Overview

This study examines the relationship between crude oil and petroleum products prices in the European, Asian and North American markets over the period January 2005 to December 2011. We develop a statistical model, based on the long term equilibrium between the prices, which takes into account the changes in the oil product demand trends. We explain price behaviors by the impact of the demand trends. Because the refining industry which transforms crude into petroleum products is a joint product industry, petroleum product pricing is affected by demand trends both in terms of quality and quantity (2012).

Consequently, the long term equilibrium between prices, estimated through a cointegration approach, are affected by several structural breaks. We also develop a panel econometric model which takes into account the relative share of each oil products in the final demand. Finally, the different results are compared to a marginal cost derived from an oil refining optimisation model. This econometric modeling approach enables a better understanding of the long term equilibrium between prices of petroleum products and crude.

Methods

Our objective is to model the formation of prices of petroleum products on the international markets. Among the more than twenty different products that come out of a refinery, we have selected a limited number of products for our analysis: two light cuts (gasoline and naphtha), two middle distillates (jet fuel and diesel oil) and heavy fuel oil. Except for naphtha, that is used by the petrochemical industry, all products are used for transportation and energy production.

In a first step, our approach is to study the cointegration relationship between petroleum products and crude oil prices (Engle and Granger and Johansen methodologies). Challenges in indentifying stable relationships and the presence of the 2008 oil price crisis, changes of the final demand (both in terms of quantity and specification) in the period covered led us to search for structural breaks in the data. We implemented the testing procedure suggested by Perron (1997), which grew out of the work of Perron and Vogelsang (1992a,b). In these tests, the null hypothesis is that the temporal series is characterised by the presence of a unit root and a constant, which may be null, with the presence of a break. With significant results for the presence of such breaks around 2008, we tested for the presence of a potential break in the cointegration relationship with the Gregory and Hansen test (1996). Again with significant results for the changes in the cointegration relationship, we estimated the long term equilibrium between the prices taking into account the structural breaks with both Engle and Granger and Johansen methods.

However, the structural change that was identified could be associated to the evolution of the demand. Thus, a second approach was then implemented using panel time series in order to introduce demand trends in the modeling of the equilibrium. Indeed, panel system modeling enables the introduction of weights on the data to account for the evolution of demand. After first generation unit root testing for the panel data (LLS, IPS and Hadri), cointegration was tested thanks to Pedroni and Westerlund tests (2008, 2007).

Results

The econometric analysis was performed with monthly data on the period January 2005 to December 2011 from Platts. The equilibrium relationships derived from the cointegration analysis point out the coefficient greater than one for gasoline, naphta, diesel oil and jet fuel and less than one for heavy fuel oil which is a by-product.
The comparison between the three worldwide oil product markets point out the influence of the demand structure for each regional market: the highest coefficient of gasoline in North America corresponds to the highest share of light products in this region of the World, the same result is observed for diesel oil in Europe. The coefficient of heavy fuel is higher on the Singapore market than in the other regions of the World due to the tensions on this product.

The panel econometric approach gives coefficients of the same order than with the cointegration approach without structural change due to the evolution of the demand. Moreover, the variance of the coefficient are reduced. Thus the simulations of the petroleum prices from a given crude oil price are more reliable.

Conclusions

Recent events in the crude oil markets, such as the sharp rise in prices between January and July 2008, have left many analysts and researchers puzzled by the underlying explanations for determination of prices. The analysis carried out of the crude oil market through our work on petroleum and crude oil prices leads us to the following conclusions:

- From the cointegration test, we could not reject the hypothesis of a long term equilibrium between the prices on the different regional markets (Europe, North America, Singapore). Nevertheless, structural breaks have been clearly identified. Subsequently, we could associate some of these structural changes to the evolution of the demand.
- Through a panel econometric approach, the evolution of the demand is taken into account. Subsequently, the estimated relationships seem more accurate for simulation purposes.

References