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Is VIX a Contrarian Indicator? On the Positivity of the Conditional Sharpe Ratio †

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Abstract: The notion of compensation for systematic risk is well ingrained in finance and constitutes the basis for numerous empirical tests. The concept an increase in systematic risk is accompanied by an increase in the required risk premium has strong intuitive content: The more risk there is to be borne, the greater the compensation therefor. In recognizing previous research on the ex ante and ex post reward to risk, the thrust of this paper is to augment those previous tests of expected and realized returns by providing several distinct empirical tests of the proposition the market rewards the undertaking of systematic equity risk, the latter as measured by the VIX volatility index. Thus, in this paper's empirical section, we use several empirical approaches to answer the question, Using realized returns, is an increase in systematic risk VIX accompanied by an increase in the equity risk premium? While the empirical results are not always statistically significant, our answer is in the affirmative.

Keywords: sharpe ratio; equity contrarian indicators

JEL Classification: G12—Asset Pricing; G13—Contingent Pricing



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1. Introduction

One of the better known results in the empirical finance literature is the estimates of the Sharpe Ratio provided by the long-term studies of Ibbotson and Harrington "Stocks, Bonds, Bills, and Inflation® (SBBI®): 2021 Summary Edition" excerpted in the Appendix A.

Using these data, it is indisputable the estimated Sharpe Ratio for Equities is positive:

$$\text{Sharpe Ratio for Equities} = \frac{12.3 - 4.6}{17.2} = 0.448. \tag{1}$$

Using the standard notation, let

μ = Expected rate of return on the market portfolio;
λ = Sharpe Ratio for the market portfolio;
σ = Volatility for the market portfolio;
r = Riskfree rate of interest.

Then, clearly,

$$\lambda = \frac{\mu - r}{\sigma} \tag{2}$$

Employing observable riskfree rate and a measure of prospective stock price volatility to data such as that in Ibbotson & Harrington (Appendix A), three methods of estimating the current Expected S&P 500 Return are sequentially identified in classic presentations to introductory finance classes:

1. Assuming the historical arithmetic average is an unbiased estimate of the expected rate of return, $E_{S\&P} = 12.3\%$.
2. The historical risk premium $E_{S\&P} - r$ is assumed constant. This implies $E_{S\&P} = r + (12.3\% - 4.6\%)$, where the current riskfree rate of interest r (e.g., 3 mo. T-Bill rate) is added to the historical average risk premium $12.3\% - 4.6\%$.
3. If the historical Sharpe Ratio $\frac{E_{S\&P} - r}{\sigma}$ is assumed constant, then $E_{S\&P} = r + 0.448\,\sigma$, where

   0.448 is the historical Sharpe Ratio, computed in this case as $\frac{12.3 - 4.6}{17.2}$;

   σ = the measure of prospective S&P volatility (e.g., the VIX implied vol on S&P 500 index[1].

   The argument proffered in favor of the third approach is that it permits variation in both the riskfree rate as well as volatility to "inform" a current estimate of the expected rate of return. Thus, solving for μ from (2), we have

$$\mu = r + \lambda\sigma, \tag{3}$$

   which clearly indicates a positive relationship between expected return and (systematic) risk.

The significance of this issue in financial economics is evident in recent discussions of asset pricing, which emphasize the role of objective external risk factors. As highlighted in the research of Campbell (2000) and Cochrane (2000), asset pricing revolves around identifying sources of risk and understanding the economic mechanisms that determine compensation for bearing those risks. A key challenge in the field is to ascertain the fundamental risks that influence asset prices and expected returns.

Using both ex ante and ex post empirical tests, the purpose of this paper is to demonstrate risk-adjusted returns are higher in the presence of larger values of VIX—that is, the market rewards higher ex ante systematic risk with greater reward for bearing that risk. We first present ex ante results in support of the maintained hypothesis. Turning to ex post results using realized returns, the presence of significant "noise" in ex post results compels us to present different versions of these ex post empirical results. When these are taken into full account, we present substantial ex post evidence supportive of the hypothesis, especially when we look at long-term results.

