Energy Policy 102 (2017) 318–331

Contents lists available at ScienceDirect

Energy Policy

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

Another look on the relationships between oil prices and energy prices

Amine Lahiani[a,b], Anthony Miloudi[c], Ramzi Benkraiem[d], Muhammad Shahbaz[b,*]

[a] LEO – University of Orléans, France
[b] Montpellier Business School, Montpellier, France
[c] La Rochelle Business School & CRIEF University of Poitiers, France
[d] Audencia Business School, Nantes, France

ARTICLE INFO

Jel Classification:
C32
C5
G1

Keywords:
Energy prices transmission
Cointegration
Quantile regression

ABSTRACT

This paper employs the Quantile Autoregressive Distributed Lags (QARDL) model developed recently by Cho et al. (2015) to investigate the pass-through of oil prices to a set of energy prices. This approach allows analyzing simultaneously short-term connections and long-run cointegrating relationships across a range of quantiles. It also provides insights on the short-run predictive power of oil prices in predicting energy prices while accounting for the cointegration between oil prices and each of the considered energy prices in low, medium and high quantiles. Two key findings emerge from this paper. First, all considered energy prices are shown to be cointegrated with oil price across quantiles meaning that a stationaryequilibrium*relationship* exists between single energy price and oil price. Second, we find evidence that oil price is a significant predictor of individual petroleum products prices and natural gas in the short run. This paper has important policy implications for forecasters, energy policy-makers and portfolio managers.

1. Introduction

The idea that oil price changes are increasingly significant and have considerable influence on world economies is generally accepted and has recently received considerable attention. Relationships between crude oil prices and various commodity prices, on the other hand, have been widely investigated in both theoretical and empirical studies. A number of them focused on the transmission of oil prices to energy prices. In particular, a stream of research has been devoted to the relationship between crude oil and extensively refined petroleum products and natural gas prices. Previous research focused on the transmission of oil prices to energy prices by using a couple of linear econometric methodologies. Borenstein et al. (1997) confirm the common belief that retail gasoline prices respond more quickly to increases than to decreases in crude oil prices. Other empirical studies confirm the existence of a long-run link between crude oil, natural gas and refined petroleum prices by using more rigorous econometric techniques (Yucel and Guo, 1994; Asche et al., 2006; Villar and Joutz, 2006, to name a few). Indeed, many economic data such as energy time series are non-stationary in level while their respective first differences are stationary, therefore it is necessary to use appropriate econometric tools to model the transmission mechanisms between them. This is the reason why long-term relationship between crude oil and energy prices has been investigated in a cointegration setting using the Error Correction Model (ECM) framework. Serletis and Herbert (1999) study the existence of common trends in Henry Hub and Transco Zone 6 natural gas prices, the New York Harbor fuel and PJM electricity prices. They find that the three energy prices are cointegrated. Asche et al. (2006) state that a strong relationship between oil prices and natural gas prices indicates the strongly integration of these markets. In the same vein, Villar and Joutz (2006) find a cointegrating relationship between crude oil prices and natural gas prices suggesting that oil prices and gas prices have a stable long-run cointegrating relationship. They argue that the effect of oil prices on natural gas demand is dominant in the short-run. However, natural gas is shown to have a negligible effect on oil price suggesting that oil price is exogenous to natural gas. In accordance with previous authors, Brown and Yucel (2008) show that oil price movements have an important role in driving natural gas price implying that oil and natural gas are considered as substitutes and also complements in production of electricity. Hartley et al. (2008) employ a similar approach to test for the relationship between the WTI crude oil and Henry Hub natural gas prices. They provide two fundamental points concerning the relationship between oil and natural gas prices. First, these authors find that the long-run relationship can be partly explained by technical factors related to the use of natural gas instead of oil to produce electricity.

* Corresponding author.
E-mail addresses: amine.lahiani@univ-orleans.fr (A. Lahiani), miloudia@esc-larochelle.fr (A. Miloudi), rbenkraiem@audencia.com (R. Benkraiem), shahbazmohd@live.com (M. Shahbaz).

http://dx.doi.org/10.1016/j.enpol.2016.12.031
Received 11 August 2016; Received in revised form 28 November 2016; Accepted 16 December 2016

Second, they demonstrate that the short-run dynamic between these energy prices are influenced by a couple of exogenous variables, namely weather and inventories in addition to other seasonal factors. By employing a VEC-MGARCH approach Lin and Li (2015a,b) study the price and volatility spillovers between oil and natural gas markets. They also discuss the hedging strategy based on the spillover effect between the two markets. Their results indicate that the European and Japanese gas markets are cointegrated with Brent whereas the US gas market is decoupled from the US oil market due to the liberalization of gas market in the US. The results evidence the existence of a one directional price spillover from oil market to gas market but volatility seems to spillover from oil market to gas market, and vice versa, in the US and Europe.

