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Hossein Asgharian, Charlotte Christiansen and Ai Jun Hou

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Department of Economics and Business Economics
Aarhus University
Fuglesangs Allé 4
DK-8210 Aarhus V
Denmark

Email: oekonomi@au.dk
Tel: +45 8716 5515

Economic Policy Uncertainty and Long-Run Stock Market Volatility and Correlation[*]

Hossein Asgharian, Lund University[a]

Charlotte Christiansen, Aarhus University[b]

Ai Jun Hou, Stockholm University[d]

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[a] Hossein Asgharian, Department of Economics and Knut Wicksell Center for Financial Studies, Lund University, Box 7082, 22007 Lund, Sweden. Hossein.Asgharian@nek.lu.se.

[b] Charlotte Christiansen, CREATES, Aarhus BSS, Aarhus University, Fuglesangs Allé 4, 8210 Aarhus V, Denmark. cchristiansen@econ.au.dk. Lund University.

[d] Ai Jun Hou, Stockholm Business School, Stockholm University, SE-106 91 Stockholm, Sweden. Aijun.Hou@sbs.su.se.

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Abstract: We use Baker, Bloom, and Davis's (2016) economic policy uncertainty indices in combination with the mixed data sampling (MIDAS) approach to investigate long-run stock market volatility and correlation, primarily for the US and UK. Long-run US–UK stock market correlation depends positively on US economic policy uncertainty shocks. The dependence is asymmetric, with only positive shocks - increasing uncertainty - being of importance. The US long-run stock market volatility depends significantly on US economic policy uncertainty shocks but not on UK shocks, while the UK long-run stock market volatility depends significantly on both. Allowing for US economic policy uncertainty shocks improves the out-of-sample forecasting of US–UK stock market correlation and enhances portfolio performance. Similar results apply to the long-run correlation between the US and Canada, China, and Germany.

Keywords: economic policy uncertainty index; mixed data sampling; stock market correlation; stock market volatility; asymmetry

JEL classifications: G11; G15; G30; C32

1. Introduction

The time variation in the correlation of international stock markets has been investigated in prominent papers such as Longin and Solnik (1995). We continue this research by scrutinizing long-run stock market volatility and correlation. In particular, we examine the effects of economic policy uncertainty (EPU) shocks on long-run stock market volatility and correlation. The main analysis is concerned with the US and UK stock markets.

We use Baker, Bloom, and Davis's (2016) EPU indices, which quantify newspaper coverage of policy-related economic uncertainty to obtain country-specific (US and UK) EPU shocks. We build on a growing line of research applying these EPU indices, especially those of the US. There is theoretical and empirical evidence that EPU affects stock returns and volatility. For instance, Pástor and Veronesi (2012) show theoretically that EPU is related to stock market volatility, correlation, and jumps. Pástor and Veronesi (2013) find that individual US stock returns are more volatile and that pairwise US stock returns are more correlated when EPU is higher. Brogaard and Detzel (2015) find that EPU forecasts stock market returns and that EPU shocks earn a negative risk premium. Recently, Kelly, Pástor, and Veronesi (2016) show that EPU also plays a role in the pricing of stock options. Scheffel (2016) shows that EPU shocks have important effects on various economic variables. Fang, Yu, and Li (2017) use the EPU index to predict US stock-bond correlation. Fang, Chen, Yu, and Qian (2017) use the EPU shocks to predict gold futures volatility.

Our paper is also related to the strand of the literature investigating the effects of country-specific and US economic news on international asset prices. Becker, Finnerty, and Friedman (1995) find that UK stock market volatility reacts significantly to releases of US public information. Albuquerque and Vega (2008) find that US economic news affect the Portuguese stock market while the effect becomes weaker when controlling for US stock returns.

Wongswan (2006) studies the effect of important macroeconomic announcements from the US and Japan on the Korean and Thai stock markets and documents a significant effect of developed-economy macroeconomic announcements on emerging-economy stock volatility and trading volume.

Based on previous research, we expect that EPU shocks are of importance for international stock market correlation. We analyze the impact of EPU shocks on long-run volatility and correlation. We focus on the long-run effects of EPU shocks, because Barrero, Bloom, and Wright (2017) show that EPU is mainly important for long-run uncertainty and Davis (2017) finds a larger correlation between VIX and EPU for longer horizons than for shorter horizons. We apply Ghysels, Santa-Clara, and Valkanov's (2005) mixed data sampling (MIDAS) framework to combine daily stock returns with monthly EPU shocks. In particular, we use the bivariate dynamic constant correlation (DCC–MIDAS) specification of Colacito, Engle, and Ghysels (2011). This approach allows us to concentrate on the long-run behavior of the volatility and correlation. To the best of our knowledge, this paper is the first attempt to analyze how the long-run volatility and correlation of different equity markets are influenced by economic policy uncertainty.

Our main analysis concentrates on the US and UK stock markets. We find that US long-run volatility depends positively and significantly on US EPU shocks. UK long-run volatility depends significantly on both US and UK EPU shocks, and the magnitude of the influence from US shocks is greater than from UK shocks. Similarly, long-run US–UK correlation depends significantly on US EPU shocks, but not on UK shocks, once we account both countries' EPU shocks. We also show that the importance of the US EPU shocks for the long-run US–UK correlation reflects a contagion effect from the US to the UK rather than US importance for the global economy, in general. Our study of 10 categorical US EPU indices show that news about regulation, taxes, and fiscal policy are more important than other news types for long-run stock market volatility and correlation. The empirical findings on the importance of US EPU shocks also apply to alternative countries such as Canada, China, and Germany.

The out-of-sample analysis shows that the DCC-MIDAS model with US EPU shocks provides a significantly better prediction of US–UK stock market correlation compared to both a random-walk and a DCC-MIDAS model based on realized correlation. Engle and Colacito's (2006) test confirms the benefits of using US EPU shocks for portfolio selection.

We also contribute to the literature by extending the univariate GARCH-MIDAS and the multivariate DCC-MIDAS models to include asymmetry. The new framework allows us to investigate the asymmetric impact of positive and negative EPU shocks on long-run volatility and correlation. US and UK long-run stock market volatilities display only weak signs of asymmetry. Only positive EPU shocks from the US are significant for long-run US–UK stock market correlation. Neither negative US EPU shocks nor UK EPU shocks are significant. Thus, increasing US uncertainty implies an increasing long-run correlation.

The remainder of the paper is structured as follows. First, we introduce the data in Section 2, followed by the econometric framework in Section 3. In Section 4, we discuss the empirical results before concluding in Section 5.

2. Data

The main part of the analysis is concerned with the US and UK stock markets. The sample period is from January 1997 to April 2016 with the beginning determined by the availability of the EPU index for the UK. For the US stock market, we use the S&P500 total return index and for the UK stock market, we use the FTSE100 total return index. To get synchronized daily observations from both markets, we use the last transaction price at 15:00 GMT to ensure that both markets are open. The intraday transaction prices are collected from Thomson Reuters' SIRCA database.

The monthly news-based EPU indices for the US and the UK are freely available from Baker, Bloom, and Davis (2016). The indices quantify newspaper coverage of policy-related economic uncertainty. We use log first differences of the EPU indices as these reflect EPU shocks (cf. Li, Zhang, and Gao, 2015). The US and UK EPU shocks truly measure different types of shocks as their correlation coefficient only amounts to 0.60 and it is even lower for the EPU indices (0.32).

