20 years of VIX: Implications for Alternative Investment Strategies

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Introduction

Whaley (1993) introduced the VIX index. In the same year, the Chicago Board Options Exchange (CBOE) introduced the CBOE Volatility Index and it quickly became the benchmark for stock market volatility and, more broadly, investor sentiment. The original VIX was a weighted measure of the implied volatility with 30 days to expiration of eight S&P 100 at-the-money put and call options. Ten years later, the methodology was updated. The new VIX methodology is based on a broader index, the S&P 500, and includes further out-of-the-money options which allows for a more accurate view of investors' expectations on future market volatility. The historical time series of the new methodology VIX index has been calculated back to the start of 1990. On March 26, 2004, the first trading in futures on the VIX index began on the CBOE.

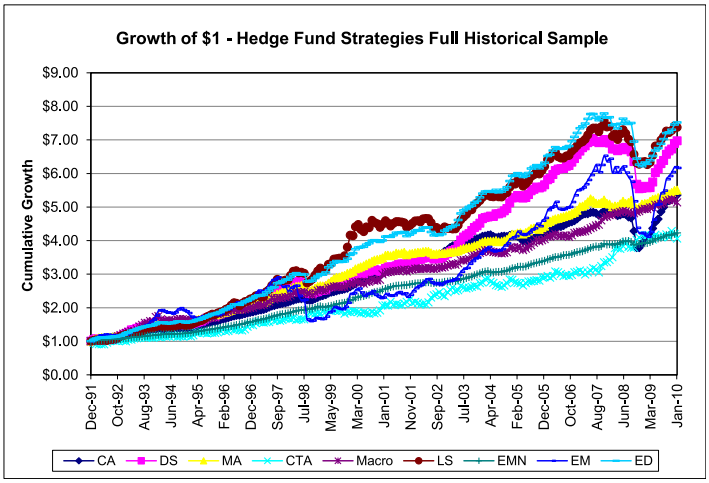
Munenzon (2010) demonstrates that varying levels of VIX are associated with very different return and risk characteristics of traditional asset classes. This article extends this analysis to nine common alternative investment strategies as convertible arbitrage (CA), distressed (DS), merger arbitrage (MA), commodity trading advisor (CTA), macro, equity long/short (LS), equity market neutral (EMN), emerging markets (EM), event driven (ED). This paper also evaluates relationships between traditional assets and alternative investment strategies.

Data and Methodology

This study uses data for the following traditional asset classes: equities – S&P 500 Total Return Index (SPX); bonds - JPM Morgan Aggregate Bond Total Return Index (JPMAGG); commodities – SP GSCI Commodities Index (GSCI); real estate – FTSE EPRA/NAREIT US Total Return Index (NAREIT).[1] Performance data for alternative investment strategies are Center for International Securities and Derivatives Markets (CISDM) indices.

[1] Some investors consider commodities and real estate alternative asset classes, as compared to stocks and bonds. However, for the purposes of this analysis, I consider all such asset classes to be traditional ingredients in an investment program.

Exhibit 1: Full Period Performance Hedge Fund Strategies and VIX



The monthly data for the indices was downloaded via Bloomberg and covers the period from 12/31/1991 to 1/29/2010. The full historical sample is divided into six groups based on the level of VIX to evaluate any differences in results, assuming one remains invested only when VIX is in that particular state.

Key Empirical Results

Exhibit 1 shows the historical level of VIX and cumulative return graphs for the hedge fund strategies. Though VIX begins and ends the period at nearly the same level, the range of VIX over the period is very wide; one also finds that there are extended periods of high and low volatility. The figure also suggests that crashes don't just happen – they are generally preceded by periods of increasing market tension and turbulence, which ultimately push markets over the edge.

Exhibit 2 presents key statistics for traditional asset classes, VIX, and the alternative investment strategies for the full period of study. For all the asset classes and strategies, cumulative returns are strongly positive, particularly for real estate[2]. However, statistical results vary widely across strategies. As expected, and similar to traditional asset classes, the strategies' returns are strongly non-normal. The assumption that returns follow a normal distribution, one of the fundamental assumptions of classical finance, can be strongly rejected for all strategies[3].

Not only does one not observe normality, but one also finds serial correlation for most of the time series[4], which is inconsistent with a random walk model. In classical finance, correlation[5], a linear measure of dependency, plays a key role in portfolio risk measurement and optimization.

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[2] Secular decline in long term interest rates and the subsequent real estate bubble, which is still being resolved, also played key roles.
[3] For a normal distribution, skewness should be 0 and kurtosis should be 3.
[4] Positive returns are likely to be followed by positive returns and negative returns are likely to be followed by negative returns.
[5] Throughout the paper, correlation refers to what is more formally known as Pearson product-moment correlation coefficient, which is used extensively by practitioners and academics to model dependence.