The paper is now organized as follows. Section 2 addresses the literature review in specific details. In this section, we show how the previous literature has not directly and forthrightly addressed our objective here: As measured by VIX, does the market reward increased systematic risk? Section 3 briefly describes the data we utilize in this research. Section 4 presents the different models we examine, whereas Section 5 reports the empirical tests and their results. Section 6 presents our conclusions regarding the value of the VIX index as a contrarian indicator: The greater the value of VIX, the greater the risk-adjusted return.

2. Literature Review

In the context of our paper, we deem it especially important to review whence the literature has come on this topic. In that light, our paper pertains to six strands in the literature.[2]

2.1. The Opposing Point of View

The empirical literature has not consistently supported the intuition of Equations (2) and (3). For instance, Moreira and Muir (2017) asserted adjusting exposure based on volatility can enhance Sharpe ratios, as fluctuations in volatility are not matched by proportional changes in expected returns.

This particular paper has also influenced the views of a financial economist. Although he finds it puzzling, James Choi of Yale University Choi (2020) has articulated his perspective on this point. Having had his thinking influenced by Moreira and Muir (2017), Choi observes that sharp market drops are typically accompanied by significant increases in market volatility, which remains predictably high for a short period afterwards. He claims average returns on stocks do not increase much, if at all, during these times of predictably high volatility. He infers the expected compensation for bearing risk is unusually low right after a market crash.[3] His inference is investors can achieve better risk-adjusted returns by reducing their stock market exposure when volatility spikes, and then quickly re-entering the market once volatility settles down.

As we demonstrate empirically below, proposals for market-timing strategies should always be tempered with significant caution.

2.2. Investor Sentiment

As the finance profession struggled to explain the relationship between risk and return, a number of papers have weighed in with analysis of investor sentiment, seeking to assess how investors perceive the relationship between these two. The literature has used numerous measures for expected volatility, though less so of the VIX measure used here, purportedly due to its availability for a relatively shorter time sample.

In Hirshleifer (2002), the author raises the issue of "security expected returns [being] determined by both risk and misvaluation". In Ghosh and Roussellet (2023), their Figure 2 demonstrates the consistent directional relationship between the "conditional equity premium" and NBER recessions.

2.3. The Volatility Risk Premium

The current paper faces a recognized challenge in using VIX for forward-looking volatility—VIX is the risk-neutral expectations of future volatility and therefore likely embeds a volatility risk premium. Several authors have focused on the latter as the driver for expected returns:

Research by Bollerslev et al. (2009) demonstrates that the variance risk premium—the difference between implied and realized market volatility—accounts for a significant portion of the time-series variation in aggregate stock market returns since 1990. Specifically, higher premiums are associated with higher future returns, while lower premiums predict lower future returns. Similarly, Drechsler and Yaron (2011) identify conditions under which the variance premium exhibits notable time variation and predictive power for returns.

In implementing its empirical tests on realized returns, the current paper forthrightly addresses the issue of whether the risk-neutral volatility computed in VIX does present a risk measure from which to infer expected returns.

2.4. An International Perspective

Anarkulova (2023) analyzed data from 33 developed countries, encompassing nearly 2600 years of market returns. This extensive dataset allowed her to provide robust empirical evidence supporting the fundamental finance theory that higher risk is associated with higher returns. Her findings indicate a positive and statistically significant mean variance relationship across the sampled developed markets.

2.5. Empirical Results Supportive of the Current Paper's Maintained Hypothesis

We now turn to enumerating those empirical papers that, while broadly supportive of our maintained hypothesis, differ in specific details. While these previous empirical papers describe specific hypotheses, they do not directly address the broad, specific and clear-cut objective we are investigating: When systematic risk is measured by VIX, does the market reward increased systematic risk?