3. Econometric Methodology

We use Colacito, Engle, and Ghysels's (2011) two-step DCC-MIDAS model, extended to allow for exogenous variables (the EPU shocks) influencing the long-run volatility and correlation as in Asgharian, Christiansen, and Hou (2016) and Fang, Yu, and Li (2017). In addition, we extend the DCC-MIDAS model to allow for asymmetries in the effects from positive and negative EPU shocks. The estimation is done similarly to Asgharian, Christiansen, and Hou (2016). The first step consists of separately estimating the GARCH-MIDAS models for the US and UK stock returns using all daily observations in the sample, where the subscripts denote day $i = 1, \ldots, N_t$ in month t:

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

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

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

where $\alpha > 0$ and $\beta \geq 0$, $\alpha + \beta < 1$. We denote the EPU shocks (log first differences of the EPU indices) for month t as $EPU_{\mathrm{US},t}$ and $EPU_{\mathrm{UK},t}$, respectively. We use the weighted moving average of 24 historical values of EPU shocks to define the long-run volatility component for each country (K=24):

$$\log(\tau_t) = \theta_0 + \theta_{\text{US}} \sum_{k=1}^{K} \varphi_{\text{US},k} EPU_{\text{US},t-k} + \theta_{\text{UK}} \sum_{k=1}^{K} \varphi_{\text{UK},k} EPU_{\text{UK},t-k}. \tag{3}$$

The parameters θ_{US} and θ_{UK} measure the effects of the US and UK EPU shocks on the long-run volatility. The weighting scheme used in equation (3) is described by a beta lag polynomial:

$$\varphi_k(w_1, w_2) = \frac{\left({}^{k}/_{K}\right)^{w_1-1}\left(1-{}^{k}/_{K}\right)^{w_2-1}}{\sum_{j=1}^{K}\left({}^{k}/_{K}\right)^{w_1-1}\left(1-{}^{k}/_{K}\right)^{w_2-1}}, k = 1, \ldots, K, \tag{4}$$

with $w_1 = 1$ to ensure that higher weights are given to the most recent observations.

In the second step, we estimate the DCC-MIDAS specification for US–UK stock market correlation using the standardized residuals ($\xi_{\text{US},i,t}$ and $\xi_{\text{UK},i,t}$) from the first step.

$$\begin{gathered} q_{i,t} = \bar{\rho}_t(1 - a - b) + a\xi_{\text{US},i-1,t}\xi_{\text{UK},i-1,t} + bq_{i-1,t} \\ \bar{\rho}_t = \frac{\exp(2\bar{z}_t) + 1}{\exp(2\bar{z}_t) - 1} \\ \bar{z}_t = \gamma_0 + \gamma_{\text{US}} \sum_{k=1}^{K} \delta_{\text{US},k} EPU_{\text{US},t-k} + \gamma_{\text{UK}} \sum_{k=1}^{K} \delta_{\text{UK},k} EPU_{\text{UK},t-k} \end{gathered} \tag{5}$$

$q_{i,t}$ is the short-run correlation, $\bar{\rho}_t$ is a slowly moving long-run correlation, and K is the numbers of lags/periods over which we smooth the covariance or the EPU. Aiming at a fast convergence in the estimation while using as little data as possible for calculating lags, we set K=60. γ_{US} and γ_{UK} measure the effects of the US and UK EPU shocks on the long-run correlations, and $\delta_{\text{US},k}$ and $\delta_{\text{UK},k}$ are the corresponding weighting schemes, defined in equation (4).

Rossi and Sekhposyan (2015) suggest a variable-specific US macroeconomic uncertainty measure based on the forecast error distributions of, for example, the GDP growth rate as an alternative to Baker, Bloom, and Davis's (2016) EPU indices, partially to distinguish between upside and downside uncertainty. Similarly, in this paper, we investigate asymmetries between positive and negative EPU shocks. Therefore, we extend the DCC-MIDAS model to account for asymmetry, such that positive and negative EPU shocks are allowed to have different effects on the long-run correlation.

We define the positive EPU shocks as $EPU^{+}_{\mathrm{US},t-k} = I\left[EPU_{\mathrm{US},t-k} > 0\right]EPU_{\mathrm{US},t-k}$ and the negative EPU shocks as $EPU^{-}_{\mathrm{US},t-k} = I\left[EPU_{\mathrm{US},t-k} \leq 0\right]EPU_{\mathrm{US},t-k}$. This means that the positive EPU shock is equal to the EPU shock itself when it is positive and zero it is negative. The negative EPU shock is defined vice versa. The long-run components of the variances and correlation in equations (3) and (5), respectively are then replaced by the following equations:

$$\log(\tau_t) = \theta_0 + \theta^{+}_{\mathrm{US}} \sum_{k=1}^{K} \varphi_{\mathrm{US},k}\, EPU^{+}_{\mathrm{US},t-k} + \theta^{-}_{\mathrm{US}} \sum_{k=1}^{K} \varphi_{\mathrm{US},k}\, EPU^{-}_{\mathrm{US},t-k} + \theta^{+}_{\mathrm{UK}} \sum_{k=1}^{K} \varphi_{\mathrm{UK},k}\, EPU^{+}_{\mathrm{UK},t-k} + \theta^{-}_{\mathrm{UK}} \sum_{k=1}^{K} \varphi_{\mathrm{UK},k}\, EPU^{-}_{\mathrm{UK},t-k} \quad (6)$$

$$\bar{z}_t = \gamma_0 + \gamma^{+}_{\mathrm{US}} \sum_{k=1}^{K} \delta_{\mathrm{US},k}\, EPU^{+}_{\mathrm{US},t-k} + \gamma^{-}_{\mathrm{US}} \sum_{k=1}^{K} \delta_{\mathrm{US},k}\, EPU^{-}_{\mathrm{US},t-k} + \gamma^{+}_{\mathrm{UK}} \sum_{k=1}^{K} \delta_{\mathrm{UK},k}\, EPU^{+}_{\mathrm{UK},t-k} + \gamma^{-}_{\mathrm{UK}} \sum_{k=1}^{K} \delta_{\mathrm{UK},k}\, EPU^{-}_{\mathrm{UK},t-k} \quad (7)$$

4. Results and Analyses

In this section, we first discuss US and UK long-run volatility and then their long-run correlation, including the world market's effect on these. We then discuss the asymmetric responses to EPU shocks and compare all the models' out-of-sample performance. We end by considering shocks from categorical EPU indices as well as alternative stock markets than the UK.

4.1. Long-Run Volatility

Table 1 shows the results for the volatility model with four different specifications of the equation for long-run variances. Our benchmark, Model 1, is the conventional GARCH-MIDAS model with realized variance in place of EPU shocks in equation 3. Model 2 uses only US EPU shocks, Model 3 uses only UK EPU shocks, and Model 4, which is our main model, uses both US and UK EPU shocks in equation 3. We do not include the realized variance and EPU shocks at the same time in the long-run volatility equation, since the EPU shocks may also affect realized moments and using both in the same model may only capture the effect of EPU on the long run variance after eliminating its effect on the past realized variances. Therefore, we would not be able to assess the total effect of EPU shocks. The same applies to the correlation specification.

Based on the BIC, Model 2 is preferable for the US variance. For the UK variance, all models are very similar with respect to the BIS. This suggests a high correlation between EPU shocks and realized variances.

In Model 1, the coefficients of the realized volatility are positive and significant for both the long-run US and UK volatility, which is in accordance with previous studies (see, e.g., Engle, Ghysels, and Sohn, 2013; Asgharian, Christiansen, and Hou, 2015). In the other models, the long-run US volatility depends positively and significantly on US EPU shocks such that larger economic uncertainty accompanies greater long-run US volatility. UK EPU shocks have no influence on long-run US volatility as θ_{UK} is insignificant. When both the US and UK EPU shocks are included, only the US EPU shock has a significant impact on long-run US volatility.

Long-run UK volatility depends strongly on the UK EPU shocks, but it also depends positively on the US EPU shocks. When we consider US and UK EPU shocks jointly, they are both significant for explaining long-run UK stock volatility, although the US EPU shocks have a larger coefficient in the US volatility. This is most likely due to the strong correlation between the US and UK markets, but it could indicate that the measure of economic uncertainty is more precise for the US than for the UK.

