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Time-varying return-volatility relation in international stock markets

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ABSTRACT

This study examines the time-varying relationship between stock returns and volatility in sixteen stock markets during January 2001 to October 2014. After estimating the volatility process without assuming any specific form of its behavior, we find the volatility to be long-term dependent with the Hurst exponent on a verge of stationarity and nonstationarity. We then apply the detrended cross-correlation coefficient to overcome this complication and find evidence of a significant and negative relationship between current stock market returns and current market volatility. Additionally, we find the strength of the negative return-volatility relation is different for specific scales and is stronger in longer time horizon. We further investigate the presence of volatility feedback and leverage effects in international stock markets by examining the lead-lag relation between stock returns and volatility and confirm that the negative return-volatility relation seems to be return-driven (the leverage effect). Finally, we examine the dynamic behavior of the return-volatility relation by applying a rolling window approach and find that time-varying negative return-volatility relation is more likely to generate an asymmetric response with a greater effect when returns decline, which is the common characteristic of international stock markets.

1. Introduction

Due to its importance and broad implication in financial economics, the underlying link between the return on a financial asset and its volatility as a proxy for risk has been a fundamental issue in financial research. Ghysels, Santa-Clara, and Valkanov (2005) even argue that the risk-return trade-off is so fundamental in financial economics that it could be described as the "first fundamental law of finance". Although most asset pricing models postulate a positive link between stock portfolio's expected returns and volatility (Baillie & DeGennaro, 1990) under the assumption of investor risk aversion, it is not uncommon in empirical finance to model stock return volatility as negatively correlated with stock returns (Bekaert & Wu, 2000; Whitelaw, 2000). However, there is no consensus on even the most basic theoretical properties of the return-volatility relationship and either a positive or a negative relationship between current stock returns and current volatility is possible (Bollerslev & Zhou, 2006; Glosten, Jagannathan, & Runkle, 1993). In fact, even if numerous empirical studies have been carried out to investigate the return-volatility relation in stock markets, there is still no clear consensus about the empirical evidence. On the one hand, Campbell (1987), Glosten et al. (1993), Whitelaw (1994) and Brandt and Kang (2004) have reported a negative and/or insignificant relation. On the other hand, French, Schwert, and Stambaugh (1987), Campbell and Hentschel (1992), Guo and Whitelaw (2006) and Salvador, Floros, and Arago (2014) have documented a positive and

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significant relation. Particularly, Wu and Lee (2015) reveal that the return-volatility relation is significantly positive in bull markets, but significantly negative in bear markets.

In the strand of negative return-volatility relation, two competing theories, i.e. the leverage effect and the volatility feedback effect, have been documented to provide an economic justification for this negative relation in stock markets. The leverage effect, which is firstly discussed by Black (1976) and Christie (1982), relies on a corporate finance argument and indicates that a decrease in stock price causes an increase in the debt-to-equity ratio. The increased leverage gear will make the stock riskier and result in a higher volatility of stock returns. On the other hand, the volatility feedback effect relies on the existence of time-varying risk premiums as the link between changes in volatility and returns (Poterba & Summers, 1986). This effect implies that if expected future stock returns increase when volatility increases, then current stock prices (and hence returns) will fall to adjust to this change in future expectations. Therefore, an increase to volatility causes negative returns (Campbell & Hentschel, 1992). While both of these effects could be at work, the empirical results are mixed and inconclusive in terms of which of these effects is the main determinant of the negative return-volatility relation. Black (1976), Christie (1982), Duffee (1995) and Li, Yang, Hsiao, and Chang (2005) find a negative leverage effect, while, Glosten et al. (1993), Hatemi-J and Irandoust (2011) and Smith and Yamagata (2011) find a negative volatility feedback effect.

The inconclusive finding in terms of the nature of the relation as well as the prevailing theory explaining it appears puzzling. Hence, many of the previous studies attribute this to the appropriateness of using the conditional variance to proxy for risk (see Li et al., 2005; Li, 2011). As stock return volatility is a latent variable and cannot be directly observed, most of the abovementioned studies apply parametric GARCH-class models to estimate volatility, and thus suffer the problem of model misspecification and could lead to an inaccurate relation.[1] Furthermore, the return-volatility relation is very sensitive to the length of the return horizon and the selection of exogenous predictors (Harrison & Zhang, 1999).

