経済政策不確実性と金融市場ボラティリティ

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概要

本研究では，日本の金融市場における経済政策の不確実性と金融市場のボラティリティとの関係を示す．不確実性は，Baker らが新しく開発した新聞報道に基づく経済政策不確実性（EPU）の指数によって測定される．ボラティリティは，実現ボラティリティ（RV）として知られている日次収益率の二乗和として計算される．経済政策の不確実性ショックが日本の金融市場のボラティリティとどのように関連しているかを分析するために，EPU と RV を混合データサンプリング（MIDAS）モデルに適用する．ここでの結果は，本邦金融市場の分析と経済政策に関する研究に寄与するであろう．

キーワード：経済不確実性；実現ボラティリティ；GARCH-MIDAS モデル；DCC-MIDAS モデル；日本の金融市場

Economic Policy Uncertainty and Financial Market Volatility: Evidence from Japan

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Abstract

In this study, we show a relationship between economic policy uncertainty and financial market volatility in Japanese financial market. Uncertainty is measured by the index of economic policy uncertainty (EPU) based on newspaper coverage, frequency newly developed by Baker et al. Volatility is calculated as a sum of squared intraday returns, which is known as the realized volatility (RV). The EPU and RV are combined with the mixed data sampling (MIDAS) approach in order to investigate how economic policy uncertainty shocks are associated with the Japanese financial market volatility. The result will contribute to financial market research and economic policy studies.

Keywords: Economic policy uncertainty index; Realized volatility; GARCH-MIDAS model; DCC-MIDAS model; Japanese financial market.

1. Introduction

Asgharian et al. (2016) investigate US and UK stock market movements using the economic policy uncertainty indices of Baker et al. (2016) in combination with the mixed data sampling (MIDAS) approach. They find that the long-run US-UK stock market correlation depends positively on US economic policy uncertainty shocks whereas the UK long-run stock market volatility does significantly on the US and UK economic policy uncertainty shocks.

In this research, we follow Asgharian et al. (2016) and apply their method to Japanese stock market. Specifically, we investigate the relation between Nikkei225 which is the stock index for the Tokyo Stock Exchange (TSE) and individual stocks comprised in TOPIX100 which is composed of Top 100 stocks traded on TSE in light of economic policy uncertainty and stock market volatility. Uncertainty is measured by the index of economic policy uncertainty (EPU) based on newspaper coverage, frequency newly developed by Baker et al. (2016) Volatility is calculated as a sum of squared intraday returns, which is known as the realized volatility (RV). The EPU and RV are combined with the mixed data sampling (MIDAS) approach proposed by Ghysels et al. (2004, 2006) in order to investigate how economic policy uncertainty shocks are associated with the Japanese financial market volatility.

Meanwhile, Engle et al. (2013) use the MIDAS approach to link macroeconomic variables to the long-term component of volatility. They incorporate a mean reverting unit daily heteroscedastic volatility process with a MIDAS polynomial that applies to long-term macroeconomic variables, which is called the generalized autoregressive conditional heteroscedasticity model with MIDAS (GARCH-MIDAS) approach. Now we replace a macroeconomic variable with a monthly EPU in GARCH-MIDAS model following Asgharian et al. (2016). Furthermore, Colacito et al. (2011) introduce a novel component model for dynamic correlations which is called the dynamic conditional correlation model with MIDAS (DCC-MIDAS) approach. DCC-MIDAS model is a natural extension of GARCH-MIDAS model to DCC model advocated by Engle (2002). We also use DCC-MIDAS model to capture the dynamic correlation of volatilities between the market index and individual stocks in TSE.

The EPU index of Japan which can be downloaded on the web site: www.policyuncertainty.com is based on frequency counts of articles in Japan's newspapers, Asahi and Yomiuri. It counts the number of news articles containing the terms uncertain or uncertainty, and one or more policy terms. Policy terms are the Japanese equivalents of `tax', `policy', `spending', `regulation', etc. To capture `spending' by the government, they use a set of four terms: `saishutsu', `kokyo jigyohi', `kokyo toushi', and `kokuhi', see the web site for more details.

