

# A behavioral explanation for the negative asymmetric return–volatility relation <sup>☆</sup>

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## Abstract

We examine the short-term dynamic relation between the S&P 500 (Nasdaq 100) index return and changes in implied volatility at both the daily and intraday level. Neither the leverage hypothesis nor the volatility feedback hypothesis adequately explains the results. Alternatively, we propose that the behavior of traders (from the representativeness, affect, and extrapolation bias concepts of behavioral finance) is consistent with our empirical results of a strong daily and intraday negative return–implied volatility relation. Moreover, both the presence and magnitude of the negative relation and the asymmetry between return and implied volatility are most closely associated with extreme changes in the index returns. We also show that the strength of the relation is consistent with the implied volatility skew. © 2008 Elsevier B.V. All rights reserved.

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## 1. Introduction

Empirical evidence shows a negative relation between realized daily and weekly market returns and volatility. More specifically, negative (positive) innovations to return are correlated with positive (negative) innovations to volatility, with a greater asymmetric effect when returns decline/volatility increases. Two documented theories attempt to explain this negative relation. Black (1976) postulates that negative shocks to returns increase financial leverage, making stocks riskier and therefore subsequently driving up volatility, labeled the leverage hypothesis.

Poterba and Summers (1986) and Campbell and Hentschel (1992) present the volatility feedback hypothesis, where any innovations to volatility (especially positive ones) lead to a decrease in returns. The leverage hypothesis has few supporters (see e.g. Low, 2004), while the volatility feedback hypothesis involves a complicated economic process that passes through expectations and dividends to validate the negative relation and only (weakly) explains the longer-term return–volatility relation. More recently, Low (2004) suggests that a behavioral explanation could be the cause of the asymmetric effect of losses being associated with larger volatility changes than are gains, but he does not relate his results to behavioral concepts and only examines the leverage effect to test the overall relation.

We investigate the relation between daily and intraday changes using the new CBOE Volatility Index (the VIX) and the returns on the S&P 500 index, as well as the corresponding Nasdaq volatility (VXN) and index return. We focus on the short-term dynamics of the return–volatility

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relation, contrary to the majority of past studies that employ weekly and monthly data on realized volatility to examine this relation. Our aim is to provide a detailed analysis of the *short-term* relation between market returns and implied volatility in order to identify the characteristics of the strong negative and asymmetric correlation between these variables.

We add to the literature by providing intraday results for the return–volatility relation, determining the factors affecting the relation, comparing five different forms of the model, and linking specific behavioral explanations with the observed daily and intraday results. In particular, we show that the negative and asymmetric association of return to changes in implied volatility is consistent with behavioral explanations of this phenomenon, while the leverage and volatility feedback models do not explain our results. We also examine: (1) return quintiles to show how implied volatility reactions are associated with the size of return innovations and (2) different measures of implied volatility to investigate the influence of the implied volatility skew, as well as determining the importance of realized volatility.

The empirical aspects of our study include four major differences from previous research. First, we use both the new VIX and the new VXN to measure implied volatility, with the new measures being better metrics of market expectations since they include the entire strike price range of implied volatilities. Second, we compare results using the VIX (VXN) to those of the near-the-money implied volatility, as well as including 5-min realized volatility as an independent variable. This allows us to disentangle the effects of the implied volatility skew from near-the-money implied volatility to examine the characteristics of the return–volatility relation and to distinguish the importance of implied volatility from current volatility. Third, we quantify the volatility response to the magnitude of return innovations, unlike other studies that only test for the presence of an asymmetric response. Fourth, in addition to using daily data, we investigate the relation at the intraday frequency using data sampled at 30-min and 5-min intervals, which allows us to solidify our behavioral explanation.

Our main empirical findings can be summarized along three dimensions. First, consistent with earlier studies, we find a significant negative and asymmetric correlation between innovations in return and (implied) volatility for stock indexes. However, by using regression models similar to those of [Bollerslev and Zhou \(2006\)](#), the results are consistent with behavioral explanations of the relation, but not the leverage or volatility feedback explanations. The results also show the superiority of employing the new VIX (VXN) to examine the return–volatility relation compared to either the near-the-money implied volatility or the contemporaneous realized volatility.

Our second contribution is a detailed analysis of the relation between return and implied volatility through time, as well as for quintiles of returns and their associated volatility innovations. We find that the individual years

show a consistently strong relation over the different periods, unlike the sample inconsistency reported by others. Moreover, the quintiles of return results show that the strongest support for the negative and asymmetric relation is associated with the extreme changes in returns and volatility. The main implication of this finding is that “tail” events are important determinants of the return–volatility relation, which subsequently relates to the shape of the return distribution.

Third, by comparing the results of two implied volatility measures, the new VIX that employs all strike prices and the near-the-money implied volatility of the market, we show the importance of the implied volatility skew in explaining the return–volatility asymmetry. This supports the inferences of [Dennis et al. \(2006\)](#), who suggest that the magnitude of the asymmetry might be related to the slope of the implied volatility function, although they do not calculate the IVF.

Taken as a whole, our research shows that there is more to the return–volatility relation than suggested by the established hypotheses. In particular, we show the lack of support for established leverage and volatility feedback theories concerning this relation, while the results are consistent with behavioral explanations. In addition, we examine the characteristics of the relation using different models, across samples, for different measures of volatility, and for the sign and size of the return innovations.

## 2. The relation between returns and volatility in equity markets

### 2.1. The leverage and volatility feedback hypotheses

The negative relation between returns and volatility is widely documented in the literature. As pointed out by [Bollerslev et al. \(2007\)](#), most studies show a negative correlation between current return shocks and future volatility, with some studies illustrating that negative news is associated with a larger increase in volatility than positive news. The two popular theories associated with the negative return–volatility relation are the leverage hypothesis and the volatility feedback hypothesis. The leverage hypothesis states that when the value of a firm falls, the value of its equity becomes a smaller percentage of the total firm’s value. Since the equity of the firm bears the entire risk of the firm, the volatility of equity should subsequently increase. This theory has been associated with the observed negative return–volatility relation for so long that this relation is typically referred to as the leverage effect. However, [Christie \(1982\)](#) and [Schwert \(1989\)](#) argue that it is difficult to account for the return–volatility effect given realistic estimates of leverage.

The volatility feedback hypothesis postulates that positive shocks to volatility cause negative returns. [Campbell and Hentschel \(1992\)](#) show theoretically that if *expected* future stock returns increase when volatility increases, then current stock prices (and hence returns) will fall to adjust to

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