Panels A and B of Figure 1 show the long-run volatility components from the various specifications. For comparison, we plot the EPU indices for the US and the UK in Figure 2. Both the US and UK EPU indices are strongly time varying. The behavior is similar for both stock markets. The long-run volatility component is very smooth when including the realized volatility. When only including the UK EPU shocks, the long-run volatility component is flat, while it is less flat when only including the US EPU shocks. The variation in the long-run volatility is most pronounced when both US and UK EPU shocks are included. For the US volatility there is no discernable difference between including both US and UK shocks and only US shocks. The estimated US volatility closely follows the US uncertainty index and reflects the uncertainty spikes related to such extreme events as 9/11, the Lehman Brothers failure in 2008, the debt ceiling fight in 2011, and the fiscal cliff of 2012.

4.2. Long-Run Correlation

Table 2 shows the results for the correlation models. For comparison, Model 1 uses the realized correlation as the exogenous variable in equation 5 in place of the EPU shocks. Model 2 uses US EPU shocks, Model 3 uses UK EPU shocks, Model 4 uses both US and UK EPU shocks, and Model 4* is a modified version of Model 4 (see Section 4.3). According to the BIC, the preferred correlation model (amongst model 1 to 4) includes only US EPU shocks.

The long-run correlation depends positively on the realized correlation. The long-run US–UK stock correlation depends positively and significantly on the US EPU shocks. Similarly, the long-run US–UK stock correlations also depend positively and significantly on the UK EPU shocks. When we account jointly for the US and UK EPU shocks, only the US shocks remain significant. For the long-run correlation, essentially the state of the US economy is important.

Panel C of Figure 1 shows the long-run correlation for the various EPU specifications. The long-run correlation follows the same pattern as the long-run volatility components. It is very smooth when including realized correlation, flattest with only UK EPU shocks, followed by only US EPU shocks. The variability is strongest when accounting for both US and UK economic uncertainty shocks. In general, the correlation is higher in periods with higher uncertainty (see Figure 2).

4.3. Effects of World Market

US EPU shocks are supposedly informative for the global economy. Therefore, the significance of the US EPU shocks for the long-run US–UK correlation may simply reflect the importance of US EPU shocks for the global economy, rather than reflecting its direct effects on the UK stock market. To investigate this possibility further, we modify the DCC-MIDAS model to include the world index (excluding the UK) in the mean equation for the UK stock returns.[1] The purpose is to eliminate the co-movement of the UK with the world market, thereby isolating the importance of US EPU shocks for the UK stock market. Since, the US stock market's impact on the world market is significant, we make the world market orthogonal to the US stock returns using the residuals from a regression of the world index on the US returns, denoted $r_{i,t}^{\mathrm{OW}}$. More specifically, the mean in equation (1) is modified as

$$r_{i,t} = \mu_0 + \mu_1 r_{i,t}^{\mathrm{OW}} + \sqrt{\tau_t g_{i,t}}\varepsilon_{i,t} \quad \varepsilon_{i,t} \sim (0,1) \tag{8}$$

[1] We use the Datastream world stock index excluding the UK.

The results of estimating the modified specification (Model 4*) are reported in Table 2 (we only show the correlation results). Despite a small decrease in its value, γ_{US} remains highly significant. This shows that the impact of US EPU shocks on the long-run US–UK correlation is not caused by global effects.

4.4. Asymmetric Specifications

Table 3 shows the results from estimating the asymmetric volatility specification that includes both US and UK EPU shocks (Model 5). For the US volatility, the positive and negative US EPU shocks are both significant and the effects are positive and of similar size. The positive and negative UK EPU shocks are not significant. The EPU shocks appear not to affect the US volatility asymmetrically and the BIC also indicates that the asymmetric GARCH-MIDAS model is not preferable to the corresponding symmetric model (Model 4). For the UK volatility, the asymmetric model shows that only the positive US EPU shocks are significant. However, based on the BIC, the asymmetric version does not outperform symmetric models. Overall, the long-run volatilities show only weak signs of asymmetry with respect to EPU shocks. Figure 3 shows the long-run component of the volatility in the asymmetric model and for comparison for Models 4 (symmetric) and 1 (realized variance). The long-run volatility component for the asymmetric and symmetric model appear to follow each other fairly closely, while that of the realized variance model is far more erratic.

Table 4 shows the results from estimating the asymmetric correlation specification (Model 5). According to the BIC, the asymmetric version is preferable to the symmetric specification. Only positive US EPU shocks have a significant impact on the long-run correlation. Neither negative US EPU shocks nor any of the UK shocks are significant. Therefore, the reason why the long-run US–UK stock market correlation depends on the US EPU shocks is due to positive US EPU shocks. Our results show that only increasing (and not decreasing) uncertainty increases long-run US–UK stock market correlation. Figure 3 shows the components of the long-run correlation in the asymmetric model as well as for Models 4 (symmetric) and 1 (realized correlation). Similar, to the long-run volatility component, the long-run correlation component is fairly similar for the symmetric and asymmetric model, whereas that from the realized correlation model is much more erratic.

4.5. Out-of-Sample Forecasting

We conduct out-of-sample forecasting of the long-run variances and correlation using a 10-year rolling window for the parameter estimates. The first in-sample period is from 1999 to 2008. The out-of-sample forecasting period is, therefore, 2009 to 2016. In addition to Models 1 to 5, we use the random-walk model, i.e. the lagged realized variances and correlation.

In the top part of Table 5, we report mean squared errors (MSE) calculated from comparing the forecasts from the various models with the realized variances and covariances. This part also shows the significance level of the Diebold and Mariano (1995) test for comparison of the MSEs of different models with the MSE of the random-walk model. The asymmetric model has the smallest MSE for the long-run volatilities. Still, the difference to the random walk is insignificant for all models with EPU shocks (Models 2 to 5).

The smallest MSE for the US–UK long-run correlation is obtained by Model 2, where the long-run correlation depends only on the US EPU shocks. Models 3-5 have almost the same MSEs as Model 2. All the models including the EPU shocks have significantly smaller MSEs than the random-walk model.

In the bottom part of Table 5, we report the results from univariate regressions of realized variances and correlation on their predictions. For accurate models, the intercept should be close to zero and the slope close to one. For the variances, the conclusions are mixed, in that none of the models are best in this sense for both countries. For the correlation, the picture is clear: For Models 2 and 5 the intercept and slope are not significantly different from zero and one, respectively.

Based on the results above we conclude that, the DCC-MIDAS model with only the US EPU shocks (Model 2) and the asymmetric specification (Model 5) perform best for the out-of-sample forecasting of the correlation between UK and US stock returns. In contrast, it is difficult to find a best-performing model for variance predictions. Therefore, we perform the Engle and Colacito (2006) test to obtain an overall assessment of the models' out-of-sample forecast ability. Table 6 shows the results from conducting the Engle and Colacito (2006) test. For each model, we use the estimated variances and correlation and construct a portfolio of US and UK stocks by minimizing the portfolio variance with a given vector of expected returns (unconditional mean returns of the US and UK stocks) and compare the resulting portfolio performance from the various models. A positive (negative) sign indicates that the row model outperforms (underperforms) the column model.

Model 2 gives better portfolio results than all other models and outperforms Model 1 at the 1% significance level and Model 3 at the 10% significance level. This implies that for portfolio analysis it is important to account for US EPU shocks.

All in all, the out-of-sample results are in favor of the model with only US EPU shocks (Model 2). For this reason we consider only Model 2 in the following subsection on categorical EPU shocks.

4.6. Categorical EPU shocks

We analyze shocks from 10 categorical EPU indices, also available from Baker, Bloom, and Davis (2016). The categorical EPU indices are news-based sub-indexes that quantify newspaper coverage of economic policy uncertainty as well as news related to a specific category, e.g. monetary policy uncertainty. The categorical EPU indices are: monetary, fiscal, taxes, government spending, health care, national security, entitlement program, regulations, trade policy, and currency crisis.

