The impact of crude oil prices on financial market indicators: copula approach

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ABSTRACT

Oil price changes have varying impacts on the financial indicators of global markets and economies. This study aims to explore the dependence structure between crude oil prices and stock market indices, as well as the exchange rates in a number of economies categorized with respect to their status as developing/emerging markets, and oil importer/exporter countries. Dependence structures in this study are evaluated in considerable depth using copula models. The broad time period covered allows the investigation of the effect of global financial crisis on the mentioned dependence structure. An additional feature of this study is the inclusion of 1 to 30-day analysis to capture the variation of dependence on duration change. To serve these aims, as well as ARIMA and GARCH models, various copula measures are used to illustrate the level of the association. Additionally, a special focus on the Turkish case is given to illustrate its sensitivity to oil prices. We find that exchange rates and stock indices of most oil exporter countries show higher oil price dependency, whereas, emerging oil importer markets are less vulnerable to price fluctuations. Considerable impacts were found for the global crisis and the continuing recent sharp decrease in oil prices.

1. Introduction

Crude oil prices have the potential to affect the economies through three major channels: Firstly, changes in crude oil prices have a profound effect on inflation, through changes in production costs, leading to shifts in the supply curve. Secondly, especially for oil-importing countries, changes in oil prices have a significant impact on balance of payments, thus on exchange rates. Finally, price changes affect the total consumption value of a household, causing substitution effects, i.e. a downward shift in demand with increasing prices, and vice versa. Moreover, since inflation and trade balance are both important determinants of exchange rates in the medium and long term, oil prices are expected to play an important role in this process. In contrast, short term effects usually originate from financial markets.

Crude oil is priced primarily in terms of US Dollars (USD); accordingly, a change in crude oil prices directly affects exchange rates in terms of USD, while changes in crude oil prices are believed to affect stock markets through the channel of expectations. Changes in oil prices lead to changes in production costs in the related sectors, thus affecting the prices of related stocks. Also, consumption and investment levels in the economy follow changes in crude oil prices, resulting in an increase or decrease in overall stock prices, through the effect on expected earnings. In addition, such effects are expected to be more intense in sectors with direct relations with crude oil markets. Another direct result of the relationship between crude oil and financial markets is the volatility in the latter, which is believed to affect financial flows to commodity markets, thus leading to commodity price changes.

There has been frequent discussion of the direction of the relationship between crude oil prices, and exchange rates and stock indices. Principally, a negative relation is expected between crude oil prices and exchange rates in terms of dollars, and changes in oil prices directly affect domestic currency crude oil prices. Also, it is believed that variations in oil prices originating from the demand side, such as changes in economic growth, are positively related with stock prices, while

those arising due to supply side conditions, such as conflict in exporting regions, are negatively related.

Both developed and developing countries are expected to be affected by the changes in oil prices through the channels explained above, although the degree may vary according to country specific characteristics. Nevertheless, countries that are export or import dependent are expected to be more vulnerable to impacts arising from changes in oil prices.

The increase in the importance of crude oil as a financial indicator and as an asset has brought a corresponding growth in its co-movement or dependence with other financial assets and/or indicators. Of the numerous studies conducted on oil markets and financial markets, those related to the content of this paper are extensively presented by Ozturk (2014). These are summarized below in the aspects of country specific analyses, together with the stochastic models defining the association between oil prices and other indicators such as exchange rate, stock indices, and use of copula models to capture the dependency.

1.1. Literature Review

Oil is the most influential of all commodities, and dependency as consumer or producer is characterized by different structures. Several studies investigate the influence between stock markets and oil prices. Phan et al. (2015) investigated the impact of oil price on stock markets in the aspects of producer and consumers in terms of sub-sectors. The majority of these studies examining the dependence relation between crude oil and exchange rates, as well as its relation with stock indices, are in the form of the causal dynamics with VAR and Granger causality models. For example, Adiguzel et al. (2013) indicated that different causalities may occur over different time periods. Turhan et al. (2012) found greater importance of oil price movements on the exchange rates of emerging countries after the financial crisis. To explore the time specific interrelation structure, both Benhmad (2012), and Reboredo and Rivera-Castro (2013a) made use of Wavelet Decomposition techniques, finding a bidirectional relationship between oil and the USD. Additionally, they stressed that oil price changes had no effect on USD in the pre-crisis period. Bal and Rath (2015) studied the nonlinear causality between crude oil and exchange rates for India and China, finding significant bi-directional nonlinear Granger causality between oil prices and exchange rates in both countries. Dhaoui and Khraief (2014) investigated the impact of volatility of stock market returns on oil prices for eight developed countries, revealing that stock market return and oil price are negatively correlated, whereas the oil price changes increase the volatility of returns. Sahu et al. (2014) investigated the dynamic relationships between oil price shocks and the Indian stock market, also illustrating the long-run relation between oil prices and currency. Their study revealed that oil prices yield a short run sensitivity to exchange rate in India. Copula models are also a recent innovation in this area of research. Modeling the dependence structure between oil prices and exchange rates, Reboredo (2012) and Aloui et al. (2013a) found an increase in the extreme dependence between oil and the USD, while in contrast, Wu et al. (2012) suggested that this dependence has in fact decreased since 2003. Salma (2015) compared different copula families to determine the dependence between oil and stock markets in Gulf corporate countries and emphasized that volatility in stock markets has impact on oil prices.

