



Contents lists available at ScienceDirect

Applied Energy

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

The multiscale impact of exchange rates on the oil-stock nexus: Evidence from China and Russia

Shupeí Huang^{a,b,c,d}, Haizhong An^{a,b,c,*}, Xiangyun Gao^{a,b,c}, Shaobo Wen^{a,b,c}, Xiaoqing Hao^{a,b,c}

^a School of Humanities and Economic Management, China University of Geosciences, Beijing, China

^b Key Laboratory of Carrying Capacity Assessment for Resource and Environment, Ministry of Land and Resources, Beijing 100083, China

^c Open Lab of Talents Evaluation, Ministry of Land and Resources, Beijing 100083, China

^d Department of Science and Technology, Parthenope University of Naples, Centro Direzionale-Isola C4, 80143 Napoli, Italy

HIGHLIGHTS

- The multiscale impact of real oil price on Chinese and Russian stock markets are examined.
- The co-movement between the real effective exchange rate and oil-stock nexuses are explored.
- Russian stock market respond to the oil price positively across almost all time scales.
- Chinese stock market is effected by the oil price negatively in long term.
- The exchange rate weaken the Chinese oil-stock nexus but enhance Russian one.

ARTICLE INFO

Article history:

Received 31 January 2016

Received in revised form 9 September 2016

Accepted 20 September 2016

Available online xxxxx

Keywords:

Multiscale

Oil-stock

Exchange rate

ABSTRACT

Dramatic oil price movements could spill over to the stock market, which may be weakened or reinforced by the exchange rate, particularly for net oil importing and exporting countries. Unlike previous studies considering the relationship between the stock market and the oil price quoted in USD, we explore the impact of real oil price quoted in corresponding currency on the stock markets of China and Russia by involving the nominal exchange rates through various time horizons during the sample period from January 2000 to October 2015. Furthermore, the relationship between the effective exchange rate and the oil-stock nexus is examined in a dynamic manner. The main results are as follows: first, Russian stock market responds greater to the combined influence of the oil price and exchange rate than Chinese stock market. Specifically, the bidirectional Granger causality relations running between the real oil price and stock markets are in scale 1 and 6 for China, but exist in scales 1–6 for Russia. Compared with previous studies, we infer that the exchange rate weakens the response of Chinese stock market to the oil price but close Russian oil-stock nexus. Moreover, the oil price increase could depress Chinese stock market in scale 6, while such increase has positive effect on Russian stock market in scales 2–6. Further dynamic analysis demonstrates that the correlations between the effective exchange rates and the oil-stock nexuses for both China and Russia are high and fluctuated in scales 1–4, but decrease after 2014 when the effective exchange rates of China and Russia move in the opposite direction in the long term.

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1. Introduction

Since 2014, the international oil price has decreased sharply and slipped into fluctuations in a low price range, which attracts more focus on the reputedly complicated oil-stock interactions. The uncertainty caused by these interactions makes the decision making by market stakeholders, both from oil importing and

exporting countries, for policy formulation and investment strategies become much more risky [1]. Moreover, there is convincing evidence that proves that the variability of exchange rates could spill over to the international crude oil market [2–7] and the domestic stock markets simultaneously [8–12], which aggregates the risky situation of oil and stock markets.

Crude oil is the most widely traded commodity over the world; the fluctuations of the oil price could disturb national stock markets, and these types of impacts could be enhanced or weakened by the fluctuation of the exchange rate because international crude

* Corresponding author at: School of Humanities and Economic Management, China University of Geosciences, Beijing, China.

E-mail address: ahz369@163.com (H. An).

oil trade is mainly invoiced in USD (US Dollars) and the exchange rate influences the international cash flow [13–18]. For instance, China imported 310 million tons of crude oil in 2014; China would pay 310 million USD less in the international crude oil trade if the price of crude oil per ton decreased 1 USD. Simultaneously, a decrease in the exchange rate of CNY (Chinese Yuan) against the USD could reduce the cost of crude oil for China by more when converting CNY to USD. In contrast, the same situation for oil exporters such as Russia will result in less income. For such oil importing and exporting countries with a high dependence on oil, tiny tweaks of the oil price and the exchange rate will result in large changes in the cash flow, which would exert direct influence on the domestic stock markets. Thus, considering the combined influence of the exchange rate and the oil price on the stock market may offer a fresh perspective to the traditional oil-stock topic.