Previous research finds that aggregate and categorical EPU have similar effects. Beckmann and Czudaj (2017) analyze the relationship between EPU and exchange rates. Their results hold for the EPU index as well as for two categorical EPU indices (monetary and fiscal). Similarly, Yu, Fang, Zhang, and Du (2017) find that the effects from categorical EPU on long-run stock market volatilities are similar to the effects from aggregate EPU. Thus, based on past empirical findings, we would expect that the effects of categorical EPU shocks to be similar to those from the aggregate EPU shocks that we have analyzed so far. In contrast, we expect that the effects from aggregate and categorical uncertainty shocks differ because the economic information contained in the different shocks are different.

We base the analysis on Model 2, where we only consider the effects from US EPU shocks. Table 7 shows the results from estimating the GARCH-MIDAS models for the US and UK volatility. The parameter estimates do not vary a lot across the models and with one exception the effects of all the categorical EPU shocks on volatility are significant. Table 8 shows the results from estimating the DCC-MIDAS model for the US-UK correlation. Again, the parameter estimates do not vary a lot across models. So, in this sense our results are consistent with the previous research, that the effects from categorical and aggregate EPU are similar.

To compare the importance of the various categorical EPU indices further, in Figure 4 we compare the BIC for each of the estimated models. The three most important (smallest BIC) categorical shocks are regulation, taxes, and fiscal policy. Sovereign currency crisis, that covers news on non-US sovereign debt and currency crises, has the largest BIC values for both volatilities and correlation. The ordering of the BIC values across categorical EPU indices is almost identical for US volatility, UK volatility, and US-UK correlation. Interestingly, the much-studied monetary policy uncertainty index has a fairly high BIC and thus appears to be of less importance.

4.7. Alternative Stock Markets

In order to investigate if the importance of US EPU shocks is special to the relationship between the US and UK stock markets, we look into three alternative stock markets and their relation to the US stock market. In particular, we investigate Canada (representing another large North American stock market), China (representing a large emerging stock market), and Germany (representing a large euro area stock market). We use the daily total return stock market indices in local currency of the Toronto stock exchange composite index, the Shanghai composite index, and the DAX 30 index (all available from Thomson Reuters Datastream).

Table 9 shows the results of estimating the GARCH-MIDAS model for the variances for all the countries using Model 4 with both US and own country EPU shocks. For convenience, we repeat the US and UK results. For Canada and Germany the US EPU shocks have significant influence on the long-run volatility which is similar to the UK. Their own country EPU shocks are not significant which is different from the UK. For China neither of the EPU shocks are significant for the long-run variances.

Table 10 shows the results from estimating the DCC-MIDAS model for the US and each of the other countries (Canada, China, Germany, and the UK). The results for the alternative countries are very similar to those for the UK, namely that the US EPU shocks are significant for the long-run stock market correlations and the other country's EPU shocks are not significant.

Overall, the empirical findings on the importance of US EPU shocks are not special to the relationship between the US and the UK stock markets but also apply to the relationship between the US and other types of stock markets.

5. Conclusion

We investigate the importance of economic policy uncertainty (EPU) shocks for long-run US and UK stock market movements. We use the MIDAS framework on daily stock returns and monthly EPU shocks to decompose the volatility and correlation into long-run and short-run components. We also extend the DCC-MIDAS model to allow for asymmetry. The US long-run stock market volatility depends significantly on its own EPU shocks, while the UK long-run stock market volatility depends significantly on both countries' EPU shocks. The long-run US–UK stock market correlation is strongly and positively related to the US EPU shocks. This effect is not caused by general world-market effects. The long-run volatilities show only weak evidence of asymmetry. In particular, positive US EPU shocks are important. So, increasing uncertainty increases the long-run US–UK stock market correlation. Overall, the results suggest that UK investors need mainly to be concerned with US policy uncertainty, even when investing in a domestic stock portfolio. We also conduct out-of-sample forecasting that underscores the importance of US EPU shocks for forecasting the long-run US–UK stock market correlation. Finally, our study of categorical US EPU indices indicates that regulation, taxes, and fiscal policy are more important than the other EPU indices for long-run stock market volatility and correlation. The empirical findings on the importance of US EPU shocks also apply to alternative countries such as Canada, China, and Germany.

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Table 1: Univariate GARCH-MIDAS models for the time-varying variances

The table reports the parameter estimates and standard errors (italic) of the GARCH-MIDAS model for the US and UK return variances. The estimations are based on daily returns and monthly EPU shocks. Model 1 uses own-country realized variances. Model 2 uses US EPU shocks. Model 3 uses UK EPU shocks. Model 4 uses both US and UK EPU shocks. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

		μ	α	β	θ_0	θ_{RV}	$w_{2,\mathrm{RV}}$	θ_{US}	$w_{2,\mathrm{US}}$	θ_{UK}	$w_{2,\mathrm{UK}}$	**BIC**
US	**Model 1**	0.008^{***}	0.101^{***}	0.868^{***}	-4.063^{***}	0.498^{***}	3.243^{***}					-11594
		0.002	*0.005*	*0.005*	*0.120*	*0.091*	*1.058*					
	Model 2	0.008^{***}	0.115^{***}	0.823^{***}	-3.739^{***}			3.888^{***}	1.065^{***}			-11604
		0.002	*0.006*	*0.011*	*0.060*			*0.613*	*0.092*			
	Model 3	0.007^{***}	0.093^{***}	0.898^{***}	-3.294^{***}					0.674	1.000^{***}	-11545
		0.002	*0.004*	*0.001*	*0.344*					*0.662*	*0.000*	
	Model 4	0.007^{***}	0.099^{***}	0.887^{***}	-3.366^{***}			2.159^{***}	1.001^{***}	0.956	1.000^{***}	-11593
		0.002	*0.005*	*0.002*	*0.235*			*0.691*	*0.350*	*0.735*	*0.000*	
UK	**Model 1**	0.005^{**}	0.117^{***}	0.851^{***}	-4.030^{***}	0.625^{***}	3.055^{***}					-11322
		0.002	*0.006*	*0.005*	*0.145*	*0.106*	*0.993*					
	Model 2	0.005^{**}	0.104^{***}	0.884^{***}	-3.306^{***}			1.091^{**}	1.001^{***}			-11323
		0.002	*0.004*	*0.002*	*0.267*			*0.555*	*0.000*			
	Model 3	0.004^{**}	0.102^{***}	0.886^{***}	-3.329^{***}					1.466^{**}	1.001^{***}	-11324
		0.002	*0.004*	*0.002*	*0.256*					*0.688*	*0.000*	
	Model 4	0.004^{**}	0.077^{***}	0.904^{***}	-3.684^{***}			3.403^{***}	1.103^{***}	0.659^{***}	1.000^{***}	-11324
		0.002	*0.003*	*0.004*	*0.103*			*0.698*	*0.105*	*0.170*	*0.000*	

Table 2: DCC-MIDAS models for the time-varying correlation

The table reports the parameter estimates and standard errors (italic) of the DCC-MIDAS model for US–UK return correlation. The estimations are based on daily returns and monthly EPU shocks. Model 1 uses realized correlation. Model 2 uses US EPU shocks. Model 3 uses UK EPU shocks. Model 4 uses both US and UK EPU shocks. Model 4* is a modified version of Model 4. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	a	b	γ_0	γ_{RC}	$w_{2,RC}$	γ_{US}	$w_{2,US}$	γ_{UK}	$w_{2,UK}$	BIC
Model 1	0.034***	0.9117***	−0.130	1.626***	5.779**					20137
	0.005	*0.0179*	*0.302*	*0.382*	*2.939*					
Model 2	0.030***	0.920***	1.163***			2.338***	1.031***			20038
	0.005	*0.014*	*0.023*			*0.631*	*0.189*			
Model 3	0.032***	0.939***	1.165***					2.254***	1.219***	20218
	0.004	*0.009*	*0.029*					*0.821*	*0.324*	
Model 4	0.029***	0.923***	1.182***			4.188***	1.207***	−1.037	1.562	20084
	0.005	*0.015*	*0.024*			*1.281*	*0.207*	*1.244*	*1.058*	
Model 4*	0.030***	0.923***	1.193***			3.804***	1.294***	−1.192	1.539**	19919
	0.005	*0.013*	*0.024*			*1.307*	*0.264*	*1.251*	*0.696*	