1. Harvey (1991) examined the conditional risk of 17 countries within a financially integrated global market. He found that the expected return on a country's securities portfolio is influenced by its exposure to global risk factors. The compensation for each unit of this risk is referred to as the world price of covariance risk.
2. In closely related work, Martin (2017) derived the relationship

$$E(R_T) - R_{f,t} = \frac{1}{R_{f,t}} \operatorname{var}_t^* R_T - \operatorname{cov}_t(M_T R_T,\, R_T),$$

where M_T is the stochastic discount factor at date t. He uses the SVIX index to represent the risk-neutral volatility. Whereas the SVIX index equally weights option prices by strike, the VIX index weights option prices by $1/K^2$, giving relatively more weight to out-of-the-money puts and less weight to out-of-the-money calls. Consequently, the VIX index places more emphasis on left-tail events. Our preference for the use of VIX in this work follows from the recognition that VIX is commonly known among equity market participants. In the relevant regression for intercept α and independent variable SVIX, "[t]he null hypothesis that $\alpha = 0$ and $\beta = 1$ is not rejected at any horizon". The article concludes, "These empirical results suggest that the SVIX index can be used as a direct proxy for the equity premium".
3. Copeland and Copeland (1999) observed that variations in the Market Volatility Index (VIX) of the Chicago Board Options Exchange are significant predictors of daily market returns. They noted that after an increase in the VIX, large capitalization stock portfolios tend to outperform small capitalization stock portfolios, and value-based portfolios generally outperform growth-based portfolios. Conversely, following a decrease in the VIX, the opposite patterns emerge. This suggests that market timing might be possible, at least for enhancing portfolio yield.
Although the analysis there focused on the distinction between "value-based portfolios" relative to "growth-based portfolios", it is in the spirit of the empirical results we report below.
4. In an early research paper, Johnson (2012) focused on the VIX term structure instead of the VIX itself to enhance our understanding of the equity premium. While Johnson demonstrated the VIX alone has limited predictive power for future S&P 500 returns, the VIX term structure can predict next-quarter S&P 500 returns with an adjusted R^2 of 5.2%.
5. Lettau et al. (2007) explored the connection between asset values and risk. They investigated whether the substantial increase in asset values at the end of the 20th century could be reasonably attributed to macroeconomic factors, particularly the significant and prolonged decline in macroeconomic risk. They found that this explanation was largely plausible.
6. The next paper comes to us from the option literature, which has spent considerable amount of time modeling the relationship between the stock return and volatility-generating process. One of the latest papers to consider its empirical contents is S. Heston et al. (2023), which harkens back to the physical dynamic of S. L. Heston (1993) processes:

$$\begin{aligned} \frac{dS(t)}{S(t)} &= [r + \mu(v(t)]dt + \sqrt{v(t)}\, dz_1(t) \\ dv(t) &= \kappa[\theta - v(t)]dt + \sigma\sqrt{v(t)}\, dz_2(t) \end{aligned} \tag{4}$$

where $\mu(v(t))$ denotes the equity premium as a function of the variance rate $v(t)$. In this set of equations, the sign of a coefficient in which we are interested here is that of μ, as shown in Table 1.

Table 1. Sign of Expected Return as Function of Volatility. Data Period: January 1996 to June 2019.

Coefficient	Value
μ	2.637 (1.062)

Robust standard errors are in parentheses.

Although model (4) is clearly a richer model than (3), the statistically significant positive value of μ is nevertheless supportive empirical evidence of a positive historical relationship between equity expected returns and variance.

7. Chow et al. (2020) analyzed the components of the VIX by breaking it down into four key elements: Realized variance (RV), variance risk premium (VRP), realized tail (RT), and tail risk premium (TRP). Their research indicates that the unbiased premiums of both variance risk and tail risk are significant predictors of future S&P 500 returns.
8. Liu et al. (2023) focus on the issue of addressing the market's expected risk premium by "combining risk-neutral variance from the options market with the traditional time-series return predictability", finding the combination outperforms either type of information alone. In their paper,

$$R_T - R_{f,t} = b_{tM},$$

where b_{tM} denotes the Martin (2017) bound.

9. In an indirectly related paper, Miljkovic and SenGupta (2018) "analyze S&P 500 market fluctuations and forecast jumps in S&P 500 prices [using] Daily VIX and Squared VIX close prices".

