The extreme-value dependence between the crude oil price and Chinese stock markets

Qian Chen [a], Xin Lv [b,c,*]

[a] School of Public Finance and Public Policy, Central University of Finance and Economics, Beijing, China
[b] Center for Energy and Environmental Policy Research, Beijing Institute of Technology, Beijing 100081, China
[c] School of Management and Economics, Beijing Institute of Technology, Beijing 100081, China

ARTICLE INFO

ABSTRACT

This paper examines the asymptotic dependence between the Chinese stock market and the world crude oil market based on the Extreme Value Theory (EVT) and finds a positive extremal dependence. We explain this positive dependence in terms of economic cycles due to the co-movement between the Chinese stock market, the world oil market and the global economic cycle. EVT satisfactorily captures the Chinese special oil price adjustment mechanism. We also examine the contagion effect and find that the dependence level tends to increase dramatically during the crisis period but that the simultaneous booms between these two markets decrease considerably after the crisis.

© 2015 Elsevier Inc. All rights reserved.

1. Introduction

In recent years, investigating the relationship between the crude oil market and the stock market has attracted more attention in the theoretical and empirical fields. Although study of the relationship between the crude oil market and the stock market began in the 1980s, there is no consensus among economists about the relationship. Traditional papers have documented a negative relationship between the two markets (e.g., Basher & Sadorsky, 2006; Hammoudeh & Choi, 2007; Hammoudeh & Li, 2005; Jones & Kaul, 1996; Kilian & Park, 2009; Nandha & Faff, 2008; Sadorsky, 1999). The popular explanation for the negative relationship could be summarized as follows: a higher oil price will reduce the current or expected profit by increasing the costs of companies; and the stock prices of firms will then decline. However, some papers found a positive connection between the two markets (e.g., Arouri & Rault, 2012; El-Sharif, Brown, Nixon, & Russel, 2005; Faff & Brailsford, 1999; Kilian & Park, 2009; Narayan & Narayan, 2010; Sadorsky, 2001; Zhang & Chen, 2011). One influential explanation for the positive relationship is from Kilian and Park (2009), which is expressed in terms of "business cycle theory". In their declaration, crude oil price is a synchronous, macroeconomic indicator of early economic expansion, and a positive innovation in the global business cycle will simultaneously stimulate the crude oil market and stock market, leading to a positive connection.

---

 * Corresponding author at: School of Management and Economics, Center for Energy and Environmental Policy Research, Beijing Institute of Technology, Beijing 100081, China.
   E-mail addresses: water111716@hotmail.com (Q. Chen), lvxin2311@bit.edu.cn (X. Lv).

Both categories of theoretical and empirical findings above are based on developed countries. However, as the largest oil importer and the second-largest oil consumer (EIA, 2014[1]), China plays an important role in the global oil market. However, there is surprisingly little literature investigating the relationship between the Chinese stock market and the global oil market. Furthermore, among the limited empirical studies of China, none includes an explanation for the economic logic behind the relationship between the global oil market and the Chinese stock market.

In addition, no research considers the Chinese special refined oil pricing mechanism. The difference between the stock markets in developed countries and the Chinese stock market is so great that the latter may respond to the global oil price in a different way. In China, the retail price of refined oil does not closely follow the world crude oil price changes.[2] The original aim of the Chinese local refined oil price adjustment mechanism was to avoid the negative effect on the whole macroeconomy from oil price shocks. The National Development and Reform Commission (NDRC) controls the frequency and quantity of the adjustment. After a series of reforms, the refined oil price was adjusted more and more frequently. However, adjustments in the refined oil price are still much less frequent and less dramatic than in developed countries, even after the last reform. Only when change in the world crude oil price hits a certain level and lasts for a certain time will the Chinese refined oil price respond to the change and make a corresponding adjustment. As indicated in Fig. 1, the Chinese refined oil price was adjusted only 34 times from 2005 to 2012, whereas the world crude oil price is changing every day. The Chinese special refined oil price mechanism may mitigate the negative impact of the oil price shock on the economy and stock market, and Kilian and Park's (2009) explanation for the positive relationship between the oil price and stock market return may take the dominant position in China.

