Journal of International Money and Finance 32 (2013) 719–738

Contents lists available at SciVerse ScienceDirect

Journal of International Money and Finance

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

Conditional dependence structure between oil prices and exchange rates: A copula-GARCH approach

Riadh Aloui [a], Mohamed Safouane Ben Aïssa [a], Duc Khuong Nguyen [b,*]

[a] LAREQUAD & FSEGT, University of Tunis El Manar, B.P 248, El Manar II, 2092 Tunis, Tunisia
[b] ISC Paris School of Management, Department of Finance and Information Systems, 22, Boulevard du Fort de Vaux, 75848 Paris Cedex 17, France

JEL classification:
C58
F37
G17
Q43

Keywords:
Copulas
Dependence measures
Crude oil price
U.S. dollar exchange rates
CML method

A B S T R A C T

We study the conditional dependence structure between crude oil prices and U.S. dollar exchange rates using a copula-GARCH approach. Various copula functions of the elliptical, Archimedean and quadratic families are used to model the underlying dependence structure in both bearish and bullish market phases. Over the 2000–2011 period, we find evidence of significant and symmetric dependence for almost all the oil-exchange rate pairs considered. The rise in the price of oil is found to be associated with the depreciation of the dollar. Moreover, we show that Student-*t* copulas best capture the extreme dependence, and that taking the extreme comovement into account leads to improve the accuracy of VaR forecasts. Our main results remain unchanged when considering alternative GARCH-type specifications and the crisis period, but are sensitive to the use of raw returns.

* Corresponding author. Tel.: +33 140 539 999; fax: +33 140 539 898.
E-mail addresses: riadh.aloui@isg.rnu.tn (R. Aloui), safouane.benaissa@univmed.fr (M.S. Ben Aïssa), dnguyen@iscparis.com (D.K. Nguyen).

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http://dx.doi.org/10.1016/j.jimonfin.2012.06.006

1. Introduction

Crude oil is one of the most important commodities for the global economy today and commonly regarded as a comparative advantage and a strategic resource. Past studies suggest that oil price dynamics influences economic activity and equity markets.[1] Research on crude-oil price dynamics and its impacts on both real and financial sectors has recently been challenged by several important facts. First, crude oil prices experienced very large fluctuations over the last three decades and became more volatile than they did over the period from the Second World War to the early 1970s. The greater instability in the oil prices initially appeared in the aftermath of the world oil crises of 1973 and 1979. This tendency was strengthened by the collapse of oil prices during the 1980s. More importantly, over the last five years, oil prices have increased very sharply, rising from about U.S. $42 per barrel at the beginning of 2005 to their highest level of U.S. $147 per barrel in July 2008. Plourde and Watkins (1998) and Regnier (2007) find that crude oil's price volatility is substantially higher than that of other energy products since the mid-1980s. The unrest in Libya and the ongoing threats to political instability in other Middle East and North Africa countries currently contribute to run up in oil prices,[2] which may severely slow down the global economic growth. Second, some papers provide evidence of inefficient behavior of world oil markets, which makes the forecasting of oil price volatility and the oil risk hedging more complicated (Green and Mork, 1991; Shambora and Rossiter, 2007; Arouri et al., 2010). Finally, oil prices are denominated in U.S. dollars, and so their fluctuations in domestic currencies depend closely on the dollar exchange rates, which experienced frequent and uncertain changes over recent years. As an illustration, Fig. 1 shows that the trade-weighted average of the foreign exchange value of the U.S. dollar against world major currencies was under downward pressure over the period January 2002 to August 2008 owing to concerns about the U.S. growing public debt and high current account deficit.[3] The depreciation trend was inverted during the most severe episode of the global financial crisis from September 10, 2008 to September 29, 2010. Its ongoing descent since October 2010 particularly reflects market concerns about the implications of the U.S. debt, very low interest rates and monetary expansion policies, known as "quantitative easing 2".

It is thus obvious from the above discussions that oil and non-oil economies have not seen the oil price increases in the same manner and that oil traders (consumers and producers) have reasons to worry about the fluctuations in the dollar exchange rates. In this context, modeling and forecasting the comovements between oil prices and the dollar exchange rates are crucial, not only for market trading and risk management issues, but also for the proper regulation of foreign exchange markets in all economies which operate with floating exchange rate regimes.

As regards theory, Krugman (1983), Golub (1983) and Rogoff (1991), among others, document the potential importance of oil prices as an explanatory variable of exchange rate movements. The empirical evidence on the interactions between oil prices and dollar exchange rates is however much less extensive than that on the oil effects on economic and market activities. Using various datasets anterior to the global financial crisis, the majority of works in this literature have mainly found a positive link between oil price and dollar value, meaning that an increase in the price of oil is associated with a dollar appreciation (e.g., Dibooglu, 1996; Amano and van Norden, 1998; Bénassy-Quéré et al., 2007; Chen and Chen, 2007; Basher et al., 2012). For example, Amano and van Norden (1998) find, from an error-correction model (ECM), a stable link between the real effective traded-

[1] Hamilton (1983) shows that rising oil prices are responsible for nine out of ten of the U.S. recessions since the Second World War. Other earlier studies in which an analysis of oil–macroeconomy relationships is conducted using various methodologies as well as different datasets also confirm these findings (Mork, 1989; Hooker, 1996). More recent attempts such as Balke et al. (2002), Zhang (2008) and Cologni and Manera (2009) document both asymmetric and nonlinear links between oil price shocks and macroeconomic variables. On the other hand, several studies have found that stock market activities are significantly affected by oil price movements (Sadorsky, 2001; Park and Ratti, 2008; Arouri and Nguyen, 2010; Fayyad and Daly, 2011). The oil's impact is however sensitively different across economic sectors (e.g., oil versus non-oil industries) and across countries (e.g., net oil-exporting versus net oil-importing ones).

[2] The Brent crude oil index closed at U.S. $123.26 on April 29, 2011, or an increase of about 45.32% on a year-to-year basis.

[3] The countries/area included in the major currencies index are the Euro Area, Canada, Japan, United Kingdom, Switzerland, Australia, and Sweden.