2.6. Ex Ante, Rather than Ex Post, Empirical Results

Unlike the previous research that focused on realized returns, our final referenced paper, published a decade ago, highlights the positive conditional relationship between expected returns and volatility. Doran et al. (2009) used a dividend–discount valuation approach applied to the Livingston–Philadelphia Fed series growth rates to compute a time-series of expected returns. This time-series allowed them to calibrate their model, producing estimates of the time-varying, stochastic Market Price of Risk in U.S. equity markets. This calibrated model subsequently generates a time-series of historical and inferred prospective expected rates of return.

In this context, it is important to note the use of realized returns in the finance literature is predicated on the notion that, over a sufficiently long period needed to attain statistical significance, expectations indeed materialize from realized returns. The advantage of using a model for expected, rather than realized, returns, à la Doran et al. (2009), is the ability to overcome the substantial "noise" in realized returns when seeking to extract expected returns.

Doran et al. (2009) explain that the assumption of decreasing relative risk aversion in the utility function leads to a higher propensity to invest in risky assets when current wealth is elevated. Their model accounted for an assumed decreasing relative risk aversion by incorporating and estimating the impact of the past 5.5 years of S&P 500 returns, the latter captured analytically by including a term representing the accumulated wealth factor $\text{S\&P 500}_t/\text{S\&P 500}_{t-5.5\text{years}}$.

In empirical work of Doran et al. (2009), their model related growth rate-generated expected rates of return μ_t to three observable variables—the riskfree rate of interest r_t, the implied volatility VIX_t on the Index, and the realized S&P 500 Index rate of return over the past 5.5 years $\text{S\&P 500}_t/\text{S\&P 500}_{t-5,t-6}$:

$$\mu_t = r_{S,t} + \left(0.46 - 0.162\,\frac{\text{S\&P 500}_t}{\text{S\&P 500}_{t-5,t-6}}\right)\text{VIX}_t \tag{5}$$

The estimated positive coefficient 0.46 clearly identifies a positive relationship between the expected rate of return μ_t and concurrently observable implied volatility VIX.[4]

Whereas Doran et al. (2009) confronted Moreira and Muir (2017) by focusing primarily on expected rates of return, the current paper challenges their results using realized rates of return. While Doran et al. (2009) did briefly touch upon the issue of realized returns, the matter of realized returns is the primary focus of the empirical work reported in the current paper.

3. Data

Obtained from the Bloomberg LLP platform, our daily, weekly, and monthly data consist of three basic series:

1. S&P 500 Index,
2. VIX 30-day Implied Volatility on the S&P 500 Index,
3. Rates on three-mo. Treasury Bills.

4. The Econometric Models

In presenting the models we intend to estimate, it is important to note the specific lag we implement in our models. To begin, it is a very well-known result for contemporaneous date, S&P 500 returns are strongly negatively related to levels and changes in VIX:

$$\frac{\text{S\&P 500}_t}{\text{S\&P 500}_{t-1}} = a + b(\text{VIX}_t - \text{VIX}_{t-1}) \tag{6}$$

The intuition is compellingly simple: When the market receives adverse (favorable) news, a negative (positive) return is accompanied by an increase (decrease) in the VIX level of nervousness.

However, that is quite different from that which we wish to contemplate here. Rather, our intent is empirically to test Equation (3) in one of two forms:

$$\begin{aligned} \frac{\text{S\&P 500}_t}{\text{S\&P 500}_{t-1}} &= a + b\,\text{VIX}_{t-1} \\ \frac{\text{S\&P 500}_t}{\text{S\&P 500}_{t-1}} - r &= a + b\,\text{VIX}_{t-1} \end{aligned} \tag{7}$$

Further, if we recognize the effect documented in Doran et al. (2009)—namely that a high wealth level (linearly) diminishes the "need" and compensation for bearing VIX risk—that results in two alternate formulations:

$$\begin{aligned} \frac{\text{S\&P 500}_t}{\text{S\&P 500}_{t-1}} &= a + b\,\text{VIX}_{t-1} + c\,\frac{\text{S\&P 500}_{t-1}}{\text{S\&P 500}_{t-5,t-6}} \\ \frac{\text{S\&P 500}_t}{\text{S\&P 500}_{t-1}} - r &= a + b\,\text{VIX}_{t-1} + c\,\frac{\text{S\&P 500}_{t-1}}{\text{S\&P 500}_{t-5,t-6}} \end{aligned} \tag{8}$$

It is important to note the second regressor has the subscript $t-1$ in the numerator, hence does not include the contemporaneous return $\frac{\text{S\&P 500}_t}{\text{S\&P 500}_{t-1}}$ of the dependent variable.