Given the important role of China in the global oil market and its special refined oil pricing mechanism, it is definitely worth reexamining the relationship between the oil market and the Chinese stock market. The primary objective of this paper is to examine this relationship and find a reasonable explanation for the economic logic behind this relationship. We will base this study on the Chinese special refined oil price mechanism, traditional negative relationship logic (e.g., Jones & Kaul, 1996; Sadorsky, 1999) and positive relationship theory (e.g., Kilian & Park, 2009) to construct an economic explanation for the impact of oil price on the Chinese stock market.

This article contributes to the current literature in three ways. First, we find a positive tail dependence between the Chinese stock market return and world crude oil return and indicate that this positive tail dependence could be explained by Kilian and Park's (2009) economic cycle theory. We note that this positive relationship between the oil market and Chinese stock market is not only different from that of many developed countries but also from much of the research on the Chinese market (e.g., Broadstock, Cao, & Zhang, 2012; Cong, Wei, Jiao, & Fan, 2008; Fang & You, 2014). In terms of the positive relationship that has been reported between the Chinese stock market and oil market (e.g., Zhang & Chen, 2011), no detailed explanation has been offered. Due to the increasing number of connections in international markets, the world macroeconomy has become a main driving force for Chinese business cycles. Meanwhile, the oil price dynamics indicate the same trend as the global economic cycles. Therefore, these may give rise to a positive relationship between the Chinese stock market and the global oil market. Furthermore, the negative impact caused by increasing the production costs of companies (e.g., Jones & Kaul, 1996; Sadorsky, 1999) is eventually canceled out by the smoothing effect from the Chinese special refined oil pricing mechanism, and therefore, the positive relationship between the Chinese stock market and oil price may exist in the long run. To examine whether the positive relationship is caused mainly by global economic cycles and the Chinese special refined oil pricing mechanism, we divide the sector index into two groups based on the characteristics of the industry: cyclical and non-cyclical. We find that the degree of relationship between the stock market return of cyclical businesses and the crude oil return is much stronger than that in the non-cyclical businesses. This finding indicates that Kilian and Park's (2009) "business cycle theory", associated with the Chinese special refined oil pricing mechanism, is an alternative explanation for the positive relationship between oil price and the Chinese stock return and fills gaps in the current literature.

Second, we investigate the relationship between the crude oil market and the Chinese stock market through extreme value analysis. Theoretically, only the adjustment of the Chinese local refined oil price will affect the production cost for companies and the inflation rate for the real economy, and the stock market will reflect this (e.g., Broadstock et al., 2012). However, due to the special price mechanism in the Chinese oil market, it is unrealistic to apply the data set from the Chinese oil market directly due to the low and irregular data adjustment frequency. Therefore, as in many applications, we choose the world crude oil price as the proxy variable for the Chinese local oil price. Fig. 1 displays the path of Chinese oil prices and the Europe Brent spot price. We can see that these two paths deviate in many parts but coincide during large fluctuations, which reflect rare events. Therefore, applying an empirical model (such as the VAR or GARCH) based on the whole data set may not fully reveal or may offer some misleading information about the co-movement between the oil market and the Chinese stock market. It is more reasonable to apply Extreme Value Theory (EVT) to examine the extremal dependence between the Chinese stock market and the oil market. The extremal dependence is based on the extreme values that measure the probability of a co-crash or co-boom between two series. When the extreme values of two series occur simultaneously, these two series are asymptotically dependent. Otherwise, the series are asymptotically independent. Pearson correlation is widely applied to measure the dependence level, but there are some drawbacks in this case: first, in many cases, the dependence structure in the tail area is different from that in other parts, so the Pearson correlation coefficient may be a biased estimator for the extremal dependence; second, for many financial series, the dependence is nonlinear, but Pearson correlation measures only the linear association. The extremal dependence overcomes both of these problems. Estimations of extremal dependence can be obtained by a parametric or nonparametric method. In this paper, we apply two nonparametric measures χ and $\overline{\chi}$ proposed by Coles, Heffernan, and Tawn (1999) and Poon, Rockinger, and Tawn (2003, 2004) to measure the asymptotic dependence level in the tail part. In many empirical analyses, the results of extremal dependence are asymptotic independent. This phenomenon

---

[1] The data is from the EIA website: http://www.eia.gov/countries/country-data.cfm?fips=ch.
[2] See Appendix A: The reform of china's refined oil pricing mechanism.