Long run analysis of crude oil portfolios

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ABSTRACT

This paper deals with the analysis of the long-run behavior of a set of mispricing portfolios generated by three crude oils, where one of the oils is the reference commodity and it is compared to a combination of the other two ones. To this aim, the long-term parameter related to the mispricing portfolio are estimated on empirical data. We pay particular attention to the cases of mispricing portfolios either of stationary type or following a Brownian motion: the former situation is associated to replication portfolios of a reference commodity; the latter one allows to implement forecasts. The theoretical setting is validated through empirical data on WTI, Brent and Dubai oils.

1. Introduction

Among the characterizing features of a time series, a relevant role is played by the so-called *persistence* or *long-term memory property*. Such aspect is related to the autocorrelation of the time series, and reflects the behavior of the process on the long-run. Hurst (1951) has been the pioneer of the formalization of the concept of long-term memory property for a hydrological time series.

The persistence property of a time series has a relevant informative content in many applied contexts. This paper deals with one of the most prominent one. In fact, we consider the series of deviation of the price of a portfolio of commodities from a reference commodity. In so doing, we explore the long-term memory properties of a so-called *mispricing portfolio* of commodities. The selected commodities are crude oils. Yet, the persistence properties of a mispricing portfolio of crude oils explain the replicability of the reference oil price dynamics through the non-reference oils. This is of paramount importance in many respects, like hedging and assessing statistical arbitrage effects.

In general, the exploration of the long-run behavior of a time series brings key information on if and how the related phenomenon can be predicted (see e.g. Corazza and Malliaris, 2002; Cajueiro and Tabak, 2004; Kyaw et al., 2006; Singh and Prabakaran, 2008; Potgieter, 2009). Furthermore, in the field of finance, the existence of long-term memory associated with slow decay of autocorrelation functions in asset returns indicate the existence of exploitable market inefficiencies as suggested by Baillie (1996).

We feel close to the mentioned papers for our purpose of gaining insights on the properties on the long-run of an aggregation of crude oils prices by discussing the predictability of the mispricing portfolio.

We choose to analyze the crude oil markets because their dynamics play a central role in the worldwide economy since oil price movements substantially affect the most macroeconomic activity, especially after the 1970s crises (see Barsky and Kilian, 2004; Kilian, 2009; Ferraro et al., 2015). A great deal of recent literature discusses the efficiency of crude oil markets (see, for example, Ortiz-Cruz et al., 2012) and research focuses on the dynamics of the three major crude oil prices, that is WTI, Brent and Dubai oils (see, for example, Kristoufek and Vosvrda, 2014), with a particular interest in the empirical evidence of long-run dependence phenomena for prices. In this respect, Alvarez-Ramirez et al. (2002) and Serletis and Andreadis (2004) show that long-run memory mechanism affects the

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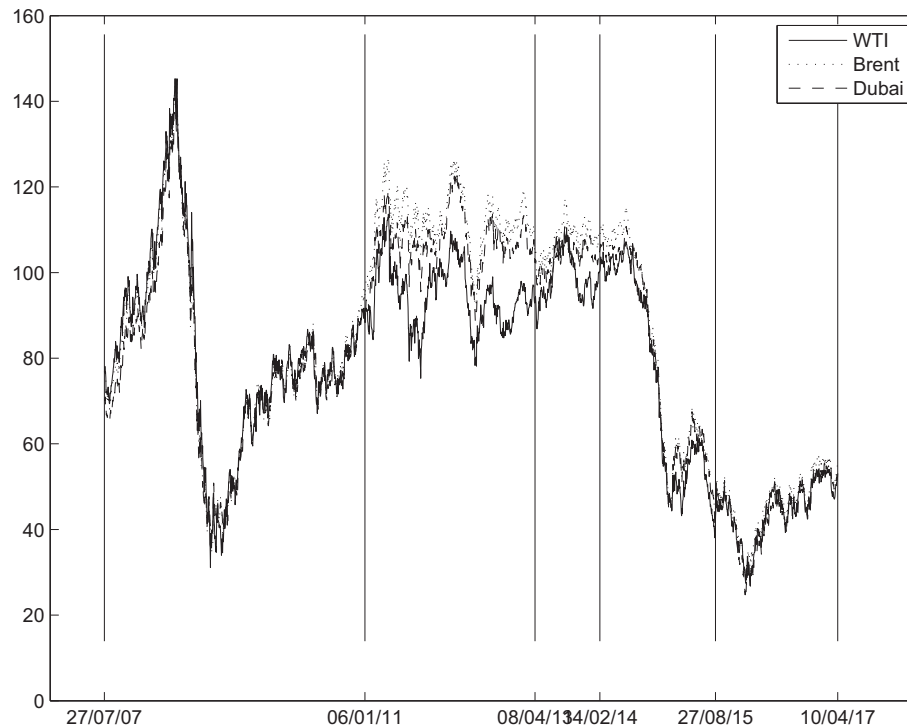
Fig. 1. Plot of the time series WTI, Brent, Dubai, and the corresponding structural breaks.