5. Empirical Tests

5.1. Yale Economist James Choi's Use of VIX as a Negative *Market Timing Signal*

While confronting greater systematic risk is intuitively consistent with higher expected rates of return, some have advocated a different investment strategy. Further to the views in the Introduction, Yale Economist James J. Choi was interviewed in the Wall Street Journal, 8 August 2022, and advocated a perspective distinct from the one considered in this paper. Instead of using VIX as a contrarian indicator, Choi proposed lowering the equity exposure in the face of higher volatility:

> "When the VIX ... rises above 30%, I start thinking about modestly reducing my stock exposure. ... But be aware that high-volatility episodes are usually short-lived, ... be attentive and ready to come back into the market quickly as soon as volatility has calmed down."

Since the prescription is not unambiguous, operationalizing this as an investment policy required some interpretation. Using weekly data and ignoring any consideration of transaction costs, we decided to implement this by decreasing the equity stake below 100% for every percentage point VIX exceeded 30%, and then subsequently restoring that to 100% once VIX declines below 30%:

$$\text{Percentage Investment in Equity}_t = \begin{cases} 100 - (\text{VIX}_{t-1} - 30\%) & \text{if} \quad \text{VIX}_{t-1} > 30\% \\ 100\% & \text{if} \quad \text{VIX}_{t-1} \leq 30\% \end{cases}$$

The remainderof the portfolio $100 -$ Percentage Investment in Equity$_t$ is assumed to be earning the de-annualized return of the prevailing three-mo. Treasury Bill.

Since this policy is reactive to realizations of VIX, there is a one-period lag between observing the value of VIX_{t-1} and modifying the equity weights in equities Percentage Investment in Equity$_t$.

Of the 1206 weeks between 7 January 2000 and 10 February 2023, 118 weeks, in 29 distinct episodes, displayed VIX results exceeding 30%. The length of these episodes was given in Table 2 as follows.

Table 2. Episodes whereby VIX > 30%. Data Period: 7 January 2000 to 10 February 2023.

	No. of Weeks	**No. of Episodes**
	1	15
	2	3
	3	2
	4	1
	5	3
	7	1
	9	1
	10	2
	36	1
Total		29

Turning now to examining the investment results, the question is whether the assumed-transaction-free adjusting the equity portion managed to generate superior returns.

Table 3 demonstrates the fallacy of following a VIX-based equity divestment policy. Even without accounting for transaction costs, such a policy demonstrably underperforms a buy-and-hold policy. Whereas the maximal underperformance of the 100% equity position was one in which the underperformance was a meager −0.02%, in contrast, the buy-and-hold policy generates an average superior annualized return of $0.21\% \times 52 = 10.9\%$.

Table 3. Investment Returns of Equity Divestment Strategy. Data Period: 7 January 2000 to 10 February 2023.

Metric	Value
No. of Episodes of Superior Returns to 100% Equity	25
No. of Episodes of Inferior Returns to 100% Equity	4
Average (Superior) 100%-Equity Episodic Performance	0.21%
Std. Dev. of Performance over All Episodes	1.08%
Maximal Episodic Underperformance to 100% Equity	−0.02%

5.2. Empirical Tests of Equation (6)

While tests of this hypothesis are virtually uncontested and likely superfluous, for completeness, we provide some of these here: Table 4 reports the results of empirical returns for differing data frequencies over alternate data periods culminating in the present time.

Table 4. Empirical Tests of Equation (6).