The relation between crude oil and stock index values has been studied extensively using various approaches, including GARCH models, Wavelet analysis and copula models (Filis et al., 2011; Fratzscher et al., 2013; Miller and Ratti, 2009; Newell, 2011; Chang and Yu, 2013; Zhu et al., 2011, Le and Chang, 2015, Wan and Kao, 2015, Arfaoui and Ben, 2016). Using VARMA–GARCH and VARMA–AGARCH models, Chang et al. (2013), concluded that there is little evidence on the dependence between crude oil and financial markets. Similarly, Reboredo (2012) found no effect of oil prices changes on stock market returns in the pre-crisis period, but, after which the interdependence became evident. Aloui et al. (2013b) applied copula models to crude oil and the stock indices of six Central and Eastern European countries, finding evidence of positive dependence, and contagion between those markets during periods of severe financial stress. Zhu et al. (2011, 2013) analyzed the dynamic dependence structure between crude oil prices and stock markets across the Asia-Pacific region through GARCH and copula models, and concluded that despite generally weak the dependence between crude oil prices and Asia-Pacific stock market returns, it has increased since the global financial crisis. Avdulaj and Barunik (2015) found decreasing benefits from diversification with crude oil for stock portfolios over the past ten years, based on GARCH models with time-varying copula.

Studies also exist which employ copula models on crude oil dependence with financial assets and exchange rates. In a comparison of China and Vietnam, Nguyen and Bhatti (2012) employed nonparametric and copula methods to determine the stock market sensitivity to oil prices. Wu et al. (2012) used time varying copula models such as Gaussian, Student t (t copula), Clayton, survival Clayton and mixture Clayton copula. They found that the Gaussian dependence structure exhibits superior explanatory ability compared to other dependence structures; however, Clayton and survival Clayton copulas have lower explanatory ability, implying that the tail dependence between oil and exchange-rate returns adds little to the explanatory ability of the models. Reboredo and Rivera-Castro (2013b) used Gaussian, t copula, Plackett, Frank, Clayton, Gumbel, Time Varying Parameter (TVP) Gaussian and TVP Student's t copula models to analyze the dependence between oil price and several exchange rates, and applied pseudo-likelihood ratio test as goodness-of-fit test of copulas, by comparing each model with the Gaussian copula as benchmark. He found no clear superiority of the Gaussian over the t copula, regardless of the existence of symmetrical tail dependence for a particular period. Aloui et al. (2013b) exploited copula models while studying the conditional dependence structure between crude oil prices and USD exchange rates, and concluded that the t copula was the most appropriate due to the results of the goodness-of-fit test.

Using copula approach, this study aims to explore in detail the dependence structure between crude oil prices, and two other important indicators, exchange rates and stock market indices, of specific countries. Countries have been deliberately selected to include both developed/emerging and oil exporter/importer countries in order to investigate the relative variation in dependence structure. Moreover, the analyses in this study are not limited to daily or monthly dependence, but consider dependence from 1-day to 30-day periods in order to enlighten daily differences in dependence from the daily to monthly time periods. Lastly, the pre- and post-crisis periods are explored separately, in order to capture the effect of financial crisis on the dependence structure. Additionally, the recent oil price decrease period (2014/7–2016/4) is analyzed in isolation to determine the impact of unexpected fall in prices on dependence structures. Additionally, this study is the first to report on analyses that compare countries in terms of trade status (importer or exporter), time domain (daily and monthly) and economic strength (developed and emerging). Special attention is also given to Turkey regarding its geopolitical location and its expanding energy demand in order to illustrate the sensitivity of stock market and foreign exchange to oil price changes.

Daily observations of ten selected countries between January 2005 and April 2016 are taken into account. Firstly, each series is modeled using ARIMA and GARCH processes to express the stochastic behavior of the realizations and their volatility, respectively. Secondly, five copula models, as well as conventional dependence measures, are applied so as to quantify the association among the variables. Finally, the comparison of the results is conducted according to the specifications, such as oil-importer/exporter, developed/emerging countries and pre-post-global financial crisis, which are expected to influence the degree of dependence.