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Stock market dynamics in a regime-switching asymmetric power GARCH model

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Abstract

This paper analyzes the dynamics of Asian stock index returns through a Regime-Switching Asymmetric Power GARCH model (RS-APGARCH). The model confirms some stylized facts already discussed in former studies but also highlights interesting new characteristics of stock market returns and volatilities. Mainly, it improves the traditional regime-switching GARCH models by including an asymmetric response to news and, above all, by allowing the power transformations of the heteroskedasticity equations to be estimated directly from the data. Several mixture models are compared where a first-order Markov process governs the switching between regimes.

JEL classification: C13; C52; G15
Keywords: Power GARCH; Regime switching; Volatility; Stock market

1. Introduction

Since the availability of high frequency financial data, a growing body of empirical studies, starting with Fama and French (1989), has investigated the predictability of mean and volatility of asset returns. Volatility of financial returns is indeed a central parameter for many financial decisions including the pricing and hedging of derivative products and risk management. Most of the volatility models presented in the empirical literature are based on the observation that volatility is time-varying and that periods of high volatility tend to cluster. The autoregressive

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conditional heteroskedasticity (ARCH) models, as introduced by Engle (1982) and extended to Generalized ARCH (GARCH) in Bollerslev (1986), have proven to be useful means for empirically capturing these stylised facts.

Although such approaches provide an improvement in fit compared with constant variance models, recent evidence from financial market data seems to suggest that persistence in variance, as measured by GARCH models, is so substantial that it sometimes implies an explosive conditional variance. To account for this apparent empirical regularity, Engle and Bollerslev (1986) introduce the Integrated-GARCH (I-GARCH) process, in which shocks to the variance do not decay over time. However, Lamoureux and Lastrapes (1990) show that one potential source of misspecification of ARCH/GARCH models is that the structural form of conditional means and variances is relatively inflexible and is held fixed throughout the entire sample period. As explained in Timmermann (2000) if the variance is high but constant for some time and low but constant otherwise, the persistence of such high- and low- volatility homoskedastic periods already results in volatility persistence. GARCH models, that cannot capture the persistence of such periods, put all the volatility persistence in the persistence of individual shocks, biasing thus upward our assessment of the degree to which conditional variance is persistent.

Although the ad hoc introduction of deterministic shifts into the variance process represents one possibility to allow for periods with different unconditional variances, the most promising approach to modelling these nonlinearities is by endogenizing changes in the data generating process through a Markov regime-switching model as introduced in Hamilton (1989). The model relies on different coefficients for each regime to account for the possibility that the economic mechanism generating the asset returns may undergo a finite number of changes over the sample period. In order not to rule out within-regime heteroskedasticity, Gray (1996) extends Hamilton's (1989) model to accommodate within-regime GARCH effects with a so-called Regime-Switching GARCH model (RS-GARCH). RS-GARCH models have the attractive feature of incorporating significant nonlinearities, while remaining tractable and easy to estimate. Although they represent a suitable framework to investigate how the volatility dynamics is affected by the states of the economy, surprisingly few improvements of the single-regime ARCH/GARCH literature have been adapted and tested in their regime-switching counterparts.

In particular, under classical GARCH models, shocks to the variance persist according to an autoregressive moving average (ARMA) structure of the squared residuals of the process. However, it is not necessary to impose a squared power term in the second moment equation as in Bollerslev (1986). Taylor's (1986) and Schwert's (1989) class of GARCH models, for instance, relate the conditional standard deviation of a series to lagged absolute residuals and past standard deviations. More recently, Ding, Granger, and Engle (1993) suggest an extension of the GARCH family models that analyses a wider class of power transformations than simply taking the absolute value or squaring the data as in the traditional heteroskedastic models. Known as the Power GARCH (PGARCH) models, this addition to the GARCH family has been shown to be superior in fit to its less sophisticated counterparts (see Brooks, Faff, McKenzie, and Mitchell (2000) for an empirical investigation in a single-regime framework). Nesting the major two classes of GARCH models (namely, Bollerslev's and Taylor–Schwert's) the PGARCH specification also provides an encompassing framework which facilitates comparison.

An important contribution of the current paper is to highlight whether and to what extent these more flexible models improve both the fit and our understanding of asset returns dynamics when the assumption of a single regime is relaxed in favor of a regime-switching model. To this end, we introduce a new Regime-Switching Asymmetric Power GARCH (RS-APGARCH) model to analyze empirically Asian stock index returns. Our findings shed light on several