Table 3: Asymmetric GARCH-MIDAS models for the time-varying variances

The table reports the parameter estimates and standard errors (italic) of the asymmetric GARCH-MIDAS model for the US and UK return variances. The estimations are based on daily returns and monthly EPU shocks. Model 5 uses both US and UK EPU shocks. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

		μ	α	β	θ_0	θ^+_{US}	$w^+_{2,US}$	θ^-_{US}	$w^-_{2,US}$	θ^+_{UK}	$w^+_{2,UK}$	θ^-_{UK}	$w^-_{2,UK}$	BIC
US	**Model 5**	0.007***	0.029***	0.894***	−4.322***	2.458***	1.000***	2.455***	1.070***	1.656	1.010***	−0.155	7.290	-11554
		0.002	*0.004*	*0.003*	*0.609*	*0.906*	*0.000*	*1.069*	*0.237*	*1.213*	*0.467*	*0.261*	*11.185*	
UK	**Model 5**	0.005**	0.080***	0.892***	−4.053***	3.075***	1.003***	1.615	1.417	1.035	1.000***	1.030	1.288	-11240
		0.002	*0.000*	*0.005*	*0.524*	*0.827*	*0.135*	*1.036*	*0.637*	*0.826*	*0.000*	*1.059*	*0.852*	

Table 4: Asymmetric DCC-MIDAS model for the time-varying correlation

The table reports the parameter estimates and standard errors (italic) of the asymmetric DCC-MIDAS model for the US and UK return correlation. The estimations are based on daily returns and monthly EPU shocks. Model 5 uses both US and UK EPU shocks. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	a	b	γ_0	γ_{US}^{+}	$w_{2,US}^{+}$	γ_{US}^{-}	$w_{2,US}^{-}$	γ_{UK}^{+}	$w_{2,UK}^{+}$	γ_{UK}^{-}	$w_{2,UK}^{-}$	**BIC**
Model 5	0.030***	0.895***	1.106***	1.535***	3.612***	0.654	5.989	−0.473	6.232	0.352	8.368	20068
	0.006	*0.023*	*0.176*	*0.470*	*1.096*	*0.376*	*6.092*	*0.340*	*3.380*	*0.312*	*6.531*	

Table 5: Out-of-sample performance

The table shows the models' out-of-sample forecasting ability. Model 1 uses realized variances and correlation. Model 2 uses US EPU shocks. Model 3 uses UK EPU shocks. Model 4 uses both US and UK EPU shocks. Model 5 is asymmetric. At the top, the table reports the mean squared error (MSE) comparing the predicted long-run variances and correlation with the corresponding realized values. The smallest MSE is bold. Based on the Diebold and Mariano (1995) test, stars indicate if the MSE for Models 1–4 are significantly different from the MSE for the random-walk. Below, the table reports the intercept and slope from estimating univariate regressions of realized values on the predicted values. Stars indicate if the intercept/slope is significantly different from zero/one. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

		US var.	UK var.	Corr.
MSE	**Random walk**	32.055	46.319	0.018
	Model 1	51.602**	64.777	0.013
	Model 2	39.187	49.366	**0.010*****
	Model 3	47.870	59.029	0.011**
	Model 4	37.610	47.277	0.011**
	Model 5	**31.021**	**39.595**	0.011**
Intercept	**Random walk**	2.083***	2.973***	0.678***
	Model 1	−2.945	2.003	0.708***
	Model 2	−2.999**	−5.309**	0.286
	Model 3	−3.731	0.938	0.465***
	Model 4	−4.053**	−5.282*	0.350*
	Model 5	-4.993***	-1.465	0.242
Slope	**Random walk**	0.626***	0.570***	0.175***
	Model 1	1.007	0.506***	0.138***
	Model 2	1.001	1.286	0.647
	Model 3	1.325	0.620**	0.431***
	Model 4	1.615**	1.489	0.576*
	Model 5	1.493***	1.325	0.691

Table 6: Engle and Colacito (2006) test for out-of-sample forecasting

The table shows the result of the Engle and Colacito (2006) test for out-of-sample forecasting of portfolios constructed based on different models. Model 1 uses realized variances and correlation. Model 2 uses US EPU shocks. Model 3 uses UK EPU shocks. Model 4 uses both US and UK EPU shocks. Model 5 is asymmetric. Stars indicate if the average of the weighted differences between the squared ex-post portfolio returns of two competing models is significant. A positive (negative) sign indicates that the row model outperforms (underperformers) the column model. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Random walk	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Random walk		0.029	−0.122	0.034	−0.045	0.100
Model 1	−0.029		-0.200^{***}	−0.026	−0.081	-0.045
Model 2	0.122	0.200^{***}		0.163^{*}	0.118	0.135
Model 3	−0.034	0.026	-0.163^{*}		−0.057	-0.043
Model 4	0.045	0.081	−0.118	0.057		-0.028
Model 5	-0.100	0.045	-0.135	0.043	0.028	

Table 7: Univariate GARCH-MIDAS models for the time-varying variances for categorical EPU shocks

The table reports the parameter estimates and standard errors (italic) of the GARCH-MIDAS model for the US and UK return variances using Model 2. The estimations are based on daily returns and monthly US categorical EPU shocks. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

		μ	α	β	θ_0	θ_{US}	$w_{2,US}$	BIC
US	Monetary policy	0.008***	0.119***	0.819***	-3.806***	3.850***	1.167***	-11528
		0.002	*0.006*	*0.011*	*0.060*	*0.728*	*0.111*	
	Fiscal	0.008***	0.113***	0.825***	-3.763***	3.633***	1.172***	-11546
		0.002	*0.006*	*0.011*	*0.059*	*0.528*	*0.102*	
	Taxes	0.008***	0.112***	0.825***	-3.757***	3.743***	1.144***	-11549
		0.002	*0.006*	*0.011*	*0.059*	*0.527*	*0.094*	
	GVT Spending	0.008***	0.117***	0.821***	-3.785***	3.529***	1.373***	-11536
		0.002	*0.006*	*0.011*	*0.060*	*0.613*	*0.148*	
	Health Care	0.008***	0.118***	0.820***	-3.797***	3.493***	1.255***	-11528
		0.002	*0.006*	*0.011*	*0.060*	*0.668*	*0.123*	
	National Security	0.008***	0.116***	0.821***	-3.800***	3.426***	1.220***	-11532
		0.002	*0.006*	*0.011*	*0.059*	*0.571*	*0.120*	
	Entitlement Program	0.008***	0.119***	0.819***	-3.808***	3.534***	1.166***	-11526
		0.002	*0.006*	*0.011*	*0.060*	*0.694*	*0.113*	
	Regulations	0.008***	0.112***	0.825***	-3.798***	4.692***	1.132***	-11548
		0.002	*0.006*	*0.011*	*0.059*	*0.688*	*0.079*	
	Trade policy	0.008***	0.124***	0.814***	-3.863***	1.514**	1.208***	-11503
		0.002	*0.005*	*0.010*	*0.061*	*0.745*	*0.318*	
	Currency crisis	0.008***	0.123***	0.815***	-3.869***	0.927	1.263**	-11500
		0.002	*0.005*	*0.010*	*0.060*	*0.792*	*0.504*	
UK	Monetary policy	0.005**	0.129***	0.809***	-3.744***	3.342***	1.115***	-11255
		0.002	*0.006*	*0.011*	*0.064*	*0.745*	*0.128*	
	Fiscal	0.005**	0.125***	0.813***	-3.683***	4.062***	1.069***	-11288
		0.002	*0.007*	*0.010*	*0.064*	*0.526*	*0.085*	
	Taxes	0.005**	0.124***	0.813***	-3.677***	4.032***	1.058***	-11291
		0.002	*0.007*	*0.010*	*0.064*	*0.528*	*0.082*	
	GVT Spending	0.005**	0.128***	0.809***	-3.715***	3.552***	1.259***	-11268
		0.002	*0.006*	*0.010*	*0.065*	*0.627*	*0.133*	
	Health Care	0.005**	0.130***	0.807***	-3.734***	3.422***	1.246***	-11261
		0.002	*0.006*	*0.010*	*0.065*	*0.665*	*0.132*	
	National Security	0.005**	0.129***	0.808***	-3.725***	3.421***	1.149***	-11265
		0.002	*0.006*	*0.010*	*0.064*	*0.593*	*0.112*	
	Entitlement Program	0.005**	0.129***	0.808***	-3.741***	3.484***	1.100***	-11258
		0.002	*0.006*	*0.011*	*0.064*	*0.721*	*0.110*	
	Regulations	0.005**	0.122***	0.815***	-3.721***	5.345***	1.063***	-11299
		0.002	*0.007*	*0.010*	*0.064*	*0.669*	*0.068*	
	Trade policy	0.005**	0.133***	0.804***	-3.790***	1.851**	1.303***	-11240
		0.002	*0.006*	*0.011*	*0.064*	*0.770*	*0.367*	
	Currency crisis	0.005**	0.133***	0.805***	-3.802***	0.199	1.114	-11240
		0.002	*0.006*	*0.011*	*0.064*	*0.815*	*0.970*	

