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A unit root model for trending time-series energy variables

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ABSTRACT

In this paper, we propose a GARCH-based unit root test that is flexible enough to account for; (a) trending variables, (b) two endogenous structural breaks, and (c) heteroskedastic data series. Our proposed model is applied to a range of time-series, trending, and heteroskedastic energy variables. Our two main findings are: first, the proposed trend-based GARCH unit root model outperforms a GARCH model without trend; and, second, allowing for a time trend and two endogenous structural breaks are important in practice, for doing so allows us to reject the unit root null hypothesis.

1. Introduction

Testing for the null hypothesis of a unit root in energy variables has become a popular strand of research in energy economics. Beginning with Narayan and Smyth (2007), and as a result motivated by the need for understanding the unit root nature of energy variables, the energy unit root literature has surged. A survey of this literature has been undertaken by Smyth (2013) and more recently by Smyth and Narayan (2015). From this survey, what becomes clear is that the energy unit root literature has progressed from using simple univariate unit root tests to using structural break unit root test to panel data unit root tests both with, and without, structural breaks. The success of this literature rests heavily on the econometric tests developed. This is important to recognise because the current paper belongs to this category of studies.

In this paper, we propose a new unit root model for testing the non-stationarity of energy variables. We propose a GARCH-based two endogenous structural break unit root test. Our main contribution is that we address important statistical issues that matter for unit root testing in energy variables which the literature has so far ignored. To be more specific, there are three statistical issues with which we deal. In equal order of importance, the first one is a GARCH model with a time trend. Here, we extend the GARCH unit root model for a unit root developed by Narayan and Liu (NL, 2011, 2013). The NL model does not, however, include a time trend, which can be costly in practice because a time trend if present can be a source of power to reject the unit root null hypothesis.

Almost all energy variables seem to be characterised by a time-trend yet so far no attempt has been made to account for trending energy variables in testing for a unit root. This is surprising because most energy variables we deal with, including the oil price data widely used for forecasting (see Narayan et al., 2014), have a clear upward trend. Indeed the observation that a linear deterministic trend should be accommodated in time series data and its practical relevance is nothing new; in fact, such an observation was made in a seminal paper by Phillips and Perron (1988). Diebold and Kilian (2000) argue that since most time series are characterised by a trending behaviour, failure to model the series properly (that is through including a time trend in a unit root model) will lead to bias estimation. Specifically to energy variables that we use; it is clear that energy variables are trending as can be seen from Figs. 1, 2, and 3. On the whole energy variables tend to grow over time. Several studies in energy economics show that growth

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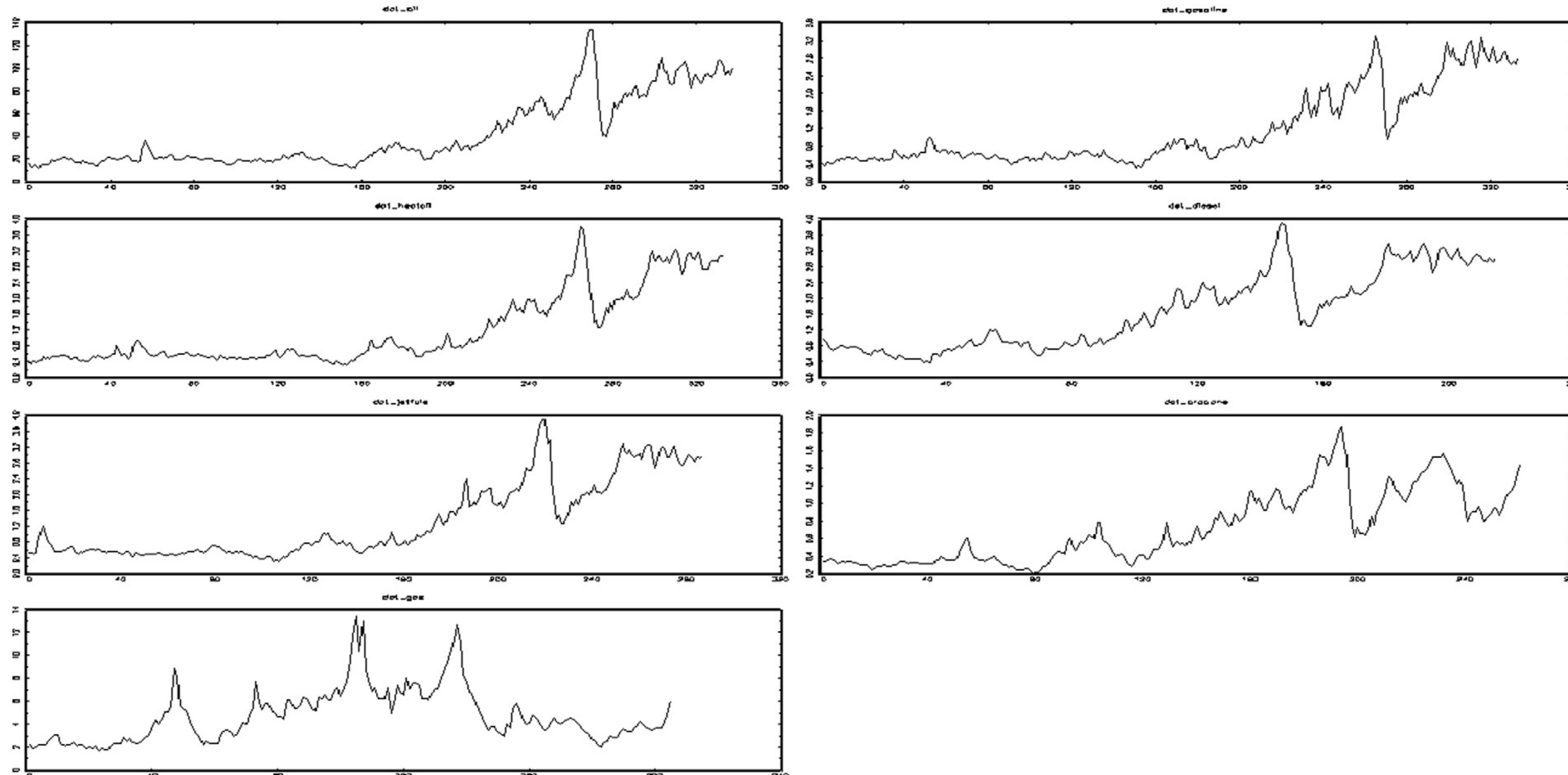

Fig. 1. A plot of monthly energy price data. This figure plots monthly data over the period 1986 to 2014 seven energy (spot) price series; namely, crude oil, gasoline, heating oil, diesel, jet fuel, propane and natural gas.