Exhibit 2: Summary Statistics Dec. 31, 1991 to Jan 31, 2010

12/31/1991 - 1/31/2010	CA	DS	MA	CTA	Macro	LS	EMN	EM	ED
monthly data									
Arithmetic Avg Return	0.8%	0.9%	0.8%	0.7%	0.8%	1.0%	0.7%	0.9%	1.0%
Compounded Avg Return	0.8%	0.9%	0.8%	0.7%	0.8%	0.9%	0.7%	0.8%	0.9%
Max Monthly Return	4.7%	5.3%	4.7%	7.9%	8.6%	9.4%	2.8%	12.1%	4.8%
Min Monthly Return	-11.5%	-10.6%	-5.6%	-5.4%	-5.4%	-9.4%	-2.1%	-26.3%	-7.3%
Monthly Standard Deviation	1.4%	1.8%	1.1%	2.5%	1.6%	2.2%	0.6%	3.8%	1.7%
Skewness	-3.9	-1.9	-0.8	0.4	1.2	-0.2	-0.4	-2.1	-1.6
Kurtosis	33.6	13.4	8.7	3.0	7.6	5.7	6.3	16.0	9.4
Normality at 95% confidence level?	No	No	No	No	No	No	No	No	No
P-Value	0.1%	0.1%	0.1%	4.5%	0.1%	0.1%	0.1%	0.1%	0.1%
No serial correlation at 95% confidence level?	No	No	No	Yes	No	Yes	No	No	No
P-Value	0%	0%	0%	20%	4%	7%	0%	0%	0%
VaR (95%)	-1.0%	-1.5%	-1.0%	-3.3%	-1.2%	-2.4%	-0.1%	-4.4%	-1.5%
VaR (99%)	-4.4%	-6.0%	-2.4%	-4.4%	-2.5%	-4.5%	-1.1%	-12.6%	-6.9%
CVaR(95%)	-3.1%	-3.9%	-2.0%	-4.0%	-2.2%	-3.9%	-0.7%	-9.2%	-3.7%
CVaR(99%)	-7.4%	-8.1%	-3.5%	-4.8%	-3.6%	-6.3%	-1.5%	-17.6%	-7.1%
Cumulative Return for Full Period	435%	597%	451%	306%	414%	637%	323%	516%	652%
% of Months with Positive Returns	85.7%	79.7%	86.2%	55.3%	71.0%	70.0%	92.2%	71.4%	80.2%

12/31/1991 - 1/31/2010	SPX	GSCI	NAREIT	JPMAGG	VIX
monthly data					
Arithmetic Avg Return	0.7%	0.7%	1.1%	0.5%	1.5%
Compounded Avg Return	0.6%	0.5%	0.9%	0.5%	0.1%
Max Monthly Return	9.8%	21.1%	31.7%	4.6%	90.8%
Min Monthly Return	-16.8%	-27.8%	-32.2%	-3.5%	-32.7%
Monthly Standard Deviation	4.3%	6.1%	6.0%	1.2%	17.9%
Skewness	-0.8	-0.3	-0.9	-0.2	1.4
Kurtosis	4.4	5.2	11.6	3.9	6.8
Normality at 95% confidence level?	No	No	No	No	No
P-Value	0.1%	0.1%	0.1%	2.3%	0.1%
No serial correlation at 95% confidence level?	Yes	No	No	Yes	No
P-Value	69%	0%	0%	51%	35%
VaR (95%)	-7.6%	-9.4%	-7.8%	-1.4%	-21.1%
VaR (99%)	-12.1%	-14.3%	-22.3%	-2.7%	-29.9%
CVaR(95%)	-10.1%	-12.9%	-15.0%	-2.1%	-26.4%
CVaR(99%)	-14.0%	-19.2%	-25.9%	-2.9%	-31.1%
Cumulative Return for Full Period	269%	175%	605%	215%	28%
% of Months with Positive Returns	64.1%	56.2%	65.0%	68.2%	46.5%

Notes: Jarque-Bera test was used to evaluate normality of a time series; null hypothesis is stated in the question.

Ljung-Box test with 20 lags was used to evaluate serial correlation of a time series;

In Exhibits 5a and 5b, one can see that in the full sample, correlations within and across asset classes and strategies are relatively low (particularly, for SPX vs. GSCI, JPMAGG, CTA, Macro; GSCI vs. Macro; EM vs. CTA; CTA vs. NAREIT, CA, and MA). Similar to traditional asset classes, all strategies with the exception of CTA have significant negative correlation with VIX in the period of study. It is also noteworthy that most strategies do not offer lower correlations with SPX than GSCI or JPAGG; some do not even improve on NAREIT correlation with SPX. Therefore, depending on an investor's goals and scenarios, an addition of a broad basket of alternative strategies to a portfolio may not always provide meaningful incremental diversification benefits as compared to other traditional asset classes, which may be available with lower fees, and higher transparency and liquidity.