Conflicting empirical findings in existing energy literature intends us to revisit the pass-through of WTI crude oil monthly prices to a set of energy monthly prices i.e. gasoline, diesel, heating and Henry Hub natural gas by examining both the short-run and long-run relationships between oil and US energy prices over the period 1997/01 to 2015/10. We extend the existing literature by employing a Quantile Autoregressive Distributed Lags (QARDL) model recently developed by Cho et al. (2015). To our knowledge this is the first paper to adopt the QARDL to examine the short-run and long-run relationships at different quantiles of the distribution of the dependent energy price time series. The QARDL modeling approach resolves two main problems to improve econometric estimation. Recent studies show that the relationship between crude oil and energy prices is more complex such that linear models are unable to account for this complexity (Aloui et al., 2014; Atil et al., 2014; Brigida, 2014). Our statistical approach tests the stability of the long-term relationship across quantiles and provides a more flexible econometric framework. The second important point is the introduction of the possible asymmetry in the response on energy prices to crude oil prices changes (Rahman, 2016; Chang and Serletis, forthcoming). The QARDL model allows for locational asymmetry in the sense that the parameters may depend on the location of the dependent energy prices within its conditional distribution. Moreover, QARDL model simultaneously addresses the long-run relationship between WTI crude oil price and each dependent variable (energy prices) and its associated short-run dynamics across a range of quantiles of the conditional distribution of each energy prices. Therefore, the QARDL is a good candidate to accurately model both the nonlinear and asymmetric linkages between oil prices and a set of energy time series both in the long- and short-run.

The keys results may be summarized as follows. The findings support the presence of a cointegrating relationship between WTI crude oil and petroleum products prices. This long-run relationship is stable across quantiles. Short-run links also exist between oil price and all the considered energy prices showing that, in the short-run, oil prices predict gasoline, heating, diesel and natural gas prices. Concerning the relationships between Henry Hub natural gas and WTI crude oil prices two key findings emerge from our analysis. First, we find evidence that a long-run equilibrium exists between them but is linear and symmetric across quantiles. This result corroborates those obtained by some studies (Serletis and Herbert, 1999; Villar and Joutz, 2006) but deviates from more recent empirical studies (Ramberg and Parsons, 2012; Brigida, 2014 to name few). Second, we report a significant short-run relationship between natural gas and oil prices mainly in medium and high quantiles. These last results have practical implications for energy policy makers and portfolio managers because natural gas and crude oil prices seem to decouple partially after the global financial crisis in 2008 but are still connected symmetrically in the long-run and asymmetrically in the short-run. Actually, in the long term oil could restrict sustainable development for its scarcity while in the short term oil price changes might lead to economic fluctuations by affecting production costs (Lin and Li, 2015a, b). Oil price changes have important implications on the macroeconomy and the financial sector. Indeed, Hamilton (1983) and Mork (1989) show that increases of oil prices are likely to cause recessions and consequently increase unemployment. It is thus crucial to understand the factors that drive oil price and pass through to the economy and energy prices via oil price. Kilian (2009) identified three main structural shocks that conduct oil prices i.e. oil supply shock, oil demand shock and oil market-specific market. Lin and Li (2015a, b) add a fourth driver of oil price namely the 'China factor' through the rapid growth of China import of oil.

The rest of the paper is organized as follows. Section 2 reviews the related literature. Section 3 describes the data, gives a preliminary analysis of the considered time series and introduces the empirical methodology. Section 4 discusses the obtained results. Section 5 concludes the paper and provides policy implications.

2. Literature review

Since the seminal work of Borenstein et al. (1997) the long-run relationship between oil and energy prices seems to be asymmetric in the sense that, for example, gasoline prices respond both faster and larger to crude oil prices increases than decreases. This empirical fact is investigated in numerous studies by using cointegration and ECM techniques (Balke et al., 1998; Bachmeier and Griffin, 2003; Chen et al. 2005; Honarvar, 2009). But in reality, empirical studies have produced conflicting results concerning the existence of price asymmetry for US energy markets. By considering daily data, Bachmeier and Griffin (2003) find no evidence of asymmetry in the response of gasoline prices to crude oil price shocks over the period 1985–1998 while Balke et al. (1998) support evidence of asymmetry over the same period of time. The sources of difference in results could be explained by the different data frequency and the heterogeneity of econometric approaches. Applying a threshold cointegration model, Chen et al. (2005) support evidence for asymmetric adjustment in gasoline prices. Honarvar (2009) explains these mixed empirical results by showing that ECM and VAR models provide misleading results when time series are not cointegrated but their positive and negative partial sums are cointegrated. The author thus employed more sophisticated econometric techniques able to detect more accurately the hidden cointegration[1] between time series. Nevertheless, Venditti (2010) also reports no systematic evidence of asymmetric transmission of oil prices to consumer energy prices in the US over a more recent period 1999–2009 by using nonlinear econometric tools. Finally, the vast majority of empirical studies advocate the existence of asymmetry in US energy markets (see Frey and Manera, 2007 for an extensive review of this literature).

More recently different models emerged as good candidates to accurately model both asymmetric and nonlinear linkages between oil price and the energy prices. Brigida (2014) employs a multi-state Markov switching model that allows incorporating cointegration to investigate the link between oil and natural gas prices. An important result emerging from this study indicates that oil and natural gas prices did not permanently decouple in the early 2000 but rather experienced a temporary shift in regimes. Aloui et al. (2014) explore the dependence structure between oil and natural gas markets and derive portfolio implications for risk management using copula-GARCH methodology. They find evidence of asymmetric dependence between the two markets in that oil and natural gas markets move closely together during bullish periods but not during bearish periods. Atil et al. (2014) used the nonlinear autoregressive distributed lags model to assess the pass-through of oil prices to gasoline and natural gas prices. They find that oil prices affect gasoline and natural gas prices in an asymmetric manner with transmission mechanisms being different.

[1] The concept of hidden cointegration is recently introduced in the econometric literature by Granger and Yoon (2002). Two time series X and Y have hidden cointegration if their respective positive and negative components are cointegrated.