Our specification employs monthly EPU index of Japan as an explanatory variable in the variance equation of a unit daily GARCH-MIDAS model, which we refer to the model as GARCH-MIDAS-EPU. In our empirical analysis, we first estimate the parameters the GARCH-MIDAS-EPU model pair of two stock returns. After that, we obtain the estimated DCC-MIDAS parameters with the standardized residuals from the GARCH-MIDAS-EPU model using the quasi-likelihood method.

2. Models

In this section, we briefly introduce GARCH-MIDAS-EPU and DCC-MIDAS models which are mentioned above, following Colacito et al. (2011), Asgharian et al. (2016) and Conrad et al. (2014).

Let us assume that the vector of returns $\mathrm{r}_t = [r_{1,t}, \dots, r_{n,t}]'$ follows the process:

$$\mathrm{r}_t \sim N(\mu, H_t)$$
$$H_t = D_t R_t D_t$$

where μ is the vector of unconditional means, H_t is the conditional covariance matrix and D_t is a diagonal matrix with standard deviations on the diagonal. Furthermore, we also assume that:

$$R_t = E_{t-1}[\xi_t \xi_t']$$
$$\xi_t = D_t^{-1}(\mathrm{r}_t - \mu)$$

where $E_{t-1}[\cdot]$ is the expectation at time $t-1$ given the observations until time $t-1$. Then we have $\mathrm{r}_t = \mu + H_t^{\frac{1}{2}} \xi_t$ with $\xi_t \sim N(0, I_n)$. We refer to g_i and m_i as the short and long run variance components respectively for asset i and denote by N_v^i the number of days that m_i is held fixed. The superscript i indicates that this may be asset-specific and the subscript v differentiates it from a similar scheme that will be introduced later for correlations. In particular, while $g_{i,t}$ moves daily, $m_{i,\tau}$ changes only once every N_v^i days. We assume that for each asset $i = 1, \dots, n$, univariate returns follow the GARCH-MIDAS process:

$$r_{i,t} = \mu_i + \sqrt{m_{i,\tau} \cdot g_{i,t}} \xi_{i,t}, \quad \forall t = \tau N_v^i, \dots, (\tau + 1) N_v^i$$

where $g_{i,t}$ follows a GARCH(1,1) process:

$$g_{i,t} = (1 - \alpha_i - \beta_i) + \alpha_i \frac{(r_{i,t-1} - \mu_i)^2}{m_{i,\tau_t}} + \beta_i g_{i,t-1}$$

while the MIDAS component $m_{i,\tau}$ is a weighted sum of K_v^i lags of realized variances (RV) over a long horizon:

$$m_{i,\tau} = \bar{m}_i + \theta_i \sum_{l=1}^{K_v^i} \varphi_l(\omega_v^i) RV_{i,\tau-l}$$

where the RV involve N_v^i daily squared returns. Namely:

$$RV_{i,\tau} = \sum_{j=(\tau-1)N_v^i+1}^{\tau N_v^i} (r_{i,j})^2$$

where N_v^i could for example be a quarter or a month. The above specification corresponds to the block sampling scheme as defined in Engle et al. (2013), involving so called Beta weights defined as:

$$\varphi_l(\omega_v^i) = \frac{\left(1 - l/K_v^i\right)^{\omega_v^i - 1}}{\sum_{j=1}^{K_v^i} \left(1 - j/K_v^i\right)^{\omega_v^i - 1}}$$

where the parameters N_v^i and K_v^i are independent of i, i.e. the same across all series.