In view of the above mixed results, we take a new look at the return-volatility relation by proposing a coherent treatment of it from the nonparametric volatility estimation, the long-term memory characteristics of volatility and its potential non-stationarity, then moving to the estimation of the return-volatility relation under borderline (non-)stationarity, and finally investigating its time-varying behavior through applying a rolling window approach. This coherent treatment enables us to bypass the issue of model misspecification and thus provide more robust empirical results. We then apply the proposed test to the empirical data of sixteen stock markets and the empirical findings can be summarized along four dimensions. First, we show some evidence that a significant negative relationship between current stock market returns and current market volatility prevails in international stock markets and the significance of the negative relationship is quite stable, which corroborates Li et al. (2005)'s finding. Considering the fact that the nonparametric variance specification is more robust than a parametric or semiparametric conditional variance specification, the results of this study provide further support to the argument that stock returns and volatility is negatively correlated (Bekaert & Wu, 2000; Black, 1976; Cox & Ross, 1976). Second, we find that the strength of the negative return-volatility relation is different for specific scales and is stronger in longer time horizon. This finding has not been reported in stock markets and may potentially open a new topic of research.[2] Third, in consistent with the spirit of Hibbert, Daigler, and Dupoyet (2008) and Fleming, Ostdiek, and Whaley (1995), we examine the presence of volatility feedback and leverage effects in international stock markets by investigating the lead-lag relation between stock returns and volatility and empirically confirm that the negative return-volatility relation seems to be return-driven (the leverage effect). This finding is in line with Black (1976), Christie (1982) and Duffee's (1995) argument but contradicts Bekaert and Wu's (2000) conclusion that the volatility feedback effect is the main source of the negative correlation between returns and volatility. Finally, we examine the dynamic behavior of the return-volatility relation by applying a rolling window approach and find that time-varying negative return-volatility relation is more likely to generate an asymmetric response with a greater effect when returns decline, which is the common characteristic of international stock markets, albeit with different fluctuating levels, and the strength of the negative return-volatility relation depends on the state of the market and is stronger in the period of market turbulence. This may partially explain the mixed and inconclusive findings in the return-volatility relation.

The empirical aspects of our study include four major differences from previous research. First, the model specification problem is taken into consideration. We use a range-based estimator to measure the volatility process without assuming any specific form of its behavior, with the new measure being better metrics of market expectations since it includes the entire price range as well as bypasses the issue of model misspecification by estimating the volatility outside the returns model. This volatility measure also enables us to investigate the time-varying behavior of the return-volatility relation outside the returns model. Second, we conduct the detrended cross-correlation coefficient analysis using a rolling window approach, which enables us to incorporate the possibility of the smooth and continuous process of international stock markets, and to obtain time-varying return-volatility relation that is robust to possible structural changes. We thus extend Li et al. (2005)'s empirical work, albeit within a different framework. Third, we provide a coherent treatment of the return-volatility relation without assuming anything about the relationship between returns and volatility which distinguishes our study from the other studies which are majorly built around assuming some kind of asymmetric volatility model. Indeed, it is well known to financial researchers that the problem that inferences drawn on the basis of GARCH-class model may be highly attributed to model specification. Fourth, we investigate the lead-lag relationship between stock returns and volatility using the detrended cross-correlation coefficient. This approach is consistent with the spirit of Hibbert et al. (2008) and Fleming et al. (1995) that run OLS regressions to investigate the daily lead-lag relation between stock returns and volatility, and thus allows us to disentangle the leverage effect and the volatility feedback effect which have been competing to provide theoretical explanation to the negative nature of the return-volatility relation. Overall, to the best of our knowledge, this is the first time that the detrended cross-correlation coefficient

[1] Harrison and Zhang (1999) show that GARCH models may be misspecified and could lead to an inaccurate relation.
[2] Kristoufek (2014) reports this effect in energy futures markets.