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Component structure for nonstationary time series: Application to benchmark oil prices

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ABSTRACT

The oil market is characterized by several hundreds of different grades of crude extracted from various locations on the planet, but prices of those grades are structured with reference to only a handful of benchmark varieties. In this context, the ability to predict near term benchmark oil prices takes on special importance. In this paper, we explore an approach to model the benchmark oil price behaviors using a structure of permanent and transitory components. This initial attempt seems very encouraging at least with respect to one-week ahead forecast and deserves further investigation. In contrast to the equities, the weekly oil permanent components do not seem to be explainable by fundamental factors. However, the returns of the short-run, transitory oil components or cycles, which differ in terms of their degrees of persistence, are mostly affected by contagion spillovers and not by the fundamentals. Their volatilities vary slightly in terms of their sensitivity to major geopolitical events. The overall findings underscore the importance of benefiting more from spillover-catching strategies over diversification ones in the short-run.

1. Introduction

Although there are hundreds of different grades of crude oil extracted in diverse geographical regions on this planet, their prices are represented by a handful of benchmark or marker prices. The benchmarks, as well as the spreads (or differentials) between two benchmarks, are economically important because they are traded on major commodity centers. Understanding the behavior of these benchmarks is important in

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the price discovery process of crude oil and its derivatives. The different grades are classified into groups based on their specific gravity as measured by the American Petroleum Institute (API) degree and their sulphur content. The API gravity categorizes crude into three main types: Light, Medium and Heavy. The second property grades oil into sweet crudes that have relatively lower naturally occurring sulphur content or sour crudes that are higher in sulphur.

The benchmarks for the light, sweet group are the West Texas Intermediate (WTI) in North America and Brent in Europe and Africa. The medium crude group is benchmarked by Dubai–Oman crude. The Dubai benchmark representing the medium, sour crudes is priced in balance to WTI and Brent. This benchmark crude (which is now supplemented by Oman crude) is currently traded at the Dubai Mercantile Exchange (DME) and London's International Commodity Exchange (ICE). WTI and Brent are much more liquid and more actively traded than Dubai/Oman.

The heavy crude group is benchmarked by Mexican Maya, which is a heavy, sour crude and sells at a significant discount to WTI and Brent. This benchmark is not actively traded and thus is illiquid. As the world becomes more critically reliant on heavier and higher-sulphur streams, the emphasis is placed more on sour crudes, and the heavy and medium grades will assume more importance in the oil price discovery process.

Understanding the dynamics of the oil grade benchmark prices and their volatilities is useful as the relationships between them will change in the future as the structure of the oil market changes. For example, the UK supply of the North Sea Brent is expected to drop from 1.7 million barrels a day to one million barrels in just five years. The Norwegian production of the North Sea oil is at a thirteen-year low. Oil refineries are being forced to accept a reduction in the discount on medium and heavy crudes relative to Brent because of the tight balance between oil supply and demand and the persistence of backwardation. In addition, Mexican oil production is falling faster than expected, and the Dubai benchmark will assume more prominence as it is now supplemented by the less sour Oman crude and have financially settled contracts traded on the newly established DME. Thus, understanding the behavior of the benchmarks is important for both physical traders and financial players not just because of trading on their own contracts and on their spreads, but also because of their functions in pricing other crude oil grades and hedging against risk.

Methodologically, the traditional econometric approach to modeling oil prices has employed supply–demand models. This approach has been more problematic in recent years due to inadequacy in modeling uncertainty and accounting for structural changes in the oil markets, making the price less responsive to the fundamentals. The results have shown that the oil supply and demand models have overpriced oil (Huntington, 1994).

Recent advances in time series econometric techniques have shown that oil prices are nonstationary. The more recent approach employs time series models that use first differences of the prices to deal with the problem of nonstationarity (see Hammoudeh et al., 2003; Hammoudeh & Li, 2008; Lien & Wilson, 2001). However, the oil price level is a composite, which includes short-term and long-term components that may be affected by different factors and thus behave differently. We will therefore gain more insight by understanding how these two components behave in response to changes in fundamental, psychological and contagion factors.

The component model provides a new approach to modeling oil prices in terms of both their short- and long-run components. This approach enables us to use weekly oil prices to examine fundamental economic factors traditionally done at much lower data frequencies. In addition, we can use the short-run component to examine stylized facts of oil prices such as conditional volatility persistence and impacts of spillovers on returns and volatility. The findings of this approach should give insightful evidence to oil market participants regarding the short-run and long-run dynamics of the benchmark prices. Oil traders, in particular, should benefit from these results in designing investment strategies to take advantage of profit opportunities. To the best of our knowledge, this study reports and examines for the first time the decomposition of nonstationary oil benchmark prices into two components and attempts to explain the factors that govern their volatilities.

The broad objectives of the study are: (1) to use the component model to decompose each of the four oil benchmarks (i.e., WTI, Brent, Dubai/Oman and Maya) into a short-term (cycle) and long-term (trend) component in order to understand how these components are related and how they are affected by various factors; and (2) to employ the ARCH model in order to have a better understanding of how their volatility responds to inter-benchmarks' spillovers and long-term trends.