Of course, this analysis is performed at the index level. A more selective addition of alternatives at the fund level to one's portfolio may result in greater diversification benefits. Finally, fat tails and negative skewness may result in historical VaR significantly understating losses that one can experience in adverse scenarios, as measured by

historical CVaR[6]. For instance, CA's historical VAR at 95% conference level is 1% but its CVaR (95%) is three times higher at 3.1%. Moreover, high serial correlation suggests that there may be return 'smoothing.' Since smoothed returns bias volatility estimates downward, they also underestimate the true extent of potential tail losses[7]. For example, CA's volatility in the full sample is only a little higher than that of JPMAGG (1.2% vs, 1.4%), but its worst loss is over three times higher (11.5% vs, 3.5%). Similarly, while CA's volatility is slightly lower than that of Macro in the full sample (1.4% vs, 1.6%), its CVaRs and worst losses are much larger.

Six states of VIX are considered. The first state (VIX below 20%) accounted for over 50% of all days in the historical sample due to extended periods of calm in the 90s and, to a lesser extent, in the middle of this decade (Exhibit 3). The first three states (VIX at up to 30%) accounted for over 90% of all days. However, as seen in Exhibit 1, the last decade was far more volatile than the decade of the 90s. As reflected in the transition matrix of Exhibit 3, once in states 1 to 3, VIX is likely to remain in that state for a period of time, as transitions occur gradually. It is not possible to draw strong conclusions with available data for states 4 to 6 as the number of observations in each state is low. However, such a conclusion is supported with daily data [see Munenzon (2010)]. Moreover, even with available data, one can observe that once in a high volatility state, one is likely to remain in one of the high volatility states of 4 to 6.

Exhibit 3: Transition probability matrix for VIX

	Next day State					
Current State	1	2	3	4	5	6
1	88.1%	11.0%	0.8%	0.0%	0.0%	0.0%
2	24.5%	52.8%	13.2%	1.9%	3.8%	1.9%
3	0.0%	37.0%	51.9%	11.1%	0.0%	0.0%
4	0.0%	28.6%	28.6%	28.6%	14.3%	0.0%
5	0.0%	0.0%	40.0%	20.0%	0.0%	40.0%
6	0.0%	0.0%	14.3%	0.0%	28.6%	57.1%

VIX State	Average Duration	Maximum Duration	% of all Months in State
1	8.4	45	54.6%
2	1.8	6	24.1%
3	2.1	5	12.5%
4	1.4	2	3.2%
5	1.0	1	2.3%
6	2.3	3	3.2%

Notes: Based on monthly data. See Munenzon (2010) for the tables above based on daily data.

[6] VaR(a) is defined as the quantity Q such that the probability of a loss is less than or equal to the confidence level of a. Thus, it stops at the start of extreme events and does not analyze the tail. CVaR(a) is defined as the average loss once Q is exceeded, with the confidence level of a. Historical based measures are evaluated based on historical data and thus fully incorporate all features of a distribution of a return series. If one assumes a normal distribution of returns, one can find VaR of a return series via an analytical formula with just its mean and volatility. However, such a measure will understate the realistic extent of losses even more than the historical VaR. For more detail, the reader is referred to Alexander (2008).

[7] Returns can be 'unsmoothed' to produce a more realistic picture of volatility and potential losses. For example, see Davies et al (2005).

How similar are risk/return properties of strategies in various states and relative to the full historical sample? They are very dissimilar (see Exhibit 4). In fact, evidence of consistent, absolute returns in all market cycles is hard to find for alternative strategies.

Only CTA, macro, and EMN (and bonds for traditional asset classes) provide positive cumulative returns across all the states.

