Energy Economics 55 (2016) 92–100

Contents lists available at ScienceDirect

Energy Economics

journal homepage: www.elsevier.com/locate/eneeco

Uncertainty and crude oil returns☆

Riadh Aloui [a], Rangan Gupta [b], Stephen M. Miller [c,*]

[a] LAREQUAD & ISGS, University of Sousse, B.P 307 Cité El Riadh, 4023 Sousse, Tunisia
[b] Department of Economics, University of Pretoria, Pretoria 0002, South Africa
[c] Department of Economics, University of Nevada, Las Vegas, Las Vegas, NV 89154-6005, USA

ARTICLE INFO

Article history:
Received 10 March 2015
Received in revised form 16 January 2016
Accepted 23 January 2016
Available online 3 February 2016

JEL classification:
C22
C52
E61
Q31

Keywords:
Uncertainty
Oil shocks
Copulas

ABSTRACT

We use a copula approach to investigate the effect of uncertainty on crude-oil returns. Using copulas to construct multivariate distributions of time-series data permit the calculation of the dependence structure between the series independently of the marginal distributions. Further, we implement the copula estimation using a rolling window method to allow for a time-varying effect of equity and economic policy uncertainty on oil returns. The results show that higher uncertainty, as measured by equity and economic policy uncertainty indices, significantly increase crude-oil returns only during certain periods of time. That is, we find a positive dependence prior to the financial crisis and Great Recession. Interestingly, estimation of the copula over the entire sample period leads to a negative dependence between the equity and economic policy indices and the crude-oil return.

1. Introduction

The recent financial crisis and Great Recession, and its aftermath, sparked a debate among economists about the proximate cause of the distressed macroeconomy. That is, did inadequate demand or policy and regulatory uncertainty lead to the economic collapse and slow recovery?[1]

To pursue the hypothesis on one side of this debate that the Great Recession and its subsequent slow recovery reflect policy and regulatory uncertainty. Baker et al. (2013) develop new uncertainty measures — economic policy uncertainty (EPU) and equity market uncertainty (EMU) indexes. Their innovative approach relies in large part on an automated text-search process of 10 large US newspapers. For the EPU index, the search identifies articles that use words related to economic policy, regulation, and uncertainty. Since their approach may raise concerns from other researchers about reliability, the authors also compute the EMU index, using the same automated text-search process, but replace the words that relate to economic policy and regulation with words that relate to the market. They then compare the EMU index with another market uncertainty index, the Chicago Board Options Exchange Market Volatility Index (VIX), showing that the two series demonstrate high co-movement. Finally, these indexes come at a daily frequency, which matches the daily frequency of the oil price that we examine in this paper.

This paper applies a copula-based approach to shed new light on the dynamic relationship between these new innovative news-based measures of economic policy uncertainty or equity-market uncertainty, developed by Baker et al. (2013), and oil price movements. That is, to the extent that policy and equity-market uncertainty affect oil price movements and to the extent that oil price movements affect the business cycle, such uncertainty measures should receive the attention of policy makers.

Following the seminal work of Hamilton (1983), a large literature exists that connects oil price movements (shocks) with recessions and inflationary episodes in the US economy (e.g., see Kang and Ratti (2013a) and Antonakakis et al. (2014) for detailed reviews). A literature also exists that emphasizes the role of economic policy uncertainty on real activity (e.g., see Bloom (2009); Kang and Ratti (2013a); and Antonakakis et al. (2014) for detailed reviews), which, in turn, probably affects oil price movements (shocks).

Early studies by Bernanke (1983) and Pindyck (1991), and more recently, Degiannakis et al. (2014) argue that oil price movements (shocks) probably affect stock-market uncertainty through firm-level investment uncertainty. Equity-market uncertainty also probably feeds into oil price movements (shocks) because, as Bloom's (2009)

☆ We would like to thank three anonymous referees for many helpful comments. However, any remaining errors are solely ours.

* Corresponding author. Tel.: +1 702 895 3969.
E-mail addresses: riadh.aloui@isg.rnu.tn (R. Aloui), rangan.gupta@up.ac.za (R. Gupta), stephen.miller@unlv.edu (S.M. Miller).

[1] These two potential causes need not reflect mutually exclusive explanations, however That is, the collapse in aggregate demand could result from collapsing consumer and business confidence.

http://dx.doi.org/10.1016/j.eneco.2016.01.012
0140-9883/

firm-based theoretical framework notes, equity-market uncertainty affects hiring and investment and, hence, production decisions of firms. In a recent paper, Ajmi et al., (2015) indicate that equity-market uncertainty drives economic policy uncertainty in the US, which, in turn, implies an indirect channel through which the former can affect the oil market, given the above discussion of the relationship between economic policy uncertainty and oil prices.

We investigate the dependence between oil returns (i.e., the natural logarithmic difference in the oil price) and these news-based uncertainty indices, using an approach that goes beyond the simple analysis of correlation, and, at the same time, can capture nonlinearity and dynamic dependence. This method also allows us to measure not only the strength of dependence but also the dependence structure in a flexible way. We achieve these objectives with copula functions in the time-varying context. We conduct our analysis at a daily frequency because crude-oil prices, already volatile in the aftermath of the global financial crisis, became even more unstable as concerns that the recent unrest in North Africa and the Middle East could spread to major oil producing countries.

Choosing a lower frequency for the data analysis (e.g., monthly data, as generally used in the existing literature) could lead to a situation where extreme co-movement occurs less frequently within the sample period. Given that we use daily data, however, we cannot categorize our oil price movements into supply-side, aggregate-demand, and oil-specific demand shocks as suggested by the on-going research of Kilian and Park (2009). We believe, however, that the movements in the two uncertainty indexes can identify the types of shocks that drive the oil price, as they reflect the situation of the economy and the equity market, in general.

