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On the macroeconomic determinants of long-term volatilities and correlations in U.S. stock and crude oil markets ☆

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ABSTRACT

Using a modified DCC-MIDAS specification, we endogenize the long-term correlation between crude oil and stock price returns with respect to the stance of the U.S. macroeconomy. We find that variables that contain information on current and future economic activity are helpful predictors of changes in the oil–stock correlation. For the period 1993–2011 there is a strong evidence for counter cyclical behavior of the long-term correlation. For prolonged periods with strong growth above trend our model predicts a negative long-term correlation, while before and during recessions the sign changes and remains positive throughout the economic recovery.

1. Introduction

In this article, we revisit the oil–stock market relationship by analyzing the macroeconomic determinants of the long-term correlation between daily U.S. stock market and crude oil price returns. Recently, Kilian and Park (2009) have shown that on average 22% of the variation in U.S. stock returns in the period 1975–2006 can be explained by oil price shocks. However, whether an oil price shock drives oil and stock prices in the same or in opposite directions largely depends on the type of the underlying shock. While oil price increases due to precautionary demand have a negative effect on stock prices, demand driven oil price shocks lead to increasing stock prices. Based on these insights, Kilian and Park (2009) argue that the time-varying sign in rolling oil–stock correlations reflects changes in the relative importance of different demand and supply shocks in the oil market.

While Kilian and Park (2009) investigate the oil–stock relationship using monthly data, our purpose is to analyze the correlation between oil and stock returns at a daily frequency. More specifically, we use a novel MIxed Data Sampling (MIDAS) approach to link the smooth component of daily return correlations to changes in monthly U.S. macroeconomic variables. While there is a growing literature on the endogeneity of monthly or quarterly oil prices with respect to U.S. and global macroeconomic

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conditions (see Barsky and Kilian, 2004; Kilian, 2008, 2009), our contribution is to provide the first evidence on the link between U.S. economic activity and the daily oil–stock correlation.[2]

Our econometric specification is based on the Dynamic Conditional Correlation-MIDAS (DCC-MIDAS) model proposed in Colacito et al. (2011). The DCC-MIDAS combines the Engle (2002) DCC specification with the GARCH-MIDAS framework of Engle et al. (2013). The latter framework extends the simple GARCH specification by modeling volatility as consisting of a short-term and a long-term component, whereby the long-term component is specified as a function of the macroeconomic environment. In the original DCC specification with correlation targeting each quasi-correlation follows a 'GARCH type' process, which is mean-reverting to the unconditional correlation of the volatility-adjusted residuals. The basic idea of Colacito et al. (2011) is to replace this unconditional correlation with a slowly time-varying long-term component. The quasi-correlation then fluctuates around this long-run trend. Hence, the new specification can be considered as a two-component model for the dynamic correlations. Colacito et al. (2011) model the long-term component as a weighted sum of the lagged monthly realized correlations between the volatility-adjusted residuals.

Using the GARCH-MIDAS framework, we first analyze whether the long-term oil market volatility is related to the U.S. macroeconomy and whether oil and stock volatility respond to the same macroeconomic information. We then extend the DCC-MIDAS model by directly incorporating a monthly macroeconomic explanatory variable X into an appropriately modified long-term correlation component. We refer to this new specification as the DCC-MIDAS-X model.

Our results can be summarized as follows. First, we find that the movements in long-term oil market volatility can be well predicted by various measures of U.S. macroeconomic activity. Our empirical results provide convincing evidence for a counter cyclical relationship between oil market volatility and variables which either describe the current stance of the economy, e.g. industrial production, or provide forward looking information about the future state of the economy, e.g. the leading index for the U.S. Current and expected increases (decreases) in economic activity clearly anticipate downswings (upswings) in long-term oil volatility. While the notion that there is reverse causality from macroeconomic variables to the level of the oil price (see, e.g., Barsky and Kilian, 2004; Kilian, 2008, 2009) is now widely accepted, our result adds a new dimension by establishing a link between U.S. macroeconomic variables and the volatility of oil price returns. Interestingly, we also find that long-term oil and stock market volatility respond to the same macroeconomic information.

Second, our empirical results show that changes in the long-term oil-stock correlation can be anticipated by the same macroeconomic factors that affect the long-term volatilities. We provide strong evidence that the long-term oil-stock correlation behaves counter-cyclically. Phases with positive long-term oil-stock correlations correspond to values of the macroeconomic factors that either indicate recessions or the beginning of expansions with growth still below or at trend. On the other hand, a negative long-run correlation emerges when the macroeconomic variables signal strong growth above trend. Clearly, the positive correlation during recessions is driven by the simultaneous drop in oil and stock prices. The economic recovery during the early phase of an expansion then leads to increasing oil prices due to higher demand as well as to rising stock prices because of the improved outlook for corporate cash flows. The combination of these two effects can explain why the long-run oil–stock correlation remains positive. This interpretation coincides with the findings in Kilian and Park (2009) regarding the positive short-run effect on oil and stock prices of an unexpected increase in global demand. Finally, during boom phases with strong growth above trend, both the further increases in oil prices as well as the expectation of rising interest rates should have a depressing effect on the stock market. Hence, for these periods our model predicts a decreasing or negative long-term correlation.

Third, the long-term correlation component can be interpreted as the predicted or expected correlation given a certain state of the economy. Since the macroeconomic variables that drive the long-term component represent aggregate demand, the deviations of the short-term from the long-term component should be driven by other factors related to the stock and/or the oil market. Typical examples for the oil market would be either oil specific, i.e. precautionary, demand shocks or supply shocks. However, the fact that various measures of macroeconomic activity lead to a convincing and coherent fit of the long-term correlation suggests that aggregate demand is the most important factor for the oil–stock relationship. This interpretation is very much in line with the view that – in contrast to the 1970s when supply shocks were likely to be predominant – oil prices have been mainly driven by high global aggregate demand since the mid-1990s (see Hamilton, 2008; Kilian, 2009; Kilian and Murphy, 2014).[3]

Fourth, the fact that the sign of the oil-stock correlation critically depends on the state of the economy reinforces Kilian and Park's (2009) argument that simple regressions of stock returns on oil price changes can be very misleading. This point may well explain the conflicting empirical evidence on the oil–stock relationship in Jones and Kaul (1996), Wei (2003), Nandha and Faff (2008), Miller and Ratti (2009) and others.

Fifth, we show that the volatility and correlation predictions from the various DCC-MIDAS-X specifications significantly outperform the ones from the simple DCC model. Hence, the explicit modeling of the long-term correlation component may be very beneficial for portfolio choice, hedging decisions or risk management.

The remainder of the article is organized as follows. Section 2 reviews the related literature while Section 3 discusses the GARCH-MIDAS and DCC-MIDAS models. The data and empirical results are presented in Sections 4 and 5. In Section 6 we evaluate the forecasting performance of the different models and Section 7 concludes the article.

[2] In the following, we refer to the correlation between oil and stock returns simply as the oil–stock correlation.

[3] Although we focus on economic activity measures for the U.S. only, while the oil price is driven by global demand, our approach may still be informative to the extent that changes in U.S. real activity are correlated with changes in global real activity.