Table 8: DCC-MIDAS models for the time-varying correlation for categorical EPU shocks

The table reports the parameter estimates and standard errors (italic) of the DCC-MIDAS model for US–UK return correlation using Model 2. The estimations are based on daily returns and monthly US categorical EPU shocks. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	a	b	γ_0	γ_{US}	$w_{2,US}$	BIC
Monetary policy	0.029***	0.900***	1.156***	3.045***	1.008***	20327
	0.005	*0.021*	*0.020*	*0.577*	*0.103*	
Fiscal	0.032***	0.906***	1.151***	1.885***	1.246***	20225
	0.005	*0.018*	*0.021*	*0.597*	*0.223*	
Taxes	0.032***	0.908***	1.155***	1.840***	1.219***	20224
	0.005	*0.017*	*0.021*	*0.608*	*0.225*	
GVT Spending	0.030***	0.909***	1.143***	1.993***	1.262***	20266
	0.005	*0.017*	*0.021*	*0.616*	*0.245*	
Health Care	0.037***	0.875***	1.138***	2.454***	1.079***	20380
	0.006	*0.027*	*0.020*	*0.568*	*0.127*	
National Security	0.034***	0.898***	1.155***	2.243*	1.350**	20498
	0.005	*0.017*	*0.021*	*1.192*	*0.585*	
Entitlement Program	0.034***	0.889***	1.136***	2.423***	1.069***	20309
	0.006	*0.022*	*0.021*	*0.574*	*0.130*	
Regulations	0.031***	0.892***	1.140***	1.938***	1.204***	20055
	0.006	*0.028*	*0.020*	*0.558*	*0.202*	
Trade policy	0.038***	0.854***	1.144***	3.847***	1.178***	20501
	0.007	*0.035*	*0.019*	*0.599*	*0.111*	
Currency crisis	0.035***	0.885***	1.142***	2.015***	1.060***	20508
	0.006	*0.020*	*0.020*	*0.573*	*0.164*	

Table 9: Univariate GARCH-MIDAS models for alternative countries

The table reports the parameter estimates and standard errors (italic) of the GARCH-MIDAS model for the US, Canada, China, Germany, and the UK return variances using Model 4. The estimations are based on daily returns and monthly EPU shocks. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	μ	α	β	θ_0	θ_{US}	$w_{2,US}$	θ_i	$w_{2,i}$
US	0.007***	0.099***	0.887***	−3.366***	2.159***	1.001***	0.956	1.000***
	0.002	*0.005*	*0.002*	*0.235*	*0.691*	*0.350*	*0.735*	*0.000*
Canada	0.006***	0.089***	0.879***	-3.918***	2.112***	6.999	-0.377	1.207
	0.002	*0.004*	*0.005*	*0.082*	*0.676*	*6.807*	*0.380*	*0.190*
China	0.009***	0.079***	0.912***	-2.476***	0.829	1.504***	-0.498	4.407
	0.003	*0.004*	*0.001*	*0.273*	*0.588*	*0.478*	*0.404*	*2.986*
Germany	0.011***	0.161***	0.817***	-2.544***	1.511*	1.017***	0.909	1.001**
	0.003	*0.009*	*0.003*	*0.309*	*0.838*	*0.227*	*1.022*	*0.460*
UK	0.004**	0.077***	0.904***	−3.684***	3.403***	1.103***	0.659***	1.000***
	0.002	*0.003*	*0.004*	*0.103*	*0.698*	*0.105*	*0.170*	*0.000*

Table 10: DCC-MIDAS models for alternative countries

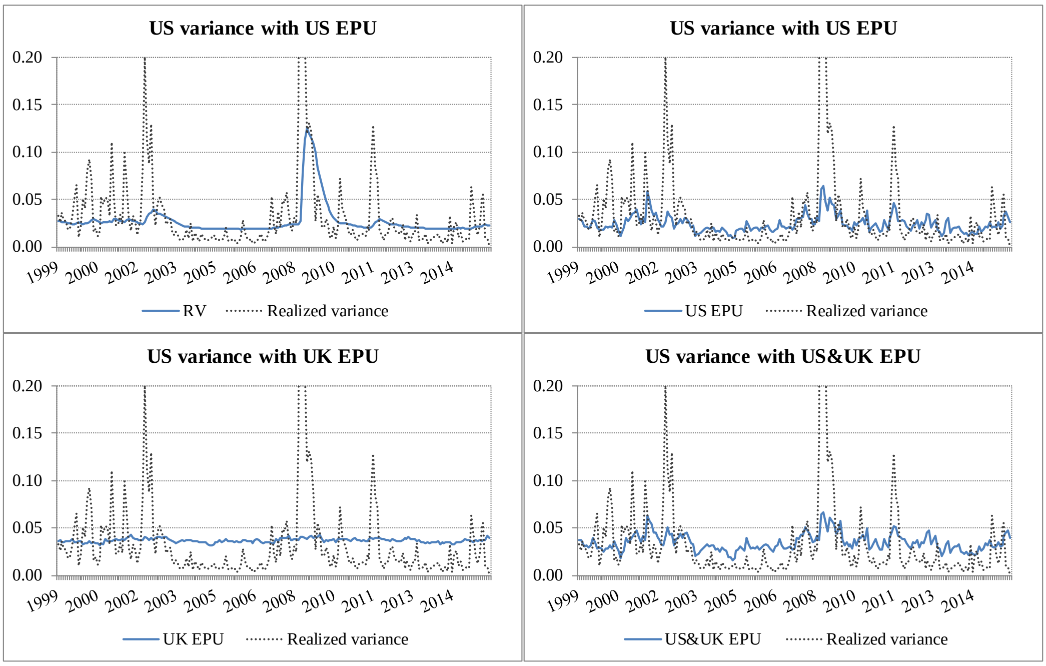
The table reports the parameter estimates and standard errors (italic) of the DCC-MIDAS model for US–country *i* return correlation (where *i* is Canada, China, Germany, and the UK) using Model 4. The estimations are based on daily returns and monthly EPU shocks. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	a	b	γ_0	γ_{US}	$w_{2,US}$	γ_i	$w_{2,i}$
US-Canada	0.030***	0.800***	0.515***	0.658***	1.000***	1.329	1.102***
	0.011	*0.043*	*0.031*	*0.129*	*0.000*	*1.143*	*0.245*
US-China	0.012*	0.895***	0.186***	1.287*	1.253***	0.277	3.426
	0.007	*0.049*	*0.021*	*0.596*	*0.402*	*0.764*	*6.596*
US-Germany	0.089***	0.795***	1.127***	2.388**	1.102***	-1.049	1.013*
	0.009	*0.030*	*0.026*	*1.026*	*0.296*	*1.490*	*0.542*
US-UK	0.029***	0.923***	1.182***	4.188***	1.207***	−1.037	1.562
	0.005	*0.015*	*0.024*	*1.281*	*0.207*	*1.244*	*1.058*

Figure 1. Long-run US–UK variance and correlation

The graphs show the long-run components of the US and UK variances and correlation. The graphs are for Model 1 (realized variance/correlation), Model 2 (US EPU shocks), Model 3 (UK EPU shocks), and Model 4 (US and UK EPU shocks).