crude oil price evolution, but Tabak and Cajueiro (2007) suggest that the crude oil market has exhibited a temporal movement towards efficiency. More recently, Alvarez-Ramirez et al. (2008) examine the empirical evidence of long-run autocorrelations in crude oil markets towards efficiencies and they analyze also short-term autocorrelations dynamics. Wang and Liu (2010) extend the existing literature by testing for the efficiency of WTI crude oil market through observing the dynamics of the local long-term parameter. They employ the method of rolling window and find that the small fluctuations of WTI crude oil market are persistent; however, the large fluctuations have high instability, both in the short- and long-terms.

We are quite different from the quoted papers. Indeed, as already preannounced above, we here do not focus on the single commodities. Rather than this, we consider a suitable aggregation of three crude oil prices, quoted in different markets: WTI, Brent and Dubai. In particular, WTI is the reference commodity while Brent and Dubai are combined together to create a replicating portfolio of WTI. The price of the mispricing portfolio is given by the difference between the price of the WTI and the one of the replicating portfolio of Brent and Dubai. Indeed it is natural thinking that three assets, having same specific features and supply and demand with the same characteristics, have prices that are influenced by market rumors
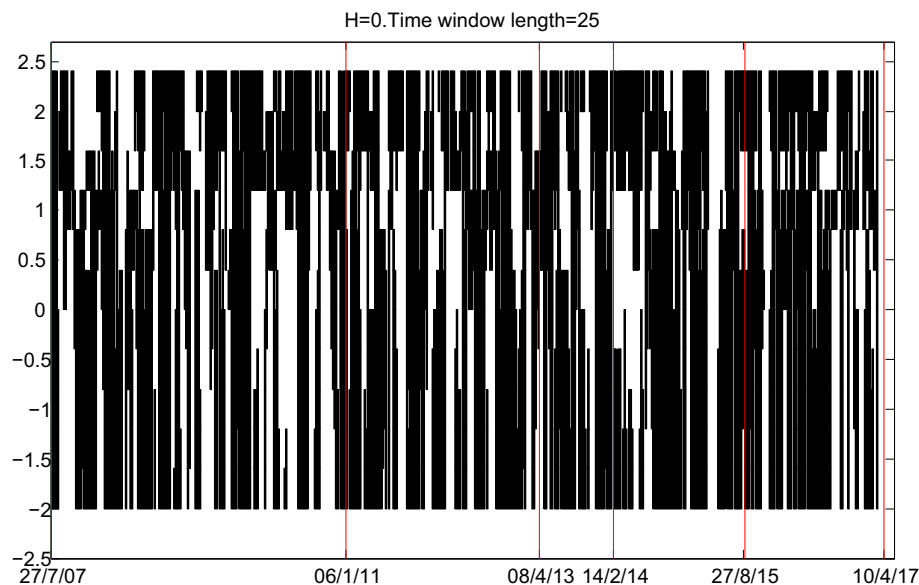

Fig. 2. Time-parameter plane. The black rectangles which left-bottom corner is given by (t, β_1) evidence the combination of parameter and time where the hypothesis of uncorrelation of the mispricing calculated parameter β_1 cannot be rejected on time windows of length 25, starting at time t. The vertical lines point out the structural breaks.