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# Asymmetric risk and return: Evidence from the Australian Stock Exchange

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ABSTRACT

This paper examines volatility asymmetry in a financial market using a stochastic volatility framework. We use the MCMC method for model estimations. There is evidence of volatility asymmetry in the data. Our asymmetric stochastic volatility in mean model, which nests both asymmetric stochastic volatility (ASV) and stochastic volatility in mean models (SVM), indicates ASV sufficiently captures the risk-return relationship; therefore, augmenting it with volatility in mean does not improve its performance. ASV fits the data better and yields more accurate out-of-sample forecasts than alternatives. We also demonstrate that asymmetry mainly emanates from the systematic parts of returns. As a result, it is more pronounced at the market level and the volatility feedback effect dominates the leverage effect.



## 1. Introduction

The intertemporal relationship between risk and return is an important concept in finance and has been an active area of research. Empirically, volatility appears to be asymmetric. That is, negative shocks to returns are associated more with upward revisions of conditional volatility than are positive shocks of the same size. The asymmetry can be described as a negative correlation between return and volatility innovations. The absolute value of this correlation measures the degree of asymmetry. Volatility models, which account for this property, generally better describe the return dynamics and provide more accurate forecasts of volatility which is an important input in derivative valuation and risk management.

Financial economists have long debated whether volatility asymmetry is due to firm-level factors, such as the leverage effect, or systematic market-wide factors, such as the volatility feedback effect. Early studies by Black (1976) and Christie (1982) use a leverage effect hypothesis to explain asymmetric volatility. Negative returns increase financial leverage which makes the stock riskier and hence drives up volatility. Higher volatility further decreases stock price and increases leverage and so on. By the same argument,

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good news leads to lower leverage which, in turn, reduces volatility. This establishes the negative relationship between current return and future volatility. Asymmetry is present because bad news results in a multiplier effect but good news does not.

The other explanation is the time-varying risk premium or volatility feedback effect (see French et al., 1987; Campbell and Hentschel, 1992; Wu, 2001). This hypothesis relies on volatility clustering to explain the phenomenon. Large shocks, either positive or negative, result in high volatility which tends to be followed by subsequent periods of high volatility. If volatility is priced into returns, an anticipated increase in volatility will raise the required return on the stock, causing the price to drop immediately. More specifically, a large piece of bad news decreases price and increases future volatility which pushes price down further. Thus, the impact of bad news is amplified by this process. A large piece of good news, on the other hand, raises both price and future volatility. Higher volatility has a negative impact on price which dampens the impact of good news. As a result, asymmetry occurs.

The two theories can explain the asymmetric return-volatility relation. They differ in the direction of causality and how volatility responds to good news. The leverage effect hypothesis postulates that news affects return, leading to changes in conditional volatility. The volatility feedback effect purports that shocks to return are caused by changes in conditional volatility. Thus, while the leverage effect is more of a firm-level factor, the volatility feedback effect is a systematic and market-wide factor. In terms of the response to good news, the leverage effect predicts that good news reduces future volatility whereas the volatility feedback effect does not predict any relationship when there is good news.

Empirical tests of the two theories have been inconclusive. Schwert (1989) and Bollerslev et al. (2006) find that the magnitude of the effect of price change on future volatility is too large to be explained solely by financial leverage. Also, while leverage is a characteristic of a firm, Tauchen et al. (1996), Andersen et al. (2001), Dennis et al. (2006), among others, find that the asymmetry seems more pronounced for market indexes than for individual stocks. Glosten et al. (1993) and Engle and Ng (1993) find evidence of asymmetry but the relationship between expected return and volatility is either insignificant or negative. Bekaert and Wu (2000) and Wu (2001) show that the volatility feedback effect dominates the leverage effect. Hibbert et al. (2008) argue that neither leverage nor volatility feedback effect adequately explains the asymmetry and their behavioral approach is more consistent with the result. Yu (2012) proposes a semiparametric SV model using linear spline in which leverage effect is time-varying. He finds that the model fits individual stocks better than other SV models. Bandi and Reno (2012) allow leverage to be a function of spot volatility. They show that stronger leverage effects are associated with higher variance regimes. Dean et al. (2010) document the asymmetry in return and volatility spillover between equity and bond markets in Australia. They show that return spills over from one market to the other whereas volatility only spills over from bond market to stock market. Liu et al. (2014) demonstrate that the threshold SV model outperforms the symmetric SV counterpart and that accounting for both asymmetry and tail thickness will improve VaR forecasts.

To date the most popular empirical method for investigating asymmetric volatility is ARCH-type models. However, Taylor (1986) argues that the volatility process is likely driven by economic forces, not the past movements of prices as assumed in ARCH-type models. SV-type models are developed under this belief. Several studies find evidence in favor of SV. For instance, Kim et al. (1998) show that the basic SV model gives better in-sample fit than ARCH-type models. Geweke (2005) finds that both perform well in periods of low and sustained volatility; however, the SV model provides superior forecasts in periods of volatility jumps. Jacquier et al. (1994) find that compared to GARCH, the SV model yields a better and more robust description of the autocorrelation pattern of squared stock returns. Abanto-Valle et al. (2011) show that the stochastic volatility in mean model with correlated errors improve the goodness of fit.

Although SV-type models are more flexible and realistic than their ARCH-type counterparts, they have received far less attention in the literature of volatility asymmetry. This may be due to the fact that SV-type models are much harder to estimate. Another issue is how to specify asymmetry in a SV model. In this paper, we intend to bridge the gap by using SV-type models to investigate the asymmetric relation of risk and return. We use the Bayesian MCMC method to estimate our models. Our findings can provide new insights into what causes volatility asymmetry and how to take it into account to improve the forecasting power of volatility models.

Our contributions are two-fold. First, we introduce the asymmetric stochastic volatility model (ASV) by allowing contemporaneous correlation between the error terms in the mean and the volatility equations. Indeed, Yu (2005) demonstrates that this specification is superior to the intertemporal one suggested by Jacquier et al. (2004). We also investigate the relationship between risk and return using the stochastic volatility in mean model (SVM), first proposed by Koopman and Uspensky (2002). Additionally, we develop an asymmetric stochastic volatility in mean model (ASVM), which nests both SVM and ASV. Our empirical findings indicate that the ASV sufficiently captures the relationship between risk and return; therefore, augmenting it with volatility in mean does not improve its performance. The ASV model fits the data better and yields more accurate out-of-sample forecasts than the alternatives. We are also able to demonstrate that the ASV model outperforms both E-GARCH and GJR-GARCH in terms of data fitting and out-of-sample forecast.

Second, in an attempt to identify the main cause of volatility asymmetry, we simultaneously estimate the ASV model for individual firms and the market index, and conduct the analysis of the correlation $\rho$ between return and volatility innovations. We find that firm-level $\rho$ is still negative but significantly smaller in absolute value than that of the index, indicating asymmetry is more pronounced at market level than at firm level. We further investigate the issue by decomposing firms' returns into a systematic part and an idiosyncratic part and analyze $\rho$ in each component. We find that volatility asymmetry is present mainly in the systematic part. It is weak in the idiosyncratic component. Furthermore, the level of asymmetry in a firm's return is largely dependent on the amount of systematic risk it contains. Since the volatility feedback effect is more systematic and market-wide, our results suggest that the volatility feedback effect dominates the leverage effect.

The remainder of the paper is organized as follows. Section 2 discusses the models and the empirical methodology. Section 3 describes the data set and reports the empirical results. Section 4 conducts the correlation analysis on individual firms. Section 5 concludes the paper.