Exhibit 4: Summary Statistics by State of VIX

State 1 - VIX <= 20	SPX	GSCI	NAREIT	JPMAGG	VIX	CA	DS	MA	CTA	Macro	LS	EMN	EM	ED
Arithmetic Avg Monthly Return	1.5%	1.4%	1.9%	0.5%	-1.0%	0.8%	1.3%	1.0%	0.7%	1.0%	1.4%	0.7%	1.5%	1.3%
Maximum Monthly Return	7.6%	15.7%	8.6%	3.7%	48.0%	3.0%	5.3%	4.7%	6.2%	8.6%	6.3%	2.2%	8.5%	4.4%
Minimum Monthly Return	-4.4%	-9.9%	-14.0%	-3.5%	-32.7%	-2.5%	-4.2%	-1.0%	-5.4%	-5.4%	-3.4%	-1.3%	-5.8%	-1.6%
Monthly Standard Deviation	2.4%	5.0%	3.7%	1.1%	14.7%	0.8%	1.5%	1.0%	2.3%	1.8%	1.6%	0.5%	2.4%	1.2%
Cumulative Period Return	435.1%	342.0%	697.7%	68.9%	-91.3%	154.3%	340.7%	229.1%	112.9%	211.6%	398.2%	134.8%	463.0%	340.4%
% of Months with Positive Returns	77.1%	62.7%	73.7%	64.4%	40.7%	86.4%	85.6%	91.5%	55.1%	73.7%	79.7%	96.6%	79.7%	86.4%
State 2 - VIX > 20 & <= 25	SPX	GSCI	NAREIT	JPMAGG	VIX	CA	DS	MA	CTA	Macro	LS	EMN	EM	ED
Arithmetic Avg Monthly Return	0.7%	-0.1%	0.7%	0.5%	2.5%	0.8%	0.9%	0.8%	0.1%	0.6%	1.0%	0.7%	1.1%	1.0%
Maximum Monthly Return	9.8%	17.7%	10.8%	2.9%	44.9%	2.7%	3.9%	2.8%	6.1%	5.7%	9.4%	2.8%	12.1%	4.4%
Minimum Monthly Return	-8.4%	-11.9%	-10.9%	-2.0%	-29.0%	-1.6%	-1.5%	-1.9%	-4.5%	-3.0%	-2.4%	-0.7%	-11.3%	-1.6%
Monthly Standard Deviation	4.4%	5.8%	4.7%	1.1%	16.9%	0.9%	1.3%	1.0%	2.3%	1.4%	2.5%	0.7%	3.7%	1.4%
Cumulative Period Return	40.0%	-13.1%	34.9%	32.4%	89.1%	49.3%	59.0%	52.0%	2.3%	34.1%	69.4%	47.0%	68.9%	70.4%
% of Months with Positive Returns	50.9%	45.3%	56.6%	71.7%	49.1%	84.9%	79.2%	86.8%	50.9%	66.0%	64.2%	90.6%	67.9%	79.2%
State 3 - VIX > 25 & <= 30	SPX	GSCI	NAREIT	JPMAGG	VIX	CA	DS	MA	CTA	Macro	LS	EMN	EM	ED
Arithmetic Avg Monthly Return	0.2%	0.9%	2.5%	0.5%	0.2%	1.3%	0.9%	0.6%	1.4%	0.7%	0.4%	0.6%	0.7%	0.9%
Maximum Monthly Return	8.1%	21.1%	14.2%	2.1%	28.8%	4.7%	4.9%	2.6%	7.9%	5.6%	4.8%	2.1%	9.5%	4.8%
Minimum Monthly Return	-9.1%	-16.6%	-4.7%	-2.7%	-31.5%	-2.4%	-2.6%	-1.6%	-4.3%	-2.1%	-4.1%	-1.0%	-6.4%	-3.2%
Monthly Standard Deviation	5.3%	7.5%	4.7%	1.0%	14.1%	1.4%	1.6%	0.9%	3.3%	1.5%	2.4%	0.7%	3.8%	1.7%
Cumulative Period Return	0.4%	16.9%	88.5%	14.7%	-19.8%	43.0%	26.3%	17.1%	43.4%	18.9%	10.1%	16.7%	19.6%	25.3%
% of Months with Positive Returns	51.9%	51.9%	70.4%	74.1%	51.9%	96.3%	74.1%	81.5%	59.3%	74.1%	59.3%	81.5%	63.0%	77.8%
State 4 - VIX > 30 & <= 35	SPX	GSCI	NAREIT	JPMAGG	VIX	CA	DS	MA	CTA	Macro	LS	EMN	EM	ED
Arithmetic Avg Monthly Return	-1.3%	0.4%	-4.3%	1.0%	9.8%	0.8%	0.4%	-0.2%	1.1%	0.1%	-0.8%	0.2%	0.2%	-0.2%
Maximum Monthly Return	8.8%	7.8%	0.2%	2.1%	28.1%	2.1%	1.6%	0.8%	3.2%	1.5%	1.1%	0.8%	2.5%	1.3%
Minimum Monthly Return	-8.1%	-10.5%	-7.3%	-0.3%	-21.5%	-0.7%	-1.3%	-2.0%	-3.3%	-1.8%	-3.4%	-0.3%	-4.0%	-2.9%
Monthly Standard Deviation	5.9%	6.9%	2.4%	0.9%	17.2%	0.8%	1.2%	1.0%	2.7%	1.1%	1.7%	0.4%	2.3%	1.7%
Cumulative Period Return	-9.6%	1.4%	-26.4%	6.9%	77.2%	5.6%	2.9%	-1.6%	7.4%	0.8%	-5.6%	1.6%	1.1%	-1.4%
% of Months with Positive Returns	42.9%	57.1%	14.3%	85.7%	85.7%	85.7%	71.4%	57.1%	71.4%	57.1%	42.9%	85.7%	71.4%	71.4%
State 5 - VIX > 35 & <= 40	SPX	GSCI	NAREIT	JPMAGG	VIX	CA	DS	MA	CTA	Macro	LS	EMN	EM	ED
Arithmetic Avg Monthly Return	-2.5%	-2.4%	8.3%	1.1%	24.1%	0.4%	-0.3%	0.3%	0.5%	0.4%	-0.9%	0.1%	-1.6%	-1.1%
Maximum Monthly Return	9.6%	5.7%	31.7%	3.4%	90.8%	4.6%	3.0%	2.1%	2.5%	1.2%	3.2%	1.2%	8.6%	2.0%
Minimum Monthly Return	-10.9%	-12.1%	-4.3%	-1.1%	-27.6%	-8.4%	-4.4%	-2.6%	-1.2%	-0.2%	-5.4%	-2.1%	-10.1%	-7.3%
Monthly Standard Deviation	8.2%	8.4%	15.6%	1.7%	49.2%	5.1%	2.7%	1.8%	1.7%	0.7%	3.2%	1.3%	6.9%	3.6%
Cumulative Period Return	-13.1%	-12.6%	43.4%	5.8%	112.6%	1.3%	-1.7%	1.2%	2.4%	2.0%	-4.4%	0.4%	-8.8%	-5.8%
% of Months with Positive Returns	40.0%	60.0%	40.0%	80.0%	60.0%	80.0%	60.0%	80.0%	60.0%	60.0%	40.0%	80.0%	40.0%	40.0%
State 6 - VIX > 40	SPX	GSCI	NAREIT	JPMAGG	VIX	CA	DS	MA	CTA	Macro	LS	EMN	EM	ED
Arithmetic Avg Monthly Return	-6.1%	-4.3%	-13.7%	1.2%	18.0%	-1.1%	-3.4%	-0.8%	2.5%	0.1%	-1.8%	0.4%	-6.8%	-2.1%
Maximum Monthly Return	8.8%	12.3%	6.3%	4.6%	78.6%	3.9%	1.1%	1.3%	7.2%	1.1%	1.7%	0.9%	3.5%	1.8%
Minimum Monthly Return	-16.8%	-27.8%	-32.2%	-2.0%	-7.7%	-11.5%	-10.6%	-5.6%	-2.0%	-2.3%	-9.4%	0.0%	-26.3%	-7.3%
Monthly Standard Deviation	9.9%	13.2%	14.3%	2.4%	33.9%	5.0%	4.6%	2.4%	3.4%	1.1%	3.9%	0.3%	10.3%	3.7%
Cumulative Period Return	-37.4%	-31.0%	-67.1%	8.6%	155.7%	-7.9%	-22.2%	-5.7%	18.2%	0.7%	-12.1%	2.9%	-41.2%	-13.9%
% of Months with Positive Returns	28.6%	42.9%	28.6%	57.1%	57.1%	42.9%	28.6%	42.9%	57.1%	71.4%	42.9%	85.7%	14.3%	28.6%