Panel A. US variance



Panel B. UK volatility

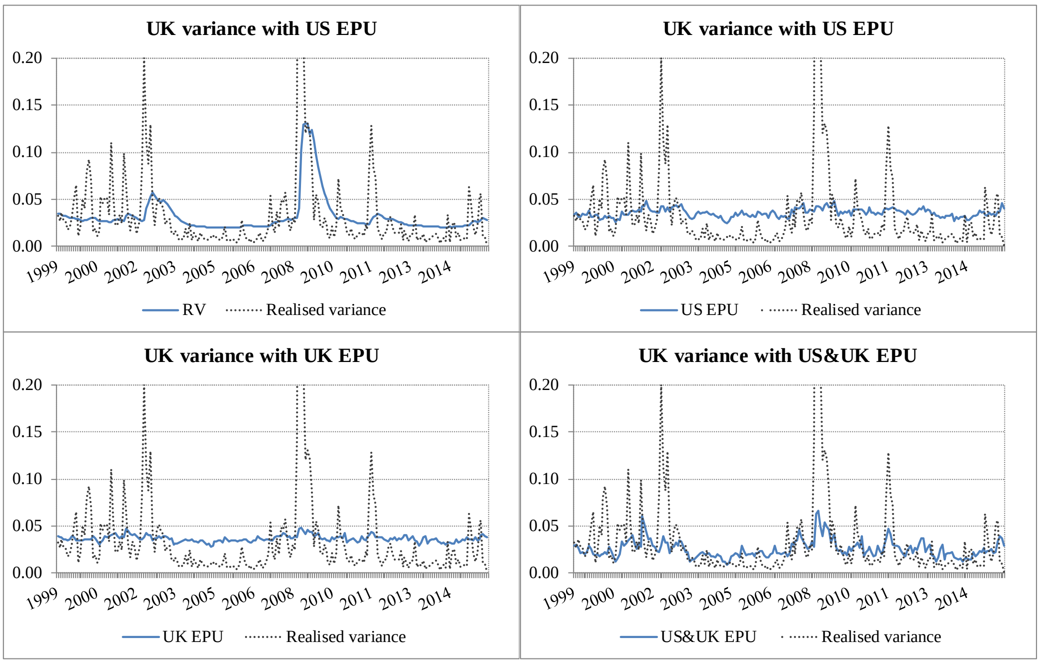


Figure 1. Long-run US–UK variance and correlation (continued)

Panel C. US–UK correlation

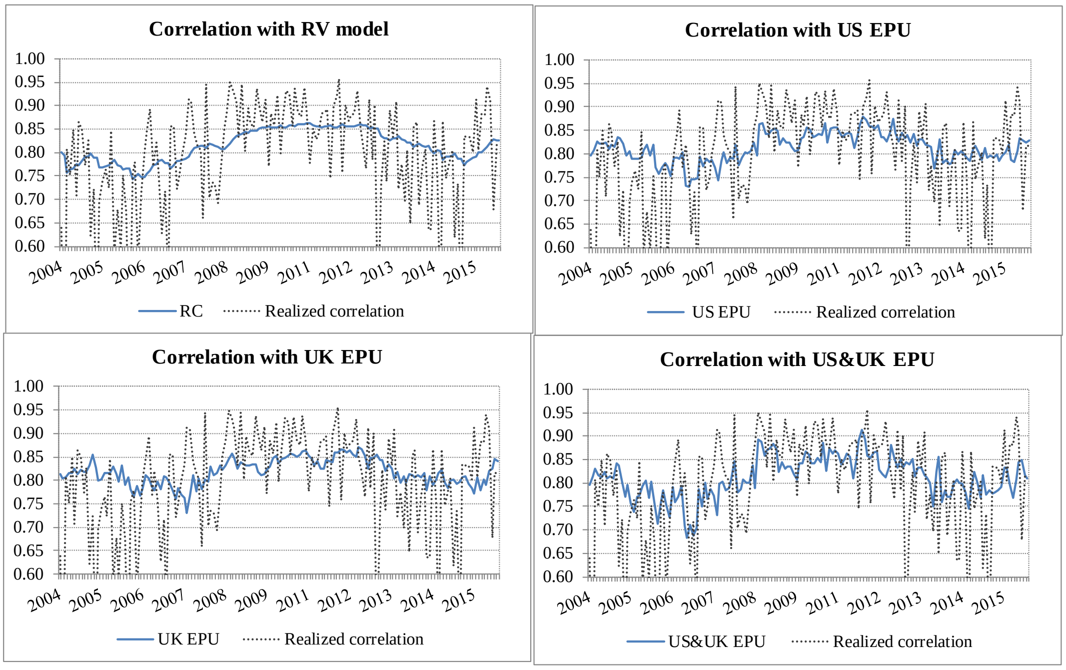
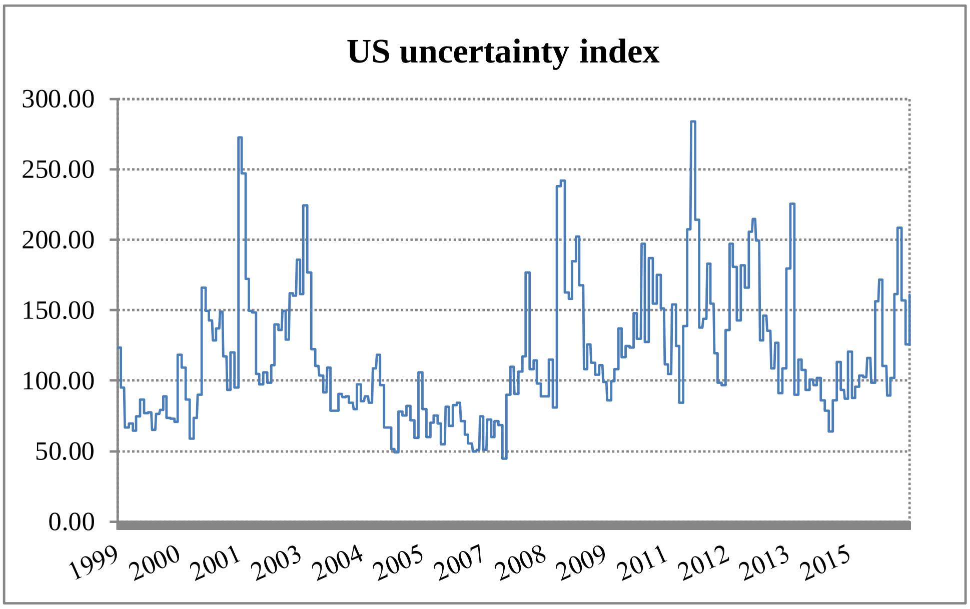


Figure 2. US and UK economic policy uncertainty

The graphs shows monthly observations of the US and UK EPU indices.



