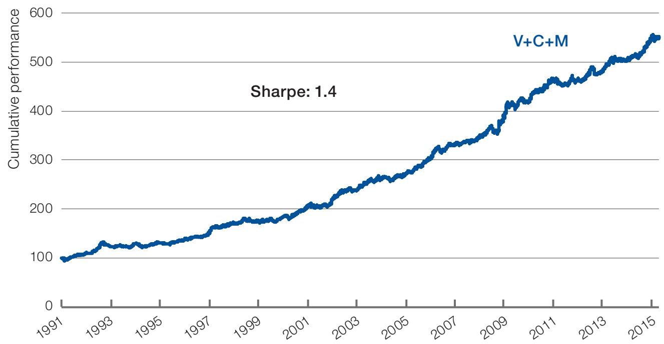

Figure 3: Cross Sectional: 3Y Rolling Sharpe (top) and its Distribution (bottom) for Value+Carry+Momentum

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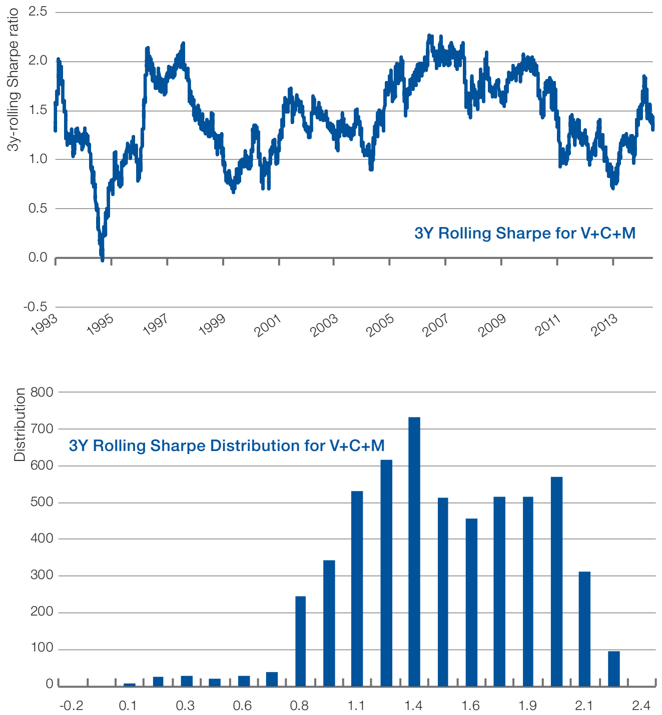


b. Time Series Portfolio

We now look at the time series approach: unlike the cross sectional portfolio, the time series portfolio is comprised of positions equivalent to 1/N of total assets under management in a universe of N assets, with positions being long (short) if the signal is positive (negative). Therefore, if the signal is uniformly positive across an asset class, the portfolio position will be directionally positive in all assets.

As in the cross sectional portfolio, all styles exhibit overall positive Sharpe ratios in the time series. However, one major difference emerges: in moving from cross sectional to time series, momentum more than doubles its Sharpe ratio from 0.42 to 0.96. The momentum drawdown to volatility ratio is lowest across styles in time series. As in the cross section, both value and momentum styles, unlike carry, are positively skewed. Overall, it appears that momentum exhibits substantially better risk return characteristics in time series than in cross section. Momentum in the time series portfolio better captures market directionality, including reversals than in the cross sectional portfolio.

In contrast to momentum, risk adjusted performance is vastly worse for value in time series than in cross section. Examining Table 4, Panel A, it is readily apparent that equity is the prime culprit. Indeed, with stocks trending higher over the last 25 years, the value factor, which relies largely on mean reversion, was bound to underperform. In the same spirit, the Table 4, Panel B shows the deterioration in the drawdowns associated with value compared to Table 1, Panel B.

