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Behind the Rejection of Alternative Measures of Implied Equity Volatility: A Note

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This note evaluates the risk-adjusted performance of the implied volatility of the NASDAQ index (VXN), Russell 2000 (RVX) and Dow Jones Industrial Averages (VXD). The results are compared to the performance of the implied volatility of the S & P 500 (VIX) in order to identify the unique contribution of each volatility index. Futures and option contracts have been offered on the VXD, VXN and RVX with results so dismal that the contracts were eventually delisted. In May 2012 futures were once again offered on the VXN but there is little market interest as indicated by the low trading volume. This note finds that the equity index implied volatility measures on VXN, RVX and VXD do not offer sufficient benefits beyond what investors can achieve with VIX which may explain, in part, the rejection of derivatives written on those measures of tradable implied index volatility.

Keywords: VIX; Implied Volatility; VXN; VXD; RVX

Introduction

In the past ten years, the number of volatility products has proliferated as has the number of assets on which volatility is calculated. Although the VIX index was created in 1993, futures contracts on the VIX (VX) were not offered until 2004; since that time contract offerings on VIX have exploded. Today there are over 30 exchange traded notes and funds based on VIX and sponsored by UBS, Barclays, Citi, Credit Suisse and ProShares Capital Management. In addition, the *Chicago Futures Exchange* (CFE) and the *Chicago Board Options Exchange* (CBOE) offer three successful VIX-based futures contracts and two VIX-based option contracts, respectively.

In response to the interest in VIX, the CBOE introduced futures on the DJIA volatility index (VD) in 2005 and in 2007 futures on the NASDAQ-100 (VN) and Russell-2000 (RV) volatility indexes were offered. In 2008, the VN contracts were withdrawn due to lack of investor interest. Likewise, in 2009 VD was delisted followed by RV in 2010. The VN contracts were re-introduced on 5/23/2012 and currently still trade in spite of low volume, averaging 9 contracts per day. **Table 1** summarizes the time line.

The low interest in alternative volatility futures may be due to the large number of stocks that are contained in at least three of the market indexes. Of the 30 firms in the DJIAs, 29 are also represented in the S & P 500 and 3 in the NASDAQ 100. Likewise, 76 of the 100 firms in the NASDAQ are also represented in the S & P 500, 1 in the Russell 2000 and 3 in the Dow Jones. The Russell 2000, on the other hand, is relatively unique compared to the other indexes. This is because the index focuses on smaller cap stocks whereas the others focus on larger cap stocks.

This note explores the reasons behind the lack of investor interest by first presenting the data and methodology, followed by an analysis of the results and conclusions.

Data and Methodology

Daily data from 2/2/2001 through 10/31/2012 is evaluated for the S & P 500 implied volatility index, VIX, the Dow Jones implied volatility index, VXD, and the NASDAQ 100 implied volatility index, VXN. The Russell 2000 volatility index, RVX, was created later, so data is evaluated from the initiation on 1/2/2004 through 10/31/2004 when the contract was withdrawn from the market.

Each cash index is used to create two portfolios resulting in a total of eight portfolios identified in **Table 2**. The first portfolio of each set consists of 75% of the cash index plus 25% of the corresponding volatility index, referred to hereafter as the *natural portfolio*. For example, portfolio #1 contains 75% of the cash NASDAQ index plus 25% of the NASDAQ volatility index, VXN. The natural portfolios represent an equity index hedged with its own implied volatility, analogous to a basis hedge. The second portfolio of each set contains the same cash index plus VIX and is referred to as the *constructed portfolio*. The constructed portfolios represent an equity index hedged

Table 1.
Time line of first offerings.

VX Offered	Variance Futures	VD Offered	VN/RV Offered	VN Delisted	Mini-VIX Futures	VD Delisted	RV Delisted	VN Re-introduced
3/26/2004	5/18/2004	4/25/2005	7/5/2007	12/12/2008	3/2/2009	7/9/2009	2/17/2010	5/23/2012

Table 2.
Portfolio identities.