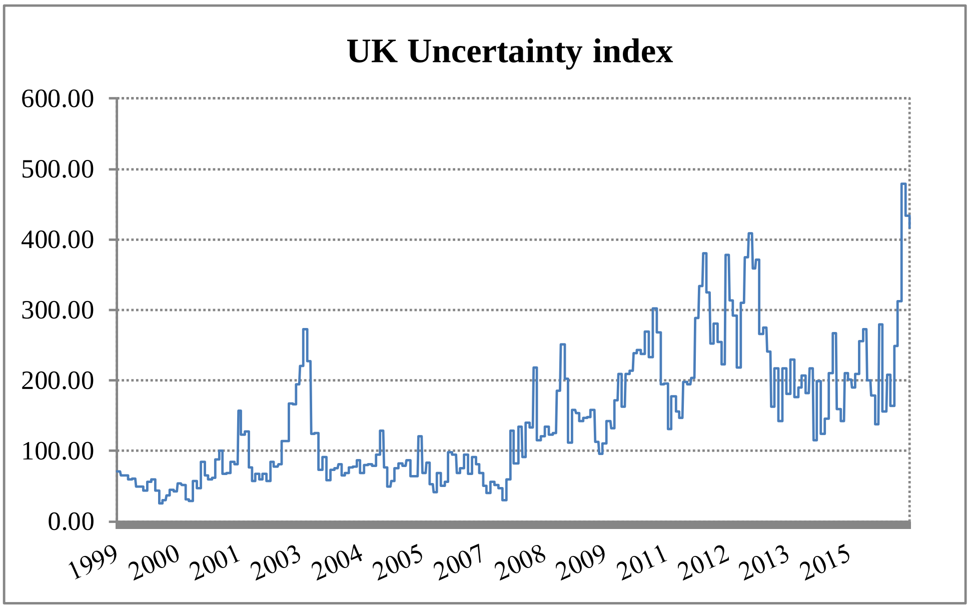
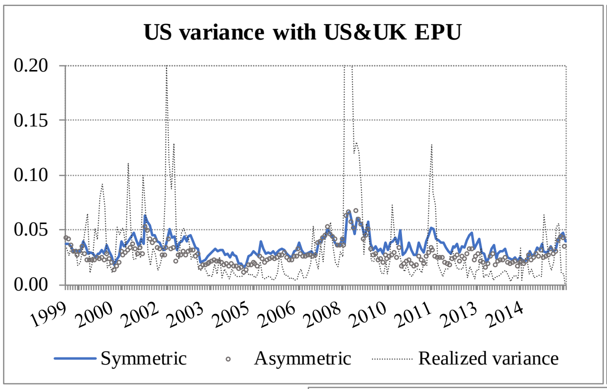
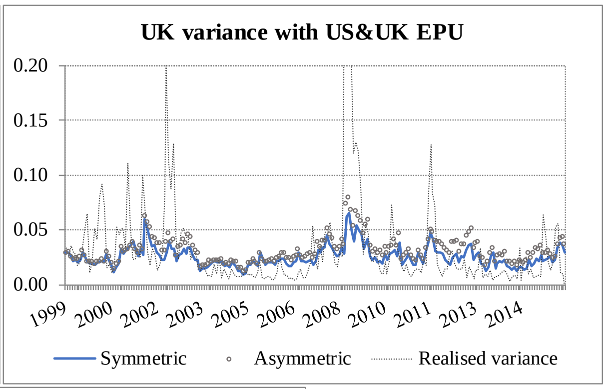


Figure 3. Long-term asymmetry components of US–UK Long-run US–UK variance and correlation

The figure shows the positive and negative EPU components of the US–UK long-run variances and correlation from DCC-MIDAS Model 5 with asymmetry and US and UK EPU shocks.





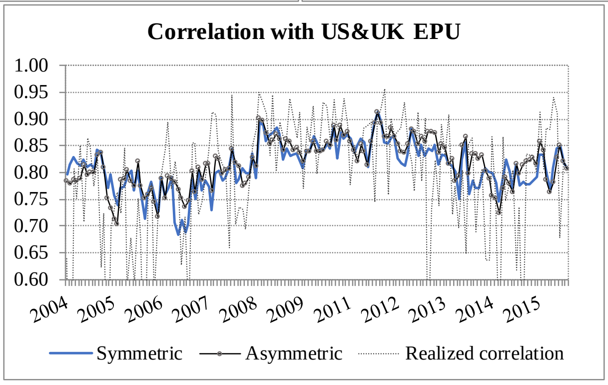
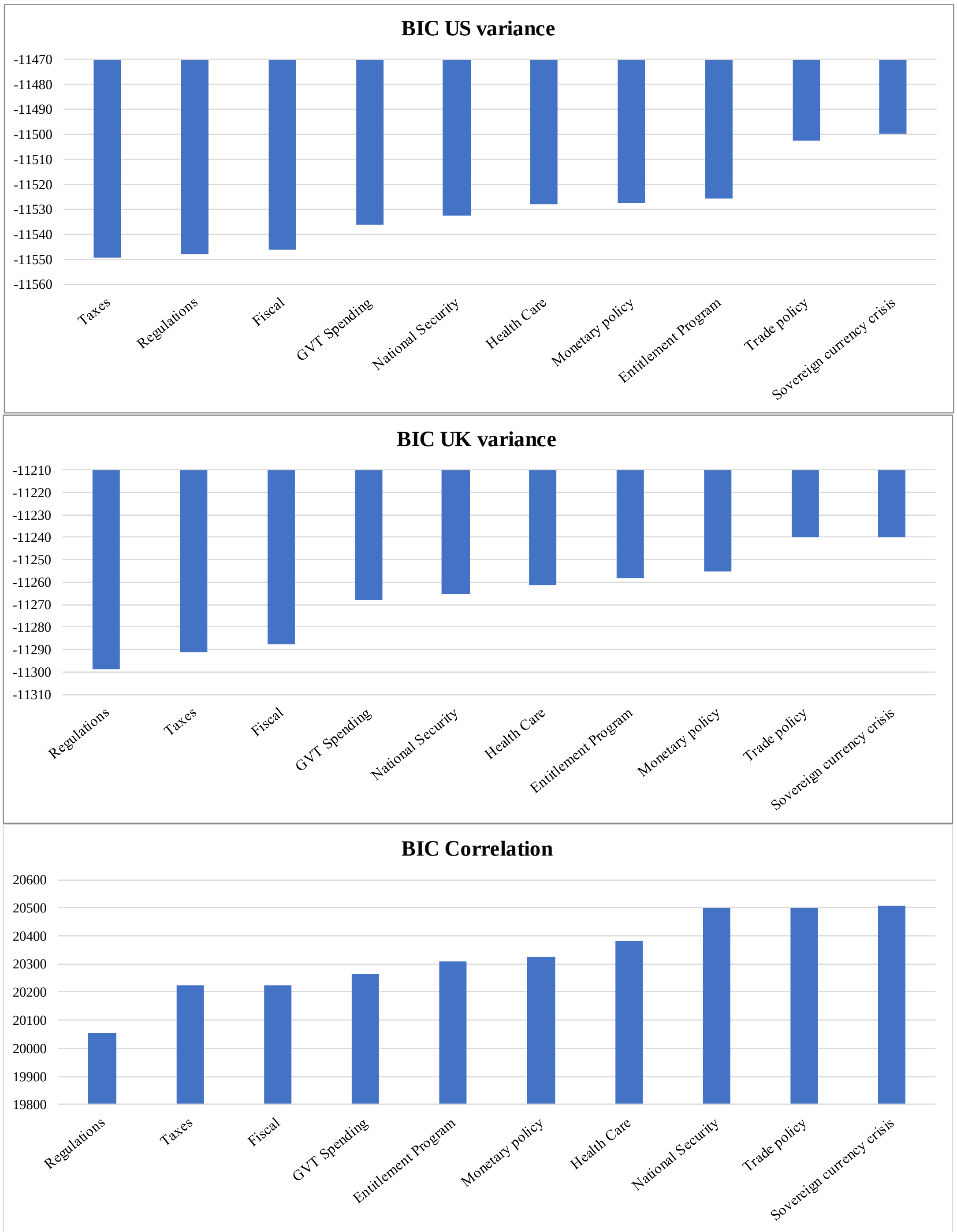


Figure 4. BIC values for categorical EPU shocks

The figure shows the BIC values from Model 2 using the categorical EPU shocks. The BIC values are from Tables 7 and 8.



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