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Non-renewable resource prices: Deterministic or stochastic trends?

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Abstract

In this paper, we examine temporal properties of 11 natural resource real price series from 1870 to 1990. Recent studies by Ahrens and Sharma [Trends in natural resource commodity prices: deterministic or stochastic? J. Environ. Econom. Manage. 33(1997)59–74], Berck and Roberts [Natural resource prices: will they ever turn up? J. Environ. Econom. Manage. 31(1996)65–78], and Slade [Grade selection under uncertainty: least cost last and other anomalies, J. Environ. Econom. Manage. 15(1988)189–205], among others, find that many non-renewable resource prices have a stochastic trend. We revisit this issue by employing a Lagrangian multiplier unit root test that allows for two endogenously determined structural breaks with and without a quadratic trend. Contrary to previous research, we find evidence against the unit root hypothesis for all price series. Our findings support characterizing natural resource prices as stationary around deterministic trends with structural breaks. We additionally show that both pre-testing for unit roots with breaks and allowing for breaks in the forecast model can improve forecast accuracy. Overall, the results in this paper are important in both a positive and normative sense; without an appropriate understanding of the dynamics of a time series, empirical verification of theories, forecasting, and proper inference are potentially fruitless.

JEL classification: Q31; C12; C53

Keywords: Commodity prices; Structural breaks; Unit root test; Forecasting

1. Introduction

An important literature has developed recently that empirically examines non-renewable natural resource price paths and investigates whether they are trend- or difference-stationary. For example, Ahrens and Sharma [2] use annual data on 11 commodity price series ranging from 1870 to 1990 and conclude that six of these series are stationary around a deterministic trend, while the remaining five display stochastic trends implying a unit root. In a related paper, Berck and Roberts [5] use a subset of the same data and find

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overwhelming support for non-stationary unit roots. Slade [32] and Abgeyegbe [1], among others, find similar overwhelming support for non-stationary natural resource prices. A consistent theme across much of this literature is that most natural resource prices are non-stationary.

Our motivation in this paper is to further the boundaries of econometric methodologies and provide new insights into natural resource price time paths. Previous empirical work on natural resource prices typically neglects possible structural change in the time series. Since the seminal work of Perron [25], it is well known that ignoring structural change in unit root tests will lead to a bias against rejecting the unit root null hypothesis when it should in fact be rejected (e.g., see also [3]). In this study, we advance the literature on time paths of natural resource prices by endogenously determining structural breaks and extending the two-break Lagrangian multiplier (LM) unit root test of Lee and Strazicich [16] to include a quadratic trend. Given that a quadratic trend might exist in some natural resource price series we believe that allowing for a quadratic trend in conjunction with structural breaks may provide additional insights.

Understanding the nature of resource price time paths is important for several reasons. Theoretically speaking, Ahrens and Sharma [2, p. 61], for example, note that in regards to both a simple and more general Hotelling [11] model as described in Slade [32], ‘‘price movement is still systematic and may be modeled appropriately as a deterministic trend.’’ In contrast, in a world with uncertainty ‘‘in which speculative motives drive the behavior of extracting firms or unanticipated events largely characterize the market, resource prices may be generated by a random walk process’’ [2, pp. 61–62]. Thus, knowing the correct time series behavior of natural resource prices can be vital to distinguish among theories that most accurately describe observed behavior.

Knowledge of the time series properties of natural resource prices is also important for proper econometric estimation. For example, Ahrens and Sharma [2] and Labson and Crompton [14] note that conventional regression analysis and hypothesis testing cannot be correctly undertaken without first understanding characteristics of the time series. Otherwise, results from estimating regression models may be rendered invalid. Several additional examples can be found in the literature (see, e.g., [9]).

Finally, given that good policymaking typically depends on sound economic forecasts, appropriately modeling the nature of the time series can be invaluable to forecasters [8]. This task recently came to hand in Berck and Roberts [5], who did not consider structural breaks. They found that each commodity price series had a unit root and hence initially paid more credence to their ARIMA forecasts. Berck and Roberts [5], however, found that their ARMA forecasts outperformed their ARIMA counterparts. In the later part of our paper, we investigate whether pre-testing for unit roots with structural change can help to identify the most accurate forecasting model. This question has not been previously examined in the literature.

Our investigation begins by examining annual data comprised of 11 fuel and metal real price series ranging from 1870 to 1990.[1] After including structural breaks, we find evidence *against* a unit root in each of the 11 series. We then estimate different forecasting models and find that ARMA models with breaks generally outperform ARIMA models with breaks, which is consistent with our pre-test expectations. These results help to solve the puzzling results noted by Berck and Roberts [5], and demonstrate the importance of considering structural breaks in economic forecasting. A second major finding is that our unit root test results are robust-with or without quadratic trends natural resource prices are stationary around deterministic trends with two structural breaks in intercept and trend slope. Thus, while nonlinear time trends are important in certain price series, rejection of the underlying unit root hypothesis and support for trend-break stationary price series does not depend on inclusion of such trends. Finally, we find that both pre-testing for unit roots and including structural breaks can improve the accuracy of forecasting natural resource prices.

The remainder of the paper is structured as follows. Section 2 provides a brief background on unit root tests and further describes the importance of understanding the time-series properties of exhaustible resource prices. Section 3 describes our empirical methodologies. Section 4 presents our empirical results. In Section 5, we examine how structural breaks affect the accuracy of forecasts. Section 6 concludes.

[1]This data was utilized to most accurately compare our empirical findings to the previous works. In Section 5, we estimate a variety of forecasting models with updated data through 2002.