Table 4: Time Series Strategies using Individual Signals

Panel A: Sharpe Ratio

Asset Class	Value	Carry	Mom.	Avg
FX	0.27	0.55	0.72	0.51
EQ	-0.13	0.23	0.41	0.17
Commo	0.22	0.64	0.45	0.44
IR	0.48	0.83	0.77	0.69
Avg	0.21	0.56	0.58	
All Asset	**0.28**	**1.25**	**0.96**	

Panel B: Maximum Drawdowns divided by Volatility

Asset Class	Value	Carry	Mom.	Avg
FX	-4.7	-4.8	-2.1	-3.9
EQ	-6.6	-6.4	-2.6	-5.2
Commo	-3.7	-3.7	-3.0	-3.5
IR	-4.5	-5.3	-1.9	-3.9
Avg	-4.9	-5.0	-2.4	
All Asset	**-4.4**	**-2.5**	**-2.4**	

Panel C: Monthly Returns Skew

Asset Class	Value	Carry	Mom.	Avg
FX	1.36	-1.20	0.34	0.16
EQ	0.41	0.18	-0.07	0.18
Commo	0.02	0.64	0.64	0.43
IR	-0.22	-0.58	0.02	-0.26
Avg	0.39	-0.24	0.23	
All Asset	**0.69**	**-0.42**	**0.47**	

As in the cross sectional case we see that the three styles are relatively uncorrelated (Table 5), though the positive correlation between carry and momentum is higher than for the cross sectional portfolio. This positive correlation is driven mostly by commodities and fixed-income and occurs because carry is reflected in the total return fed into the momentum signal. As might be expected value and momentum again show a modest negative correlation.

Also of note are the S&P betas and t-stats of asset-class/style pairs in the time series (Table 6): betas are more, yet weakly, negative and more significant in time series than in cross section. Specifically, carry strategies are well diversified across asset classes. FX carry is pro-cyclical as expected whereas equity carry, like equity value, boils down to buying market dips and selling market tops and will hence show a negative beta.

Table 5: Correlation of Time Series Strategies

Panel A: Overall

	Value	Carry	Mom.
Value	1		
Carry	-3.1%	1	
Mom.	-10.2%	23.6%	1

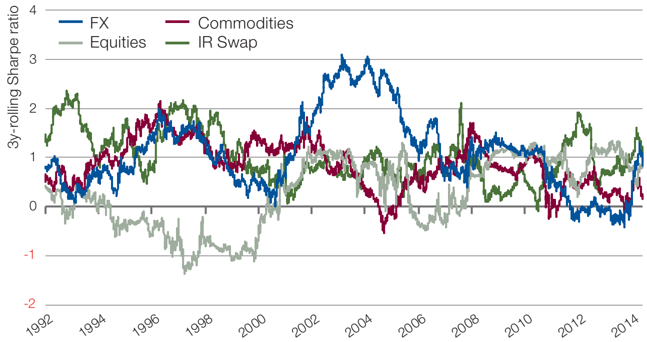
Table 6: Assessing the Market Risk of Time Series Strategies

Panel A: Beta Coefficients and T-Statistics in Parenthesis

Asset Class	Value	Carry	Mom.	Avg
FX	-29% (-25.1)	37% (35.7)	-13% (-10.9)	-2%
EQ	-31% (-24.9)	-23% (-27.7)	-20% (-18.1)	-25%
Commo	2% (1.5)	-18% (-14.4)	-10% (-8.1)	-9%
IR	7% (8.5)	-9% (-9.6)	-9% (-9.9)	-4%
Avg	-13%	-3%	-13%	
All Asset	**-13%** (-25.3)	**-3%** (-6.5)	**-13%** (-18.5)	

Figure 4: Time Series: 3Y Rolling Sharpe per Asset Class (top) and per Investment Style (bottom)

