Revisiting the oil price and stock market nexus: A nonlinear Panel ARDL approach
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**ABSTRACT**

In this paper, we re-examine the relationship between oil price and stock prices in oil exporting and oil importing countries in the following distinct ways. First, we account for possible nonlinearities in the relationship in order to quantify the asymmetric response of stock prices of these two categories to positive and negative oil price changes. Secondly, in order to capture within group differences, we allow for heterogeneity effect in the cross-sections by formulating a nonlinear Panel ARDL model which is the panel data representation of the Shin et al. (2014) model and also analogous to the non-stationary heterogenous panel data model. Thirdly, we evaluate the relative predictability of the linear (symmetric) and nonlinear (asymmetric) Panel ARDL models using the Campbell and Thompson (2008) test. Our results depict that stock prices of both oil exporting and oil importing groups respond asymmetrically to changes in oil price although the response is stronger in the latter than the former. This finding is further corroborated by the out-of-sample forecast results suggesting that the inclusion of positive and negative oil price changes in the predictive model for stock prices will produce better forecast results only for the oil importing countries. Our results are robust to different oil price proxies, lag structure and in-sample periods. Overall, the dichotomy between oil exporting and oil importing countries has implications on oil price-stock nexus.

1. Introduction

The proliferation of papers on oil–stock nexus has continued to throw up debate as to the direction and significance of relationship between the two variables. Despite the theoretical justification for negative relationship offered by Jones and Kaul (1996), the nexus has remained unresolved. The cash flow hypothesis of Jones and Kaul (1996) assumes that oil price can affect stock price directly by impacting on future cash flows or indirectly through the interest rate used to discount the future cash flows (see Basher et al. (2012)). For instance, as oil is a crucial input in most firms’ production, expected cash flows can be affected by oil price, which may consequently lead to changes in costs, affecting earnings and dividends and hence stock price (Rafailidis and Katrakilidis, 2014). Using the interest rate channel, higher oil prices may lead to overestimation of the expected inflation and thus higher nominal interest rates; and since discount rates are negatively related with stock prices, increases in interest rates depress stock prices (Rafailidis and Katrakilidis, 2014). On the contrary however, Kilian and Park (2007) have demonstrated that the response of stock price to oil price changes can be either positive or negative depending on whether the changes in oil price are driven by demand- or supply-side shocks. In their analysis of the impact of oil price shocks on the US stock market, they find that the negative response of US stock returns to oil price changes can be attributed only to demand shocks resulting from the uncertainty about future crude oil supply shortfalls; while, higher oil prices, driven by an unanticipated global expansion, have positive effects on stock returns (see also Apergis and Miller (2009)). In other words, regardless of the direction of relationship, there are convincing arguments to support the resulting empirical evidence.

Also, another issue that has engaged the attention of investors and policy makers is whether stock price responds asymmetrically to oil price shock. Detection of asymmetries in the adjustment process to long run equilibrium constitutes further valuable information that may be exploitable accordingly by investors, authorities and firms to manage their portfolios and strategies, by minimizing their exposure to oil-price risk (Rafailidis and Katrakilidis, 2014). Pioneered by Sadorsky (1999), there are a number empirical studies suggesting that aggregate stock market prices and/or stock prices of listed oil and gas companies may respond asymmetrically to oil price changes (see for example, Asteriou and Bashmakova, 2013; Jouini, 2013; Soucek and Todorova, 2013; Bouri et al., 2016; Li et al., 2017; Kang et al., 2016).
However, findings from studies such as Reboredo and Rivera-Castro (2014) and Reboredo and Ugolini (2016) do not support asymmetric response of stock market to oil price movements.

Thus, in this paper, we re-examine the relationship between oil price and stock price in the following distinct ways. First, while we acknowledge the extant literature on the nexus between oil price and stock price including asymmetries at the country specific level; however, there appears to be a dearth of work at the regional or international level. In fact, to the best of our knowledge, our paper is the first to capture simultaneously both nonlinearities and heterogeneity effects in the oil price-stock market linkage using panel data of oil exporting and oil importing countries. Our motivation for partitioning our data into these two categories is derived from the findings of Guesmi and Fattoum (2014), Bouri (2015) and Gupta (2016) papers which suggest that the response of stock market to oil price shocks depends on whether the country is a net importer or exporter in the crude oil market. However, the role of asymmetries in the nexus is not captured in these papers. Some of the recent studies that account for asymmetries but not from the perspective of net oil exporters and importers are Cuñado and Gracia (2014), Jouini and Harrathi (2014), Reboredo and Rivera-Castro (2014), Ding et al. (2016), Reboredo and Ugolini (2016), and Bampinas and Panagiotidis (2017).