$S\&P_t/S\&P_{t-1} - rd_t$	$=$	$\alpha + \beta(VIX_t - VIX_{t-1})$	$rd = (1+r)^{1/365} - 1$
$S\&P_t/S\&P_{t-1} - rw_t$	$=$	$\alpha + \beta(VIX_t - VIX_{t-1})$	$rw = (1+r)^{1/52} - 1$
$S\&P_t/S\&P_{t-1} - rm_t$	$=$	$\alpha + \beta(VIX_t - VIX_{t-1})$	$rm = (1+r)^{1/12} - 1$

Data Period		Length of Period	Data Frequency	Beta Coefficient	t-Stat on Beta Coefficient
22/12/17	15/12/22	5 years	Daily	−0.466	−44.3
17/12/18	15/12/22	4 years	Daily	−0.481	−39.65
17/12/20	15/12/22	2 years	Daily	−0.466	−24.98
17/12/18	17/12/20	2 years	Daily	−0.488	−29.87
22/12/17	16/12/22	5 years	Weekly	−0.519	−17.16
18/12/20	16/12/22	2 years	Weekly	−0.535	−10.84
14/12/18	18/12/20	2 years	Weekly	−0.492	−9.684
31/12/12	30/11/22	10 years	Monthly	−0.589	−14.38
31/12/12	30/11/17	5 years	Monthly	−0.57	−9.519
29/12/17	30/11/22	5 years	Monthly	−0.6	−10.51

Closely related to an empirical test of Equation (6) but slightly more prospective in nature is an examination of the confluence of peak VIX values with S&P 500 troughs. This particular issue is worthy of empirical examination.

While it is clearly tempting to analyze col. (5) of the following Table 5, five comments should append that discussion:

1. There exists occasionally a confluence of two crises. One example of that is the 2001 Recession with the events of 9/11. According to the NBER, the 2001 recession ranged from March 2001 through November 2001 and thus clearly overlaps with 9/11.
2. The virtual coincidence of VIX Peak and S&P 500 trough during September 2001 should be tempered by the recognition the stock market was closed between 9/11 and 17 September.

3. The discrepancy in the dates for Persian Gulf I could be explained by the two sub-crises entailed in that particular set of event which have historically been distinguished by the distinction between the two combat operations of "Desert Shield" and "Desert Storm".[5]
4. Perhaps the more surprising result is that for the Financial Crisis—Great Recession: The number of days distinguishing the two events there is relatively large, with VIX peaking 109 days before the S&P bottomed out.
5. The fact the stock market bottoms out at or near a VIX peak is of little prospective guidance, since it is only possible ex post to recognize the date of the VIX peak for any particular crisis.

Table 5. Time Separation between Peak VIX and S&P 500 Trough for Post-1990 Crises.

		Date of Crisis' Peak VIX (2)	Peak VIX Value (3)	Date of Crisis' S&P 500 Trough (4)	Time Lead/Lag, in Days (5) = (4) − (2)	S&P 500 Value (6)
1	Persian Gulf I	23/8/1990	36.47	11/10/1990	49	295.46
2	Asian Financial Crisis	30/10/1997	38.2	27/10/1997	−3	876.99
3	LTCM Collapse	10/9/1998	45.29	31/8/1998	−10	957.28
4	2000 Election Uncertainty	30/11/2000	29.65	30/11/2000	0	1314.95
5	2001 Recession	3/4/2001	34.72	4/4/2001	1	1103.25
6	9/11	20/9/2001	43.74	21/9/2001	1	965.8
7	Persian Gulf II	27/1/2003	34.69	11/3/2003	43	800.73
8	Great Recession	20/11/2008	80.86	9/3/2009	109	676.53
9	2020 Pandemic	16/3/2020	82.69	23/3/2020	7	2237.4
10	Ukraine	7/3/2022	36.45	8/3/2022	1	4170.7

5.3. Empirical Tests of Equation (7)

Table 6 reports the results of empirical returns for differing data frequencies over alternate data periods culminating in the present time.