16 November 1992 to 29 April 2015



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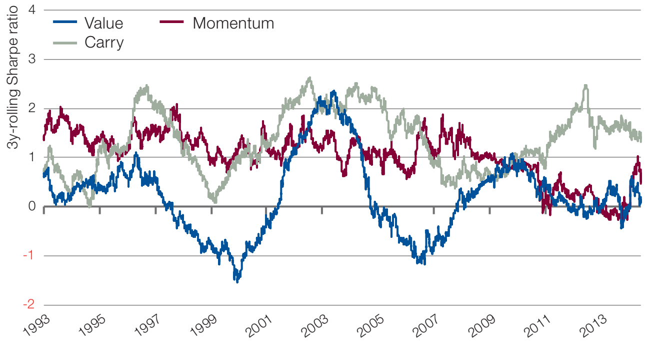


Figure 5: Time Series: Value+Carry+Momentum Compounded P&L

1 January 1991 to 29 April 2015

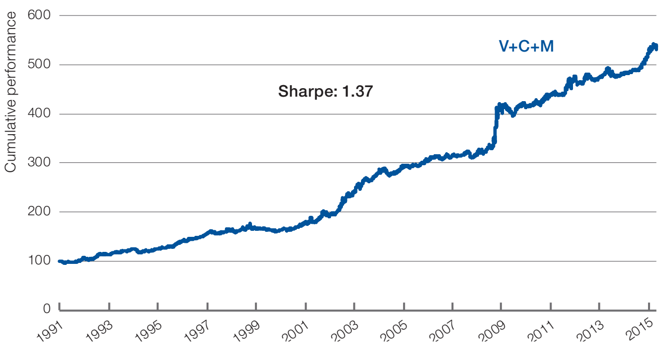
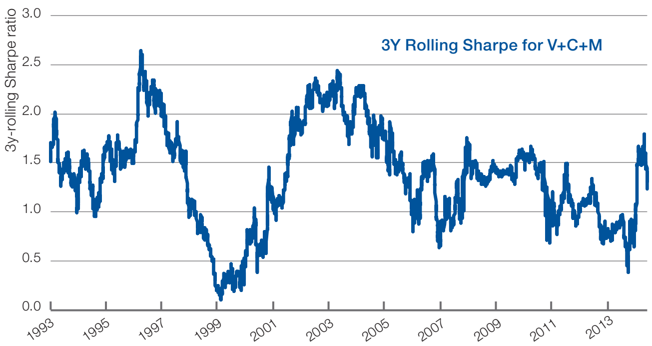
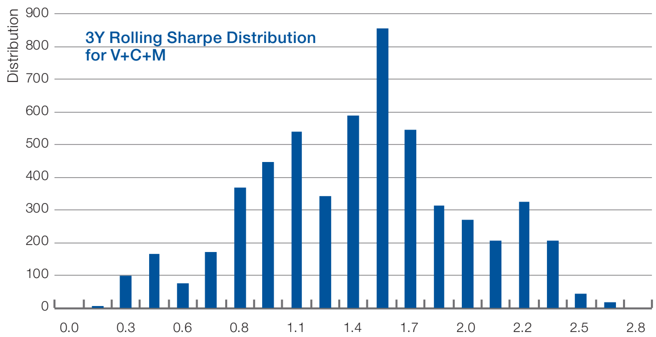


Figure 6: Time Series: 3Y Rolling Sharpe (top) and its Distribution (bottom) for Value+Carry+Momentum

16 November 1993 to 29 April 2015





Combining signals, Sharpe ratios for time series are broadly in line with those for the cross section, with the proviso that individual style performances, as noted before, are significantly different. As in the cross section, the time series Sharpe is substantial at 1.37, while the 3-year rolling Sharpe ratio for a combined carry, momentum and value portfolio was always positive and varied between 0.1 and 2.7 over the past 21 years.

c. A Few Thoughts on the Performance of Cross Section relative to Time Series

Contrasting Table 1, Panel A and Table 4, Panel A, we have quite different results for the three styles: value works well in the cross section, but poorly in time series; carry works about equally well in both cross section and time series; momentum works well in time series, but poorly in the cross section.