Symbol	Description
Portfolio #1, p_1	75% NASDAQ/25% VXN
Portfolio #2, p_2	75% NASDAQ/25% VIX
Portfolio #3, p_3	75% S & P500/25% VIX
Portfolio #4, p_4	75% S & P500/25% VXN
Portfolio #5, p_5	75% DJIA/25% VXD
Portfolio #6, p_6	75% DJIA/25% VIX
Portfolio #7, p_7	75% Russell/25% RVX
Portfolio #8, p_8	75% Russell/ 25% VIX

with the implied volatility of a dissimilar equity index. It is expected that hedging with matching volatility, as with the natural portfolios, will outperform hedging with disparate volatility, as with the constructed portfolios.

The risk-adjusted returns (*RAR*) of the *natural* portfolios (odd numbered) are compared to the performance of the constructed portfolios (even numbered). When the performance of the natural portfolio is greater than the corresponding constructed portfolio the conclusion is that the matched volatility fills a unique need.

Specifically, the risk-adjusted return (*RAR*) is defined by Equation (1) below and applied to each of the 8 portfolios:

$$RAR_{p,t} = R_{p,t} / \sigma_{p,t} \quad (1)$$

The portfolio returns and standard deviations are obtained as follows:

$$R_{p,t} = 0.75xR_{c,t} + 0.25xR_{v,t} \quad (2)$$

$$\sigma_{p,t} = \left[0.75^2 x\sigma_{c,t}^2 + 0.25^2 x\sigma_{v,t}^2 + 2x\rho_{ct,vt}x\sigma_{c,t}x\sigma_{v,t}x0.75x0.25\right]^{1/2} \quad (3)$$

The variables are defined as:

$RAR_{p,t}$ = The risk-adjusted return of the portfolio on the *t*th day;

$R_{c,t}$ = The return on the cash index on the *t*th day;

$R_{v,t}$ = The return on the volatility index on the *t*th day;

$\sigma_{c,t}$ = The standard deviation of returns for the cash index over the *t*th time period;

$\sigma_{v,t}$ = The standard deviation of returns for the volatility index over the *t*th time period; and,

$\rho_{ct,vt}$ = The correlation of returns between the cash index and the volatility index over the *t*th time period.

A second series of tests are performed to verify the robustness of the *RAR* test results. This test is a simple linear regression, shown in Equation (4), designed to determine the amount of variation in the cash index explained by volatility.

$$R_{c,t} = \alpha_0 + b_1R_{vxd,t} + b_2R_{rvx,t} + b_3xR_{vxn,t} + b_4xR_{vix,t} + \omega_t \quad (4)$$

where:

$R_{vxd,t}$ = the return on the DJIA volatility index on day *t*;

$R_{rvx,t}$ = the return on the Russell-2000 volatility index on day *t*;

$R_{vxn,t}$ = the return on the NASDAQ-100 volatility index on day *t*;

$R_{vix,t}$ = the return on the S & P 500 volatility index on day *t*.

Results

Table 3 is presented as the difference between each natural portfolio's *RAR* and the corresponding *RAR* for the constructed portfolio.

The first column, of the day-count results, indicates that in 49.5% of the days evaluated, the NASDAQ plus VIX portfolio (p_2) outperforms the NASDAQ plus VXN portfolio (p_1). The month-count and year-count results confirm that portfolio #1 and #2 perform almost equally over time.

The S & P 500 portfolios are shown in the second column of the results presented in **Table 3**. Since the S & P natural portfolio (p_3) includes VIX, the comparison portfolio (p_4) is comprised of the S & P 500 plus VXN. All three time counting schemes indicate that the performance of the two portfolios is approximately the same. Slightly different results are reported for the DJIA portfolios. According to the day-count, the performance of the natural DJIA portfolio is equal to the constructed portfolio. However, the month-count and year-count results suggest that the natural portfolio (p_5) more frequently out performs the VIX hedged portfolio (p_6).

Finally, the Russell-2000 portfolio findings diverge dramatically from the others. According to all three time measures, the natural portfolio (p_7) almost always outperforms the constructed portfolio (p_8) which suggests that option or futures contracts offered on RVX should fill a unique need that cannot be met using VIX. No so for the VXN and the VXD contracts which appear to be mostly redundant and have, therefore, been rejected by the market. Yet, the market has also rejected contracts on the unique RVX.