Table 6. Empirical Tests of Equation (7).

$$\begin{aligned} S\&P_{t+1}/S\&P_t - 1 - rd_t &= \alpha + \beta \cdot VIX_t \quad rd = (1+r)^{1/365} - 1 \\ S\&P_{t+1}/S\&P_t - 1 - rw_t &= \alpha + \beta \cdot VIX_t \quad rw = (1+r)^{1/52} - 1 \\ S\&P_{t+1}/S\&P_t - 1 - rm_t &= \alpha + \beta \cdot VIX_t \quad rm = (1+r)^{1/12} - 1 \end{aligned}$$

Data Period		Length of Period	Data Frequency	Periodic S&P 500 Average Return	Annualized Return	Deannualized Beta Coefficient	*t*-Stat on Beta Coefficient
22/12/17	15/12/22	5 years	Daily	0.039%	10.26%	0.0086	1.87
17/12/18	15/12/22	4 years	Daily	0.052%	14.00%	0.0084	1.60
17/12/20	15/12/22	2 years	Daily	0.014%	3.68%	0.0162	1.46
17/12/18	17/12/20	2 years	Daily	0.090%	25.45%	0.0070	1.07
22/12/17	16/12/22	5 years	Weekly	0.181%	9.83%	0.0300	1.39
18/12/20	16/12/22	2 years	Weekly	0.069%	3.66%	0.0552	1.08
14/12/18	18/12/20	2 years	Weekly	0.396%	22.80%	0.0197	0.65
12/31/12	30/11/22	10 years	Monthly	0.98%	12.42%	0.1185	2.20
31/12/12	30/11/17	5 years	Monthly	1.09%	13.89%	0.1788	1.78
29/12/17	30/11/22	5 years	Monthly	0.86%	10.82%	0.1684	1.99

Note: Although not empirically material, the $rd = (1+r)^{1/365} - 1$ deannualization of the daily rate using a factor of 365 recognizes that interest is earned over every day of the year, including weekends and holidays.

Notwithstanding the substantial volatility experienced by markets over the recent 2020–2022 and more distant periods, the beta coefficients in Table 6 are all positive, albeit only the longer-dated ones are significant at traditional levels of statistical tests.

5.4. Empirical Tests of Equation (8)

While the additional explanatory variable in (8) will perforce give rise to greater R^2, the statistical significance of a negative coefficient on $\frac{\text{S\&P 500}_{t-1}}{\text{S\&P 500}_{t-5,t-6}}$ reinforces the viability of that same regressor first documented in Doran et al. (2009): The higher the perceived wealth of the representative investor, the lower—albeit still positive—the market price of risk.

Including the regressor that accounts for the impact of greater wealth levels on the market price of risk, Table 7 reports the results of empirical returns for Equation (8).

Table 7. Empirical Tests of Equation (8). Data Frequency: Monthly.

$$\frac{\text{S\&P 500}_t}{\text{S\&P 500}_{t-1}} - r = a + \beta\,\text{VIX}_{t-1} + c\,\frac{\text{S\&P 500}_{t-1}}{\text{S\&P 500}_{t-5,t-6}}$$

Data Period		Length of Period	Data Frequency	R^2	Deannualized Beta Coefficient	*t*-Stat on Beta	Coefficient *c*	*t*-Stat on *c*	Five-Yr. Previous Data Begins
26/12/17	26/12/22	5 years	Monthly	6.48%	0.0017	2.00	—	—	—
22/12/17	26/12/22	5 years	Monthly	7.21%	0.0017	2.01	−0.025	−0.671	1/12/12
26/12/12	26/12/22	10 years	Monthly	3.69%	0.0012	2.13	—	—	—
22/12/12	26/12/22	10 years	Monthly	4.97%	0.0010	1.77	−0.026	−1.256	1/12/07

5.5. Discussion

We view our empirical results as providing evidence in support of the hypothesis the market conditionally rewards VIX-quantified risk-taking with a subsequent compensating return:

1. We demonstrate a policy of receding from the market whenever VIX exceeds 30% constitutes suboptimal investment behavior.
2. Although a likely self-evident result, we show that contemporaneously, a positive (negative) market return is associated with a decrease (increase) in the level of VIX.
3. More relevant, we show that of the ten crises since 1990, the peak value of VIX is relatively proximate to that crisis' S&P trough.
4. Finally, we show that the greater the immediate-past level of VIX, the subsequent market return is more positive. Moreover, consistent with theory but only weakly significant, we show that such subsequent returns are lower if the market has had a five-year record of positive returns, thus documenting the effect of decreasing relative risk aversion.