The two notable exceptions that account for asymmetries in the analyses of the nexus for oil exporting and oil importing countries are Filis et al. (2011) and Aloui et al. (2012). Our paper however differs from these studies both in terms of how asymmetries are measured and the methodology adopted. For instance, Filis et al. (2011), in addition to the fact that the analysis is country-specific, asymmetries are captured in a linear fashion using an indicator (dummy) variable since the GJR approach is adopted. However, the argument in favour of the application of the DCC-GJR-GARCH model for the estimation of oil-stock nexus may not be entirely valid since it involves a multivariate approach that implicitly assumes bi-directional volatility spillovers between oil price and stock market. This is hard to validate practically except where it can be convincingly justified that the volatility in the selected stock exchanges can impact on the global economic activities which by extension may affect the demand/supply of crude oil.

Also, the issue of heterogeneity effect, which is not evident in the Filis et al. (2011) and Aloui et al. (2012) papers, is particularly important in providing meaningful generalization since there could be differential effects of oil price on stock markets of countries within the same group (within group differences) in addition to the possible dichotomy between the two groups. Such generalizations may be necessary at the international level to understand the dichotomy (if it exists) between oil exporting and oil importing in relation to oil-stock nexus. It may also aid in the formulation of policies at the regional level (for example, the Gulf Cooperation Council) and international level (such as the G7 countries and Organization of Petroleum Exporting Countries) where the policy focus transcends individual countries.

Secondly, in order to account for both asymmetric and heterogeneity effects in the oil-stock nexus, we formulate a nonlinear (asymmetric) Panel Autoregressive Distributed Lag (ARDL) model. This model is motivated by the Shin et al. (2014) approach which allows for the consideration of asymmetry in the stock price equation rather than in the variance equation which is a common practice in the literature. Also, the approach accounts for asymmetry in a non-linear fashion by computing the positive and negative partial sum decompositions of the relevant explanatory variable(s) (which is oil price in this case). The computational advantages of using this approach in modeling economic relationships are well documented in Nusair (2016). Although the nonlinear Panel ARDL model is the panel representation of the Shin et al. (2014) model proposed for time series, it is analogous to the heterogenous panel data model except that the latter assumes a linear relationship between oil price and stock price. Thus, we account for nonlinearities by decomposing the oil price series into positive and negative changes. It appears that this is the first study to follow this procedure to model oil-stock relationship particularly within the context of the oil-exporting and oil-importing economies.

We do acknowledge the relevance of quantile regression in modeling asymmetries in oil price-stock nexus (see for example, Alagidede and Panagiotidis, 2012), however, we favour the nonlinear Panel ARDL framework for the following reasons. The Shin et al. (2014) framework adopted in this paper to capture both the symmetric and asymmetric changes in oil price relies on the ARDL model and therefore it is more appropriate and convenient to specify this framework in a nonlinear Panel ARDL form. The choice of the latter becomes necessary when non-stationarity is a concern in the panel data arising from a large T panel which is the case in this paper. Moreover, this approach enables us to capture inherent heterogeneity effects in the slope coefficient due to cross-sectional differences while it also facilitates the estimation of both the long run and short run responses of stock price to oil price changes.

Thirdly, we evaluate the predictability of the symmetric and asymmetric models based on the out-of-sample forecast performance in order to further justify the significance of including asymmetries when modeling oil-stock relationship. We consider multiple out-of-sample forecast periods as well as multiple forecast horizons for robustness purpose. This consideration is particularly important to financial market analysts and investors who regularly render predictions about the possible future path that stock prices may follow in the presence of shocks such as oil price shock.

Following this section, we structure the rest of the paper as follows. Section 2 provides some motivations for the study while Section 3 explains the theoretical framework for the oil price-stock nexus. In Section 4, we describe the data used for estimation and also render some preliminary analyses. We present the dynamic heterogenous panel data model including the estimation procedure in Section 5 while the discussion of results including diagnostics, robustness tests and policy implications are rendered in Section 6. Section 7 however concludes the paper.

2. Motivation for the study

2.1. Motivation for asymmetry in oil–stock nexus

The increasing evidence in favour of the co-movement between oil price and stock price is a major attraction to financial analysts, investors and policy makers who are keenly interested in the stock market dynamics. The literature has suggested different channels through which oil prices can affect stock prices (see Huang et al. (1996)). If there is an unprecedented increase in the oil price, the energy cost for many companies is expected to increase (assuming that these companies do not hedge the oil price risks). As a consequence, the earnings could fall and so the present cash flows. Although, the intrinsic stock value would depend on the future cash flows such that, when valuing a stock, the investors and the analysts would predict further oil price increases and estimate lower expected future cash flows, resulting in a lower stock value. But the fact that these expected future cash flows respond differently to positive and negative oil price innovations then implies that the effect of an oil price shock on stock price should also depend on the nature of asymmetry of the shock both in terms of size and sign of the shock.

Also, Wan (2007) offers another perspective for the justification of asymmetric effect of oil price on stock price. The paper argues that the optimal decision for a firm that pays dividends to its shareholders and seeks to maximize the expected present value of its dividends (without closing), could be to pay dividends only when its surplus exceeds a threshold. Thus, a negative (or a positive) oil price innovation could push the surplus below the cutoff required to pay dividends for an oil company (or an industry that uses energy intensively). If that is the case, the company could choose not to pay dividends and face a decline in stock prices. The negative impact that such a decision would have on
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