We use the two-step DCC-MIDAS model of Colacito et al. (2011) extended to allow for exogeneous variables influencing the long-run volatility and correlation as in Asgharian et al. (2016). The first step consists of estimating separate GARCH-MIDAS models for the stock returns for day $i = 1, \ldots, N_t$ in month t as:

$$r_{i,t-1} = \mu + \sqrt{\tau_t g_{i,t} \varepsilon_{i,t}} \quad \varepsilon_{i,t} \sim (0,1)$$

where the total stock variance $\sigma_{i,t}^2$ is separated into a short-run component $g_{i,t}$ and a long-run component τ_t such that $\sigma_{i,t}^2 = \tau_t g_{i,t}$. A GARCH (1,1) process describes the short-run component:

$$g_{i,t} = (1 - \alpha - \beta) + \alpha \frac{(r_{i,t-1} - \mu)^2}{\tau_t} + \beta g_{i-1,t}$$

where $\alpha > 0$ and $\beta \geq 0, \alpha + \beta < 1$. The long-run component is described by a MIDAS regression where the lagged EPU shocks of the EPU_{t-k} are included over $k = 1, \ldots, 24$:

$$\tau_t = \theta_0 + \theta_1 \sum_{k=1}^{K} \varphi_k EPU_{t-k}$$

where the weighting scheme is described by a beta lag polynomial:

$$\varphi_l(\omega_v^i) = \frac{\left(1 - l/K_v^i\right)^{\omega_v^i - 1}}{\sum_{j=1}^{K_v^i} \left(1 - j/K_v^i\right)^{\omega_v^i - 1}}$$

where the parameter θ_1 measures the effects of the economic policy uncertainty shocks on the long-run volatility. We fix $w_1 = 1$ to ensure higher weights to the most recent observations as with Asgharian et al. (2016).

Colacito et al. (2011) propose the DCC-MIDAS model which is a natural extension of the GARCH-MIDAS model to the Engle (2002) DCC model. Using the standardized residuals $\xi_{i,t}$, it is possible to obtain a matrix Q_t whose elements are:

$$q_{i,j,t} = \bar{\rho}_{i,j,t}(1 - a - b) + a\xi_{i,t-1} + bq_{i,j,t-1}$$

$$\bar{\rho}_{i,j,t} = \sum_{l=1}^{K_c^{ij}} \varphi_l \left(\omega_r^{ij}\right) c_{i,j,t-l}$$

$$c_{i,j,t} = \frac{\sum_{k=t-N_c^{ij}}^{t} \xi_{i,k}\xi_{j,k}}{\sqrt{\sum_{k=t-N_c^{ij}}^{t} \xi_{i,k}^2}\sqrt{\sum_{k=t-N_c^{ij}}^{t} \xi_{j,k}^2}}$$

where we could have used simple cross-products of $\xi_{i,t}$ in the above formulation of $c_{i,j,t}$. The normalization allow us to discuss regularity conditions in terms of correlation matrices. Correlations can then be computed as:

$$\rho_{i,j,t} = \frac{q_{i,j,t}}{\sqrt{q_{i,i,t}}\sqrt{q_{j,j,t}}}$$

where we regard $q_{i,j,t}$ as the short run correlation between assets i and j, whereas $\bar{\rho}_{i,j,t}$ is a slowly moving long run correlation. Rewriting the first equation of system as

$$q_{i,j,t} - \bar{\rho}_{i,j,t} = a\left(\xi_{i,t-1}\xi_{j,t-1} - \bar{\rho}_{i,j,t}\right) + b\left(q_{i,j,t-1} - \bar{\rho}_{i,j,t}\right)$$

conveys the idea of short run fluctuations around a time-varying long run relationship. The idea captured by the DCC-MIDAS model is similar to that underlying GARCH-MIDAS. In the GARCH-MIDAS the short run component is a GARCH component, based on daily returns, that moves around a long-run component driven by realized volatilities computed over a monthly basis, see Colacito et al. (2011).

3. Empirical Analysis

We apply the DCC-MIDAS with GARCH-MIDAS-EPU model to Nikkei225 and TOPIX100 data listed on TSE from June l988 to April 2016 in order to investigate the relation between economic policy uncertainty and financial market volatility in Japanese financial market.

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