An increase (decrease) in the uncertainty indexes probably negatively (positively) affects the economy. This, in turn, reduces (increases) the demand for oil and its price. The price of oil, however, responds to a global market. Nonetheless, as recently noted by Colombo (2013) and Ajmi et al. (2014), the US EPU measure drives the EPU measure of the major European countries, as well as, Canada, India, and China, implying that a shock to the US EPU affects worldwide uncertainty and, hence, affects the global oil market. Increased uncertainty, however, can also lead to an increased oil price as oil suppliers can stock-up due to precautionary motive. So, the movement in the oil price can reflect either a demand shock or a supply shock. The ultimate effect depends on the strength of these two channels at a specific point in time. A time-varying approach, which we follow, proves most important, rather than a mean-estimate based full-sample approach, to provide an accurate picture of the conditional dependence between oil and uncertainty.

Using daily data for the West Texas Intermediate (WTI) crude oil index, the EMU index, and the EPU index, we generally find that the oil and uncertainty indices exhibit time-varying dependence, according to the three (3) copula models used. The two uncertainty indexes also exhibit time-varying dependence, according to the eight (8) copula models used.

We structure the rest of the paper as follows. Section 2 briefly reviews the relevant literature. Section 3 describes the empirical methodology and estimation strategy. Section 4 describes the data and discusses our empirical results. Section 5 provides some concluding remarks.

2. Literature review

While several papers (e.g., Kang and Ratti (2013a) and Antonakakis et al. (2013), (2014)) examine the relationship between the oil returns and the EPU index at a monthly frequency. Our paper is the first to the best of our knowledge that uses copula models to analyze the relationship between these variables as well as between the EMU index and the oil returns. Moreover, our analysis also occurs at a daily, rather than a monthly, frequency. The copula method, which started with Embrechts et al. (2001) and Cherubini et al. (2004), provides a promising solution for understanding and modeling dependent random variables. Copulas provide a flexible methodology in situations where multivariate dependence is of interest and the usual assumption of multivariate normality is in question. As documented, for example, by Jondeau and Rockinger (2006), Junker et al. (2006); Luciano and Marena (2003), and McNeil et al. (2005), the widely used measure of dependence, the Pearson correlation coefficient, may not appropriately describe the type of dependence between returns and, as a result, could underestimate the joint risk of extreme events. To overcome this problem, the copula methodology offers one possible way to characterize the multivariate distributions of asset returns. Other complications refer directly to stylized facts related to the distributional characteristics of financial market returns — the departure from Gaussian distribution, asymmetry, and dynamic dependence.

To better understand our contribution to the literature dealing with uncertainty and oil returns, we briefly review the analysis of Kang and Ratti (2013a) and Antonakakis et al. (2014).[2] Kang and Ratti (2013a), investigate the effect of oil price shocks on EPU, using a structural vector autoregressive (SVAR) model, estimated with monthly oil data and the EPU index. As in Kilian and Park (2009), they disentangle the oil price shocks according to their origin (i.e., supply-side, aggregate-demand, and oil-specific demand shocks). They find that positive aggregate-demand shocks exercise a significant negative effect on policy uncertainty, whereas oil-specific demand shocks exert the opposite effect. Furthermore, supply-side shocks do not produce any effect.[3]

Antonakakis et al. (2014) extend Kang and Ratti (2013a) by developing a dynamic spillover index based on a structural variance decomposition approach of the SVAR model used in Kang and Ratti (2013a). The results reveal that the EPU (oil-returns) responds negatively to aggregate-demand oil-return shocks (EPU shocks). Furthermore, during the Great Recession of 2007–2009, total spillovers increased considerably. Moreover, in net terms, EPU provides the dominant transmitter of shocks between 1997 and 2009, while in the post 2009 period, supply-side and oil-specific demand shocks prove net transmitters of spillover effects.

SVAR models allow for the estimation of structural shocks and impulse responses from the empirical data. We can achieve this by first estimating the VAR model by maximum likelihood and second decomposing the residuals to identify structural shocks. The decomposition of the SVAR residuals assumes normality of the unobserved structural shocks. In most cases, however, the normality assumption is unrealistic. Moreover, we also assume the independence of the identified shocks, hence the well-known orthogonality restriction. When one does not believe that only two groups of economic shocks exist, the orthogonality constraint becomes restrictive due to the low dimension of many SVAR models (Blanchard and Quah, 1989). We can generalize this method to analyze SVAR models with high dimension. For a large system dimension, however, the number of restrictions needed for the identification of shocks increases considerably (Garratt et al., 1998). All these concerns underscore the need to consider a different method to obtain more confident results of the relationship between measures of uncertainty and oil returns.

3. Empirical methodology

We use a simple time-varying copula approach to examine the dynamic relationship between crude oil returns and uncertainty indices.

[2] Besides these papers, Kang and Ratti (2013b) analyzed the importance of oil returns and EPU on stock market returns of the US, Canada, and Europe, given the interrelatedness between uncertainty and oil price returns. Also, in a recent contribution, Kang and Ratti (forthcoming) extend the same analysis to China. Antonakakis and Filis (2013) employ a dynamic conditional correlation (DCC) model to examine the time-varying correlation between oil price shocks and stock market returns. Broadstock and Filis (2014) use the Scalar-BEKK extension of the DCC model to reconsider the time-varying correlation between oil price shocks and stock market returns. El Montasser et al. (2014) use time-varying predictive regressions to analyze the effect of world oil price on EPU and EMU of the Indian economy.

[3] As a robustness check, shocks to precautionary demand for oil significantly influence EPU in Europe and the energy-exporting Canada