At a basic level, assuming linear signals, cross sectional portfolio weights are equal to time series weights minus the cross sectional average. This average can be thought of as a global factor. Therefore, we can think of a cross sectional portfolio as a time series portfolio hedged for this global factor. Pursuing this line of reasoning, time series momentum will outperform cross sectional momentum to the extent that the global factor is trending. Alternatively, to the extent that the value indicator trades reversion to the mean, time series value investing will do better than cross sectional value investing when the global factor returns are negatively autocorrelated.

So how do we explain the results from our data exploration? As stated above, momentum outperformance seems to go hand in hand with value underperformance in the time series versus the cross section. Although this result is difficult to interpret, we can offer three possible explanations.

The first is that momentum, unlike value, takes the price movements themselves as being informative and, as such, may be better placed to assimilate any truly novel information about the global factor which may not be captured by the valuation model. In other words, the momentum model may account unwittingly for factors omitted by the valuation model. This distinction between value and momentum is most prominent in the more correlated asset classes of equities and bonds.

In FX and commodities where a global factor is much less apparent the performance differences between the cross section and time series are much less. This makes sense, because in moving from time series to cross sectional portfolios we are essentially hedging out a single global factor. If this factor explains less, there will be less to hedge out and less difference between the portfolios (in either direction). This is exactly what we observe. Although this explanation may have merits, it does not help us understand why value performs better than momentum in the cross section.

Another explanation is that we have only one realisation of history, in which major global factors have exhibited very strong trends which by definition has hurt reversion based value predictors. It may even be claimed that the central purpose of stimulative public policies recently was to boost wealth effects by supporting a sustained rally in stocks and bonds, that in turn favoured momentum over value in both asset classes.

A third explanation for time series versus cross sectional performance is the correlations of the signals, and how they compare to the correlations of the underlying markets. All else being equal, a cross sectional approach has more to gain when asset correlations are very high, as the above-mentioned 'global' factor will dominate, and hedging this out will increase diversification by boosting exposure to a wider range of other factors. However, if signals are also highly correlated, a cross sectional approach will hedge out most of the (presumably informative) signals as well, potentially cancelling out any gain from the diversification. Conversely if asset correlations are high, but signal correlations low, we will likely lose very little of the information in the signals by forcing them to be cross sectional – as their 'information' already mostly relates to the non-global factors. This could potentially explain the outperformance of time series momentum against time series value in bonds and equities. Although both asset classes are internally highly correlated, the momentum signals on them are even more correlated, so moving to a cross sectional framework will potentially hedge out more of the alpha from the signals than noise from the market. Correlations of value signals are notably smaller. See Table 7 for comparison of signal and asset correlation

Table 7: Signal and Asset Average Correlations

Panel A: Signal and Asset Average Correlations

Asset Class	Value	Carry	Mom.	Asset
FX	48%	23%	40%	24%
EQ	44%	23%	66%	51%
Commo	30%	3%	19%	7%
IR	36%	30%	51%	19%
Avg	39%	20%	44%	25%

While all of the above explanations have appeal, it should be noted that value is traditionally traded in the cross section while momentum is traded in time series. So it would seem that traders have generally come to the 'correct conclusions'.

4. IS IT TOO GOOD TO BE TRUE?

By combining simple signals in carry, momentum and value across less than 100 liquid futures, forwards and swap markets we are able to achieve a remarkably stable strategy over 25 years with a Sharpe ratio of close to 1.5, returning an approximately five and a half-fold increase on a hypothetical 15% volatility target. Is this too good to be true? Why is not every investor trading these styles in combination? We suggest six possible explanations.

Selection bias is a partial answer. Why did we choose these styles and not others? Because, by and large, they have worked consistently over time and across asset classes. However, in defence of our results, not many styles make sense across such diverse asset classes in our view; so the selection pool is not large.