6. Conclusions

This paper deals with one of the more fundamental concepts in finance—that systematic risk is rewarded over time by higher expected and realized rates of return. This is clearly observed over the long time series reported by Ibbotson and Harrington (Appendix A), and by Ibbotson and Sinquefield in their earlier work. The utilization of VIX's prospective market volatility as a contrarian indicator does not constitute an inconsistency with market efficiency: Although it does anticipate a higher equity return when VIX is "high", that elevated level of VIX clearly constitutes a higher degree of risk.

Whereas Moreira and Muir (2017) claimed to refute this relationship between risk and return, the ex ante results of Doran et al. (2009) constitute strong evidence in support of the notion greater VIX induces higher expected risk premium.

In addition to ex ante results, we address several components of ex post tests, using realized rates of return. While we present related tests in previous tables, the empirical results of Tables 6 and 7 support the notion ex post results are supportive of the current paper's conjecture of higher risk-adjusted returns.

A natural investment implication of our research is this: If an investor has the financial wherewithal and intestinal fortitude to invest when market risk is high, that investor will on average be rewarded with higher return for such risk-taking.

Pursuant to the international perspective we allude to in the literature review, we believe this paper merits an international extension of the ex ante and ex post empirical results we report to other global markets, which would serve to report those perspectives on this important topic.

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Appendix A. Ibbotson & Harrington "Stocks, Bonds, Bills, and Inflation® (SBBI®): 2021 Summary Edition"

Table A1. Summary Statistics of Annual Returns (%) 1972–2020.

	Geometric Average	Arithmetic Average	Standard Deviation
Equity REITs	11.4	12.9	17.7
Large-Cap Stocks	10.8	12.3	17.2
Small-Cap Stocks	12.7	14.9	22.2
Long-term Corp Bonds	8.5	9.0	10.1
Long-term Gov't Bonds	8.2	8.8	12.0
Inter-term Gov't Bonds	6.8	7.0	6.4
U.S. Treasury Bills	4.5	4.6	3.5
Inflation	3.8	3.9	3.0

Notes

1 As noted in the literature survey below, we are keenly aware VIX contains a volatility risk premium that separates it from the "expected volatility on the S&P 500." To focus on the issue of the Sharpe Ratio, in this paper, we abstract from the volatility risk premium. It is also fair to say researchers have looked into the matter of the manipulation of the VIX Index's value by certain market participants. While any manipulation, if it occurs, is unacceptable, in this research, we assume VIX is free of first-order-effect manipulation—meaning any manipulation does not distort the values in a meaningful manner.

2 One strand of the literature of which we will abstain is the distinction between risk and "ambiguity". This distinction was raised by Brenner and Izhakian (2018), who concluded, "Introducing ambiguity alongside risk provides stronger evidence on the role of risk in explaining expected returns in the equity markets".

3 Similar skepticism was voiced by Whitelaw (2000): "When estimated using consumption data, [his] model generates a complex, non-linear and time-varying relation between expected return and volatility. . . . The results highlight the perils of relying on intuition from static models."

4 The expression in parentheses, $0.46 - 0.162$ S&P 500_t/S&P $500_{t-5,t-6}$, would only become negative at the implausibly high value for S&P 500_t/S&P $500_{t-5,t-6}$ of 2.84, which did not occur in the data.

5 Per wikipedia.com, "The Gulf War was an armed conflict between Iraq and a 42-country coalition led by the United States. The coalition's efforts against Iraq were carried out in two key phases: Operation Desert Shield, which marked the military buildup from August 1990 to January 1991; and Operation Desert Storm, which began with the aerial bombing campaign against Iraq

on 17 January 1991 and came to a close with the American-led Liberation of Kuwait on 28 February 1991". Available online: https://en.wikipedia.org/wiki/Gulf_War (accessed on 1 March 2022).

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