For all strategies, most of the cumulative returns are made in states 1 to 3, particularly state 1; returns are mostly flat to negative in higher states. This finding is very similar to that for traditional asset classes, which are also very sensitive to VIX. However, not all strategies are sensitive to VIX in the same way. While the percentage of positive months for strategies drops significantly as VIX rises (Exhibit 4), CTA responds well to a rising VIX, and Macro and EMN manage to maintain a high positive percentage even at high VIX levels. Finally, generally superior, long term performance of alternative strategies relative to traditional asset classes in the full sample came not from higher returns in good times, but rather in preserving a greater portion of those returns in bad times. For example, LS tracks SPX relatively closely in good times, but the downside is much more limited than SPX as managers have full flexibility to adjust their portfolios to a particular environment. Also, in state 1, SPX outperforms virtually all strategies but its losses are very large at stress points of state 6, which significantly affects its cumulative return ranking in the full sample.

How consistent are cumulative returns for asset classes in various states (Exhibit 4)? They are very consistent at the extreme states 1 and 6. In state 1, all are positive, especially EM, ED, DS, and LS. In state 6, CTA is consistently and meaningfully positive; EMN and Macro are very slightly positive; all other strategies are negative. Strategies exhibit a generally consistent behavior in other states as well. For example, EM, ED, and LS generally do not perform well as VIX rises; however, CTA, Macro, and EMN are generally positive across all states.