What about potential over-fitting? There was no 'fitting' in this exercise, although some potentially creeps in from experience. Why do our value predictors look back much further than the momentum predictor? Because momentum has worked better at medium frequencies, whereas value is clearly a long-term game. How obvious would this have been 25 years ago?

Survivorship and selection bias of assets is also a problem. Toxic emerging markets may be excluded. This study excluded Argentina but included the likes of Russia, Greece and Indonesia. This kind of bias will likely favor value and carry through the removal of markets where turmoil has caused major assets to exit.

Momentum suffers from another potential bias. Back in 1990, many markets we would include now were much smaller. The ones that make it into our study have likely grown over this time, often via a strong long-term up-trend. By adding data for markets which are now big, but were once small, we likely give a positive bias to momentum predictors.

Another, perhaps more appealing explanation for the performance is simply that few firms have the appetite and patience to trade something so simple. It is easy to forget the arguments in 1999 that value had been replaced by growth, in 2008 that carry was toxic, and in 2011-13 that momentum was finished. These are long-term signals whose performance oscillates over time (figures 1 and 4), with each style experiencing negative performances for at least three years. It is difficult to stick with underperforming strategies this long.

5. CONCLUSION

There are many studies that examine carry, value and momentum strategies, either individually or in combination. However, some of these studies look at the directional or time series versions of these strategies while others look across assets usually with long-short portfolios. Our paper explores the differences in the performance of any strategy – depending on the implementation: directional vs. cross-asset.

Our empirical work examines a large number of assets: equity, fixed income, foreign currency as well as commodities. While the average performance of the strategies is impressive – and is particularly striking if the strategies are combined – we argue that caution should be exercised. There is a reason that carry, value and momentum are popular. They have worked well in the past. Hence, it is no surprise that average returns for these strategies are positive. However, the focus of our paper is not to find the most profitable strategy. Our research provides information about the conditions whereby a particular strategy is best implemented in the cross-section or in the time series.

Our results are suggestive of a framework that may help identify, ex ante, the likelihood that directional trading will outperform cross-asset trading for any particular strategy. The underlying ingredients are linked to the correlation of the asset returns as well as the correlation of the trading signals. Such a framework is the subject of on-going research.

6. APPENDIX

a. Why can the interest rate be approximated by the growth rate?

Posit a profit maximizing firm. It must choose capital to optimize:

$$\max_K f(K) - wL - rK - \delta K$$

where $f(K)$ is production as a function of capital K, L is labour, w is wage, r is the interest rate and δ is the rate of depression of capital. The first order condition is:

$$f'(K) = r - \delta$$

Consumption in this economy is the difference between production and savings. Savings, in turn, finance gross capital expenditure which can be broken down into growth and depreciation:

$$\begin{aligned} C(K) &= f(K) - sf(K) \\ &= f(K) - (g+\delta)K \end{aligned}$$

where s is the saving rate and g is the growth rate.

Maximizing consumption is tantamount to:

$$f'(K) = g + \delta$$

That is:

$$r = g$$

This establishes the equality between the interest rate and the growth rate under the simple assumptions stated above.

b. Why can the equity risk premium (ERP) be approximated by the dividend yield?

A stock price can be viewed as the present value of its dividends:

$$P = \int_0^{\infty} De^{g_d t} e^{-Rt} dt = \frac{D}{R-g}$$

where D is the dividend today, g_d the long term real continuous dividend growth rate (we assume for convenience that the dividend growth rate is equal to the consumption growth rate g) and R the long term real continuous equity yield. From this equation, one may infer the implied equity yield:

$$R = g + \frac{D}{P}$$

meaning that the equity yield is the sum of the dividend growth and the dividend yield. The implied equity risk premium is the difference between the equity yield and the bond yield:

$$ERP = R - r = g - r + \frac{D}{P}$$

By further using the $r = g$ equality derived above, the implied equity risk premium is simply the dividend yield:

$$ERP = \frac{D}{P}$$

Dividend yields can therefore be used as a measure of value for broad equity markets.