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Price relationships between crude oil and transport fuels in the European Union before and after the 2008 financial crisis

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ABSTRACT

The purpose of this paper is to investigate the relationship between the crude oil price and consumer prices of transport fuels in the European Union before and after the 2008 financial crisis. We perform a two-period analysis by providing pre-break and post-break estimates. We found a strong and reciprocal linkage between crude oil and gasoline prices in the pre-break period, but there does not seem to exist a similar relationship in the post-break period. The findings are robust to variations in the specification of the empirical models with and without applicable taxes.

1. Introduction

Economic theory and intuition suggest a relationship should be present between input costs and output (product) prices; however, it does not specify how such relationships will behave in a dynamic framework that includes feedback (Goodwin et al., 1990). It is therefore just as well possible to assume a two-way relationship between the demand for petroleum-derived products that may drive the crude oil or petroleum price. Oil price volatility over the past decade appears to have influenced production and consumption decisions. Abrupt changes in supply and demand, influenced by events such as the financial crisis of 2008, affect expectations and prices.

The purpose of this paper is to investigate the relationship between the spot price of crude oil and transport fuels before and after the 2008 financial crisis. The transport fuels are sold at petrol stations to be used as a fuel in motor vehicles and are petroleum-derived products produced in refineries. The derivatives used in this study are for gasoline, diesel fuel, and liquefied petroleum gas used as a fuel (hereafter, autogas). Autogas consists of either propane or a mixture of propane and butane. Autogas is a cleaner burning fuel than gasoline and diesel fuel, and is different from natural gas, which is primarily methane.

We recognize the break of the financial crisis in the multivariate co-integration analysis by splitting the sample and providing before and after estimates. The issue of structural breaks is generally not addressed in the literature. This approach is thus an important contribution to the literature devoted to these relationships. It is important to take into account structural breaks induced by external events of considerable importance such as the financial crisis of 2008. Previous analyses in the literature on the price relationships between crude oil and petroleum-derived products has been carried out based on the implicit assumption that the econometric models are correctly specified without structural breaks.

Using weekly-frequency data, the co-movements and causality between crude oil prices and consumer prices (pump-prices) of gasoline, diesel, and autogas are analysed in both the short and long terms in order to gain insights into market changes in crude oil and transport fuels along the entire value chain. The understanding of these relationships deliver valuable evidence for corporate risk management in the oil industry and to policy makers who need to comprehend the major driving force behind energy price changes and energy market integration. The purpose of this paper is to addresses the following research question: What are the price relationships between the crude oil and transport fuels in the

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European Union before and after the financial crisis of 2008? In order to study these inter-relationships, we use co-integration and error correction modelling applied to prices covering the period from 2005 to 2014. The time series analysis is based on weekly data for both gross prices and prices net of applicable taxes.

The structure of the paper is as follows. Section 2 presents the literature review on the topic. Section 3 contains the methodology and Section 4 describes the data. Section 5 presents and discusses the empirical results. Section 6 draws final conclusions.

2. Literature review

Over the last three decades, oil prices have been extensively investigated in the applied economic literature. There exist a large number of studies offering empirical evidence in support of the link between the crude oil prices and economic performance (Huntington, 1998; Mory, 1993; Mork et al., 1994; Ferderer, 1997; Cuñado and de Gracia, 2003; Barsky and Kilian, 2004; Du et al., 2010; Difiglio, 2014). Numerous studies of oil pricing have established the existence of a long-run relationship between prices of energy commodities (Yücel and Guo, 1994; Ewing and Harter, 2000; Chen et al., 2005; Asche et al., 2006; Bachmeier and Griffin, 2003; Grasso and Manera, 2007; Brown and Yücel, 2008; Hartley et al., 2008; Meyler, 2009; Wlazlowski et al., 2009; Kuper, 2012; Atil et al., 2014; Nick and Thoenes, 2014). For instance, Radchenko and Shapiro (2011) identified anticipated and unanticipated shocks as possible sources of gasoline price asymmetry, concluding that fluctuations in unanticipated shocks in crude oil price cause asymmetric effects on gasoline prices. Polemis (2012) used an error-correction model for the Greek gasoline market and argued that retail gasoline prices respond asymmetrically to cost increases and decreases both in the long and the short-run. Studies on pricing behaviour in the market of petroleum-derived products form part of the extensive “rockets-and-feathers” or “balloons-and-rocks” literature (Borenstein et al., 1997; Peltzman, 2000; Asplund et al., 2000; Manera and Manera, 2007; Douglas and Herrera, 2010; Godby et al., 2000; Polemis and Fotis, 2013; Rahman, 2016; Bremmer and Kesselring, 2016). For instance, Bermingham and O'Brien (2011) empirically tested whether Irish and United Kingdom petrol and diesel markets are characterized by asymmetric pricing behaviour with threshold autoregressive models and a high-frequency dataset. They found no evidence to support the “rockets-and-feathers” hypothesis that prices rise faster than they fall in response to changes in oil prices.