The oil-stock nexuses attract attention since 1990s with the increasing globalization and the maturity of the stock market. Huang et al. did not find any significant evidence for the influence of oil price changes on the stock market [19], which is supported by a strand of studies [20–22]. In contrast, it is also proved that the oil price could exert negative [23,24] or positive [25–28] impact on the stock market. Then, a strand of literature explained that the mixing impacts of the oil price on the stock market depend on multiple factors. Specifically, Park and Ratti find that the response of the stock market to the oil price shocks is decided by the fact that a country is a net oil importer or exporter [29]. Filis et al. argue that the stock market response depends on the type of oil price shocks (demand side or precautionary demand) [30]. Studies leading by Jammazi et al. [31,32] find that the influence of the oil price on the stock markets varies with the time horizons [33–37]. Most existing literature focusing on the oil-stock nexus mainly uses the oil price quoted in USD and disregards the fact that the combined influence of the exchange rate and the oil price on the stock market may change. However, the exchange rate, as significant economical tool for each government, plays crucial role to connect the domestic and international markets [38]. Tiwari and Albuiescu find that the exchange rate Granger-causes the oil price in the long run, while the opposite applies in the short run through wavelet granger causality [39]. Ghosh's study displays that the oil price return increase causes the depreciation of Indian exchange rate against the USD [40]. Aloui and Aïssa probe significant and symmetric relationship between exchange rates and the oil price [41]. Jain and Biswal suggest the policy making in Indian containing the exchange rate and stock market fluctuations to use the oil price as instrument [42]. At the same time, there is strong evidence showing close interaction between exchange rates and the stock market. Bahmani-Oskooee and Saha examine the exchange rate-stock nexuses for Brazil, Canada, Chile, Indonesia, Japan, Korea, Malaysia, Mexico, and the U.K and find exchange rates have asymmetric effect on stock market [43]. Chikili and Nguyen prove that stock markets exert more effect on exchange rates during both calm and turbulent periods [44]. Even with the important role played by the exchange rate in both stock and oil markets, we find few literature consider what is the combined influence of the exchange rate and the oil price on the stock market, and what is the relationship between the exchange rate and oil-stock nexus? Answering above questions may offer a fresh perspective to observe the traditional oil-stock nexus topic, which needs to be clarified.

The exchange rate may enhance, weaken or have no significant influence on the relationship between the oil price and the stock market. To be specific, the crude oil price that is quoted in USD multiples the exchange rates of the corresponding currency against the USD could be considered as the real oil price, which involves the fluctuations of the oil price and the exchange rate at the same

time. Using the real oil price to examine the oil-stock nexus could attain a more comprehensive picture and deeper the understanding about the oil-stock nexuses and display the role of the exchange on the oil-stock nexus. In addition, the exchange rate used to transform the oil price is the nominal exchange rate that is based on the currency transformation between two countries. Actually, there is another kind exchange rate named as the real effective exchange rate that is adjusted by the consumer price, which could reflect the overall external competition and the real purchasing power of one country's currency. We also involve the real effective exchange rate in our research for a deeper understanding. We could offer a fresh outlook for the influence of the exchange rate and oil-stock nexuses with considering both the nominal and real exchange rate.

Moreover, the energy price and financial time series are generally unstationary, and their interactions display multiscale features [45–47]. Specifically, the oil price, stock indices and exchange rates show remarkably distinguished fluctuation features through different time horizons [33,48,49], which lead to their relations also being characterized by multiscale phenomena [36,50]. This multiscale information is hidden in the frequency domain and is the main cause of the complex cross-market interactions [51]. Thus, it is necessary to examine the relation between the exchange rate and the oil-stock nexus from a multiscale perspective through the exploration of the veiled frequency information.

How could we examine the oil-stock nexus considering the influence of the exchange rate in a variety of time horizons? We choose China and Russia as examples to represent the typical net oil importer and exporter. We proposed a two stages analyses framework combining the wavelet transform, vector autoregression (VAR) and gray correlation analysis compactly. In the first stage, we transform the oil price quoted in USD into CNY and RUB (Russian Ruble) with the wavelet transform; then extract the multiscale information of the transformed oil price and stock indices from multiple time scales and construct bivariate VAR model for China and Russia in each time horizon, which will achieve a dynamic estimation of the impact of the transformed oil price on the stock markets. For a more comprehensive analysis, in second stage, we also examine the co-movement between the real effective exchange rate and the oil-stock nexus. To be more specific, we estimate the correlation between the oil price and the stock index for different time horizons with wavelet coherence and then estimate the co-movement of the real effective exchange and oil-stock nexus for each time horizon in a dynamic manner.

2. Methodology and data

To explore the influence of the exchange rate on the oil-stock nexus across multiple time scales, we propose a comprehensive research framework that involves the wavelet transform, the vector autoregression model and the gray correlation analysis. First, we focus on the response of the stock index to the oil price expressed with the corresponding currency. Hence, we convert the oil price quoted in US dollar into the corresponding currency, which could reflect the real amount paid or earned by the oil importer or exporter. Then, through the discrete wavelet transform, we decompose the stock indices and transform the oil price series into different time horizons and estimate the vector autoregression model (VAR) for decomposed oil-stock pairs in each time scale. Based on the VAR model pairs, with the impulse response function and the variance decomposition, we could offer a deeper understanding of the oil-stock interaction, which includes the influence of the exchange rate in a multiscale and dynamic manner.

Second, we introduce the real effective exchange rate into our research, and it could reflect the purchasing power of the currency.

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