Given the prior discussion of returns in different states, it is not surprising to find how unstable correlations are across states (Exhibits 5a, 5b). For example, in state 1 (and state 2 to a lesser extent), all indices (traditional assets and strategies) are highly positively correlated. In state 6 (and state 5 to a lesser extent), most indices are also highly positively correlated with the exception of CTA, Macro, EMN, and JPMAGG. In other states, the relationships are mixed.

Evaluation of correlation for the full sample masks such complex behavior. Additionally, such behavior suggests that not only are dependencies among asset classes time varying, but that they are also non-linear. Therefore, correlation may not be an appropriate means of evaluating dependence among asset classes[8]. Moreover, while at points of extreme stress, diversification can provide downside protection, such benefits are evident only for CTA, Macro, and EMN (and bonds for traditional asset classes).

[8] Correlation will correctly describe dependence structure only in very particular cases, such as multivariate normal distributions. Also, at extremes, correlation should be zero for a multivariate normal distribution, which is not empirically supported. For a more detailed critique on the use of correlations to model dependence, see Embrechts et al (2002).

Exhibit 5a: Correlations by State of VIX

Full Sample

	SPX	GSCI	NAREIT	JPMAGG	VIX	CA	DS	MA	CTA	Macro	LS	EMN	EM	ED
SPX	1.00													
GSCI	0.17	1.00												
NAREIT	0.53	0.14	1.00											
JPMAGG	0.05	0.03	0.09	1.00										
VIX	-0.62	-0.16	-0.34	-0.05	1.00									
CA	0.42	0.29	0.39	0.16	-0.38	1.00								
DS	0.58	0.28	0.47	0.02	-0.44	0.67	1.00							
MA	0.52	0.12	0.36	0.03	-0.48	0.51	0.67	1.00						
CTA	-0.12	0.18	-0.05	0.25	0.06	-0.07	-0.15	-0.11	1.00					
Macro	0.34	0.09	0.15	0.18	-0.26	0.23	0.44	0.47	0.26	1.00				
LS	0.72	0.25	0.35	-0.03	-0.50	0.48	0.75	0.67	-0.02	0.55	1.00			
EMN	0.38	0.20	0.24	0.13	-0.25	0.42	0.45	0.54	0.13	0.35	0.61	1.00		
EM	0.57	0.29	0.39	-0.08	-0.46	0.55	0.73	0.59	-0.10	0.42	0.73	0.40	1.00	
ED	0.67	0.29	0.45	-0.03	-0.52	0.68	0.85	0.83	-0.11	0.44	0.81	0.60	0.75	1.00

State 1 - VIX <= 20

	SPX	GSCI	NAREIT	JPMAGG	VIX	CA	DS	MA	CTA	Macro	LS	EMN	EM	ED
SPX	1.00													
GSCI	0.94	1.00												
NAREIT	0.97	0.96	1.00											
JPMAGG	0.95	0.84	0.90	1.00										
VIX	-0.91	-0.82	-0.85	-0.90	1.00									
CA	0.96	0.84	0.90	0.99	-0.89	1.00								
DS	0.99	0.95	0.98	0.96	-0.89	0.96	1.00							
MA	0.98	0.90	0.95	0.99	-0.90	0.99	0.99	1.00						
CTA	0.98	0.90	0.94	0.97	-0.91	0.98	0.98	0.99	1.00					
Macro	0.96	0.87	0.92	0.98	-0.91	0.98	0.97	0.99	0.98	1.00				
LS	1.00	0.93	0.96	0.97	-0.92	0.97	0.99	0.99	0.99	0.98	1.00			
EMN	0.99	0.92	0.96	0.98	-0.91	0.98	0.99	1.00	0.99	0.98	1.00	1.00		
EM	0.98	0.96	0.98	0.93	-0.87	0.94	0.99	0.97	0.97	0.96	0.98	0.98	1.00	
ED	0.99	0.94	0.97	0.97	-0.90	0.97	1.00	0.99	0.99	0.98	1.00	1.00	0.99	1.00