All of the portfolio combinations produce smaller differences in performance as the holding period is lengthened. This is most likely a result of the well-documented mean reverting behavior of volatility indexes (see, for e.g., Dash and Moran, 2005), Zhu and Zhang (2007) and Banerjee, Doran and Peterson (2007). It is the mean reversion tendency that explains at least one of the reasons that sponsors of volatility products recommend a very short holding period. Given the pricing behavior of volatility products and the recommendation of the sponsors, more weight should be placed on the one-day results. The monthly and annual results are best viewed as robustness tests since, under no circumstances, are volatility products recommended for long-term investment purposes.

Table 3.
Differences between portfolio *RAR*.

Count if <0 (Day-Count)				
	p_1 - p_2	p_3 - p_4	p_5 - p_6	p_7 - p_8
#Days	1460	1464	1493	236
%of 2950	49.50%	49.60%	50.60%	10.60%
Count if <0 (Month-Count)				
	p_1 - p_2	p_3 - p_4	p_5 - p_6	p_7 - p_8
#Months	66	68	57	0
% of 141	48.50%	50%	42%	0%
Count if <0 (Year-Count)				
	p_1 - p_2	p_3 - p_4	p_5 - p_6	p_7 - p_8
#Years	6	7	4	0
% of 12	50.00%	58%	33%	0%

Table 4.
Regression results.

Y = ln(S & P 500)			Y = ln(DJIA)		
	t Stat			*t Stat*	
Intercept	0.5643	F = 786.08	Intercept	0.56072	F = 588.92
VIX	−19.327	Adj. R^2 = 0.586502	VIX	3.63642	Adj. R^2 = 0.5152
VXN	−5.5768		VXN	−2.3563	
VXD	4.6335		VXD	−48.272	
RVX	1.3136		RVX	0.5422	
Y = ln(NASDAQ-100)			Y = ln(Russell-2000)		
	t Stat			*t Stat*	
Intercept	1.2039	F = 721.25	Intercept	0.6361	F = 707.08
VIX	−11.515	Adj. R^2 = 0.5656	VIX	−1.2116	Adj. R^2 = 0.5606
VXN	−12.577		VXN	0.3100	
VXD	2.4664		VXD	0.4871	
RVX	0.6974		RVX	−53.0350	

Table 5.
Russell 2000 plus short VIX.

	p_7 - p_9		p_7 - p_9		p_7 - p_9
#Days	1167	#Months	46	#Years	3
% of 2221	52.5%	% of 106	43%	% of 8	37.50%
Y = ln(Russell-2000)					
	t-stat		t-stat		
VIX (short)	3.0596	VXD	0.4732	F	700.1282
VXN	0.1802	RVX	−52.7692	Adj. R^2	0.5575

In order to explore the robustness of the findings and uncover possible reasons for the rejection of RVX contracts, four regression equations are tested over the period 2/1/2004 to 10/31/2012 to determine the significance of each volatility index on each cash index. The findings are presented in **Table 4** and confirm the earlier results.

Note that for each cash index (dependent variable) the volatility indexes have significant *t*-stats with the exception of the RVX. The RVX is only significant when the dependent variable is the Russell 2000.

A review of the portfolio correlations, and the sign of the *t*-stats, show that the average correlation between the Russell index and the VIX is positive rather than negative as is the case with the other volatility indexes. This suggests that shorting the VIX may lead to higher risk-adjusted returns when held in conjunction with the Russell 2000. To explore this possibility, a ninth portfolio is constructed, p_9, which consists of the Russell 2000 and a *short* position in VIX. Shorting volatility is commonplace as evidenced by the existence of eleven actively traded *Exchange Traded Notes*, which are sold as inverse funds. In fact, shorting volatility has been described as a new asset class (see, e.g. Condor Options, 2007).

The previous tests are repeated for portfolio 9 and the results are presented in **Table 5**. The day-count results indicate that when the Russell 2000 is hedged with RVX the results are approximately equal to a Russell portfolio hedged with short VIX.

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