The previous studies have essentially provided econometric assessment on the price setting behaviour in domestic fuel markets to changes in oil prices. Among the studies that have investigated price dynamics of crude oil and products in petroleum markets, and more generally the relationship between the price of crude oil and the prices of petroleum-derived products, several papers adopted product prices as explanatory variables for crude oil prices. Serletis (1994) found co-integration and a common stochastic trend between daily spot prices of crude oil, heating oil and unleaded gasoline during the period from 3 December 1984 to 30 April 1993. This study applied the Johansen's maximum likelihood approach for estimating long-run economic relationships and multivariate vector autoregressive models without exploring the short-run dynamics between the variables. Girma and Paulson (1999) have investigated the long-run price relationships among crude oil, unleaded gasoline and heating oil in the European Union and found that the price of these commodities are cointegrated.

Using a bivariate error correction model, Gjølberg and Johnsen (1999) analysed co-movements between monthly spot prices of crude oil against six of its refined products in the Northwest European market during the period 1992–1998. Co-integration was found in five out of six price pairs and deviations from the long-term equilibrium can be employed to predict short-term price changes. One limitation of this study was that bivariate analysis only involves the analysis of two variables for the purpose of determining the empirical relationship between them and the relationships of multiple variables were not examined simultaneously. Asche et al. (2003) addressed this issue by reporting results on long-run price relationships between crude oil and petroleum-derived products within a multivariate framework for the North Western European market with monthly data covering the period 1992–2000. They infer that crude oil is clearly the driving factor in the price generating process and it is crude oil that binds the price series together in the long run. They show that the link between petroleum prices implies supply driven market integration where producers will adjust the output mix in response to price changes.

Adrangi et al. (2001) studied the price dynamics of the crude oil price and its relation with diesel fuel price using a bivariate vector autoregressive model in the mean equations and a autoregressive conditional heteroskedasticity model for the conditional variances. They estimated a unidirectional causal relationship going from the crude oil to the product. Lanza et al. (2005) provided an analysis of crude oil and product price dynamics using co-integration and error correction models with data from Europe for the period 1994–2002. Empirical evidence showed that product prices are statistically relevant in explaining short-run and long-run adjustment in petroleum markets. Joets (2011) improved on previous analyses by investigating the existence of a long-term link between the spot prices of crude oil and domestic fuel using panel co-integration tests and panel error correction models. The causality analysis revealed that domestic fuel prices are influenced by oil price variations in both the short-run and the long-run during the period from August 2003 to April 2010. Remarkably, this study provided estimates of short-run and long-run coefficients within the panel data. From a methodological viewpoint, potential structural breaks and cross-sectional dependence have not been acknowledged. The power of standard panel co-integration estimates may be affected by misspecification errors if structural breaks in the parameters generating the process are not considered (Banerjee and Carrion-i-Silvestre, 2015).

In summary, our paper is important in this context because we look at crude oil prices from the European market for a recent period. Several previous studies focused on co-integration and long-term relationships between fossil fuels but do not take into account structural breaks. Our study goes further by examining whether these changes are reflected in the price relationships and affect the estimation results. We investigate short-run and long-run price relationships using data inclusive and exclusive of applicable taxes, and we base our analysis on the price of the European Brent crude available to refiners.

3. Methodology

The purpose of the analysis is to first explore the long-run equilibrium relationship between the price of crude oil price and the consumer prices of transport fuels. Considering these price relationships, we estimate an error correction model that may take the following form:

$$\Delta p_{1t} = \alpha + \sum_{i=1}^{p-1} \beta_i \Delta p_{2t-i} + \sum_{i=1}^{p-1} \gamma_i \Delta p_{3t-i} + \sum_{i=1}^{p-1} \delta_i \Delta p_{4t-i} + \theta ECT_{t-1} + \varepsilon t$$

where p_{1t} is the spot price of crude oil in time t and p_{2t}, p_{3t}, p_{4t} are the consumer prices of transport fuels such as gasoline, diesel, and

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