State 2 - VIX > 20 & <=25

	SPX	GSCI	NAREIT	JPMAGG	VIX	CA	DS	MA	CTA	Macro	LS	EMN	EM	ED
SPX	1.00													
GSCI	0.50	1.00												
NAREIT	0.28	-0.38	1.00											
JPMAGG	0.59	0.04	0.66	1.00										
VIX	-0.15	-0.23	0.12	0.42	1.00									
CA	0.81	0.26	0.62	0.91	0.17	1.00								
DS	0.81	0.25	0.62	0.93	0.21	0.99	1.00							
MA	0.86	0.32	0.57	0.87	0.11	0.99	0.98	1.00						
CTA	0.11	0.06	-0.33	-0.47	-0.23	-0.35	-0.33	-0.27	1.00					
Macro	0.82	0.25	0.56	0.94	0.29	0.96	0.98	0.96	-0.25	1.00				
LS	0.89	0.44	0.49	0.83	0.09	0.97	0.97	0.98	-0.25	0.94	1.00			
EMN	0.83	0.30	0.56	0.91	0.20	0.99	0.99	0.99	-0.30	0.98	0.98	1.00		
EM	0.67	0.24	0.66	0.91	0.24	0.94	0.95	0.90	-0.47	0.92	0.91	0.92	1.00	
ED	0.83	0.29	0.60	0.91	0.15	1.00	0.99	0.99	-0.31	0.97	0.98	1.00	0.93	1.00

State 3 - VIX >25 & <= 30

	SPX	GSCI	NAREIT	JPMAGG	VIX	CA	DS	MA	CTA	Macro	LS	EMN	EM	ED
SPX	1.00													
GSCI	-0.51	1.00												
NAREIT	-0.65	0.80	1.00											
JPMAGG	-0.76	0.86	0.91	1.00										
VIX	-0.89	0.17	0.48	0.49	1.00									
CA	-0.68	0.81	0.98	0.92	0.50	1.00								
DS	-0.52	0.79	0.94	0.83	0.34	0.96	1.00							
MA	-0.64	0.41	0.76	0.59	0.65	0.79	0.80	1.00						
CTA	-0.84	0.81	0.90	0.95	0.63	0.93	0.84	0.72	1.00					
Macro	-0.81	0.69	0.91	0.88	0.68	0.94	0.88	0.87	0.95	1.00				
LS	0.71	-0.24	-0.14	-0.41	-0.58	-0.14	0.08	0.05	-0.40	-0.23	1.00			
EMN	-0.81	0.69	0.92	0.87	0.68	0.95	0.89	0.89	0.94	0.99	-0.23	1.00		
EM	0.21	0.50	0.52	0.31	-0.34	0.52	0.70	0.38	0.27	0.33	0.67	0.33	1.00	
ED	-0.50	0.55	0.85	0.67	0.46	0.88	0.93	0.94	0.74	0.87	0.20	0.88	0.63	1.00

Exhibit 5b: Correlations by State of VIX

State 4 - VIX >30 & <= 35

	SPX	GSCI	NAREIT	JPMAGG	VIX	CA	DS	MA	CTA	Macro	LS	EMN	EM	ED
SPX	1.00													
GSCI	-0.11	1.00												
NAREIT	0.06	-0.69	1.00											
JPMAGG	-0.21	0.50	-0.90	1.00										
VIX	-0.80	0.53	-0.58	0.65	1.00									
CA	0.22	0.84	-0.87	0.66	0.33	1.00								
DS	0.24	0.86	-0.76	0.52	0.32	0.96	1.00							
MA	0.66	0.25	-0.23	0.21	-0.28	0.54	0.59	1.00						
CTA	-0.53	0.29	-0.65	0.83	0.72	0.40	0.26	0.06	1.00					
Macro	-0.04	0.69	-0.88	0.82	0.58	0.87	0.84	0.54	0.70	1.00				
LS	0.48	-0.52	0.82	-0.81	-0.73	-0.51	-0.34	0.32	-0.69	-0.54	1.00			
EMN	0.15	0.68	-0.91	0.86	0.40	0.92	0.84	0.60	0.63	0.94	-0.57	1.00		
EM	0.38	0.70	-0.83	0.68	0.24	0.93	0.92	0.68	0.32	0.87	-0.38	0.92	1.00	
ED	0.62	0.58	-0.35	0.10	-0.19	0.74	0.83	0.84	-0.12	0.56	0.20	0.59	0.76	1.00

State 5 - VIX > 35 & <=40

	SPX	GSCI	NAREIT	JPMAGG	VIX	CA	DS	MA	CTA	Macro	LS	EMN	EM	ED
SPX	1.00													
GSCI	0.48	1.00												
NAREIT	0.04	-0.68	1.00											
JPMAGG	-0.38	-0.75	0.76	1.00										
VIX	-0.85	-0.41	-0.15	0.00	1.00									
CA	0.73	0.42	0.29	0.11	-0.93	1.00								
DS	0.85	0.65	0.06	-0.22	-0.90	0.94	1.00							
MA	0.63	0.07	0.52	0.41	-0.90	0.92	0.76	1.00						
CTA	-0.84	-0.69	0.37	0.81	0.50	-0.37	-0.63	-0.14	1.00					
Macro	-0.58	-0.78	0.71	0.97	0.23	-0.07	-0.38	0.20	0.91	1.00				
LS	0.93	0.61	0.03	-0.27	-0.94	0.91	0.98	0.76	-0.72	-0.46	1.00			
EMN	0.85	0.66	-0.02	-0.21	-0.94	0.94	0.98	0.78	-0.62	-0.40	0.98	1.00		
EM	0.92	0.62	0.07	-0.28	-0.90	0.91	0.99	0.74	-0.72	-0.45	0.99	0.97	1.00	
ED	0.81	0.88	-0.39	-0.56	-0.78	0.73	0.89	0.48	-0.79	-0.70	0.91	0.92	0.89	1.00

State 6 - VIX > 40

	SPX	GSCI	NAREIT	JPMAGG	VIX	CA	DS	MA	CTA	Macro	LS	EMN	EM	ED
SPX	1.00													
GSCI	0.95	1.00												
NAREIT	0.99	0.96	1.00											
JPMAGG	-0.67	-0.62	-0.74	1.00										
VIX	-0.94	-0.94	-0.93	0.50	1.00									
CA	0.60	0.79	0.64	-0.38	-0.77	1.00								
DS	0.89	0.94	0.92	-0.69	-0.94	0.87	1.00							
MA	0.37	0.56	0.37	-0.01	-0.61	0.89	0.63	1.00						
CTA	-0.82	-0.88	-0.86	0.70	0.87	-0.87	-0.97	-0.69	1.00					
Macro	-0.87	-0.83	-0.92	0.83	0.84	-0.59	-0.89	-0.24	0.82	1.00				
LS	0.95	0.97	0.94	-0.53	-0.95	0.77	0.92	0.57	-0.84	-0.79	1.00			
EMN	-0.80	-0.72	-0.86	0.88	0.74	-0.49	-0.83	-0.14	0.78	0.97	-0.70	1.00		
EM	0.92	0.95	0.94	-0.69	-0.95	0.84	0.99	0.63	-0.97	-0.88	0.93	-0.81	1.00	
ED	0.87	0.95	0.90	-0.65	-0.91	0.90	0.98	0.70	-0.96	-0.82	0.93	-0.74	0.98	1.00

Conclusions

The level of VIX seems to have important implications for return expectations of all alternative investment strategies. This is particularly true for extreme levels of VIX. Though the historical range of VIX is very broad, it exhibits clustering, which may make it a useful tool for forecasting. The preceding analysis presents evidence that during the historical period used in the article, several important assumptions of classical finance – normal distribution, randomness of data (no serial correlation), and thus the use of correlation to describe dependence – find limited support in empirical data. In the cases of large deviations from normality and in the presence of serial correlation, volatility and VaR metrics fail to capture the risk of losses appropriately. A focus on volatility with alternative strategies may overlook large, potential losses hidden in the tails, which standard deviation does not capture. Therefore, there may be value in incorporating

more realistic assumptions when modeling markets for investment analysis and risk management, such as non-normal distributions incorporating non-zero skew excess kurtosis and copulas which can capture non-linearity of dependencies, particularly in the tails.

Generally speaking, the superior long term performance of alternative strategies relative to traditional asset classes is not due to better returns in good times but rather relatively more contained losses. While the return potential of alternative strategies may have eroded due to the significant rise in assets under management since the early 90s downside management capabilities should remain intact if managers have flexible investment mandates and risk management discipline. Evidence for consistent, absolute returns is limited. Masked within the full sample is the fact that risk/return characteristics of strategies across states of VIX are very different, for example, CTA strongly outperforms in state 6 but EM outperforms in state 1. For most strategies, performance deteriorates rapidly as VIX rises; CTA is the only strategy that responds well to a rising level of VIX. Moreover, alternative strategies are much more highly correlated with each other and traditional asset classes than the full sample may suggest, with almost perfect correlation at the extremes. At stress points, only CTA, Macro, and EMN help preserve and add to capital (particularly, CTA). Interestingly, strategies and assets which are optimal for stressed periods (e.g., bonds, CTA, EMN) are those an investor may want to minimize in a portfolio to optimize returns in a good environment. Also, given the performance characteristics of VIX and its relationship with other assets and strategies, its inclusion in an investment program should provide valuable benefits in risk management.

The analytical framework presented in this article can be refined further by adding more factors deemed important, such as inflation or information about the prior VIX state; it can also be extended to sectors within an asset class and alternative investment strategies. Finally, while we do not know which volatility states will dominate in the future or how long they may last, greater awareness of the current investment environment, its implications for risk adjusted performance, and flexible investment policies to position portfolios appropriately should help investors produce more consistent results.

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