Computational Statistics and Data Analysis ▮ (▮▮▮▮) ▮▮▮–▮▮▮

Contents lists available at SciVerse ScienceDirect

Computational Statistics and Data Analysis

journal homepage: www.elsevier.com/locate/csda

Testing for persistence change in fractionally integrated models: An application to world inflation rates

Luis F. Martins [a,b], Paulo M.M. Rodrigues [c,d,*]

[a] *ISCTE-LUI, Business School, Portugal*

[b] *UNIDE, Portugal*

[c] *Banco de Portugal, Universidade Nova de Lisboa, Portugal*

[d] *CEFAGE, Portugal*

ARTICLE INFO

Article history:
Received 15 December 2011
Received in revised form 18 July 2012
Accepted 21 July 2012
Available online xxxx

Keywords:
LM tests
Nonstationarity
Fractional integration
Persistence change
Inflation

ABSTRACT

A new approach to detect persistence change in fractionally integrated models based on recursive forward and backward estimation of regression-based Lagrange Multiplier tests is proposed. This procedure generalizes approaches for conventional integrated processes to the fractional integration context. Asymptotic results are derived and the performance of the new tests evaluated in a Monte Carlo exercise. In particular, analytical and simulation results are provided for cases where the order of fractional integration is both known and unknown and needs to be estimated. The finite sample size and power performance of the statistics are encouraging and compare favorably to other recently proposed tests in the literature. The test statistics introduced are also applied to several world inflation rates and evidence of persistence change is found in most series.

1. Introduction

Testing for the presence of unit roots is now routine practice in empirical research given the different statistical and economic implications of classifying a series as stationary or nonstationary. Establishing this distinction is meaningful in understanding the effects of shocks on economic and financial variables. While the impact of shocks is transitory for stationary series, for nonstationary cases random shocks have persistent effects. In other words, while a stationary time series displays mean-reverting behavior, a nonstationary variable displays persistent behavior, *i.e.*, shocks will have long lasting effects, thus preventing the series from returning to any defined level.

In recent years a vast literature documenting changes in the historical behavior of economic time series has been put forward; see, for instance, McConnell and Perez-Quiros (2000), Herrera and Pesavento (2005), Cecchetti et al. (2006), Caporale and Gil-Alana (2008), Kang et al. (2009) and Halunga et al. (2009), Chen et al. (2012), among others. It has been observed that macroeconomic variables may display changes in persistence within a specific period. Indeed, some series appear to switch from $I(0)$ to $I(1)$ behavior, or vice-versa. One class of tests resulting from this context focused on inferring whether a stationary ($I(0)$) or a nonstationary ($I(1)$) series had changed its persistence over time to $I(1)$ or $I(0)$, respectively; see, *inter alia*, Kim (2000), Kim et al. (2002), Busetti and Taylor (2004), Harvey et al. (2006) and Davidson and Monticini (2010).

* Correspondence to: Banco de Portugal, Economics and Research Department, Av. Almirante Reis, 71-6th floor, 1150-012 Lisbon, Portugal. Tel.: +351 213130831; fax: +351 213128114.

E-mail addresses: luis.martins@iscte.pt (L.F. Martins), pmrodrigues@bportugal.pt (P.M.M. Rodrigues).

0167-9473/$ – see front matter
doi:10.1016/j.csda.2012.07.021

This paper proposes test procedures capable of detecting changes in the order of integration of a fractionally integrated process. This hypothesis has already been addressed in the literature. For instance, Beran and Terrin (1996, 1999) proposed a test procedure that builds on the difference of nonoverlapping subsamples where the orders of integration in each subsample are parametrically estimated. Related results in a nonparametric setting and results on change point detection in the marginal distribution can be found in Giriatis and Leipus (1994).

In recent work, Hassler and Scheithauer (2011) evaluate the tests proposed by Kim (2000), Kim et al. (2002) and Busetti and Taylor (2004) for the null hypothesis of short-memory against a change to nonstationarity, $I(1)$, and show that these tests are also adequate to test for changes from $\mathrm{I}(d_0)$, $d_0 = 0$, to $I(d)$, $d > 0$ (long-memory). However, considering $I(0)$ as the null hypothesis may be restrictive as one may want to consider for the null hypothesis an order of integration different from zero and not necessarily an integer. In the Monte Carlo section below we show that the tests considered in Hassler and Scheithauer (2011) also present an adequate finite sample performance when $d_0 \neq 0$.

A further development was proposed by Sibbertsen and Kruse (2009) who follow Leybourne et al. LTK (2007). They adapt their CUSUM of squares-based test statistics, computed from forward and reverse evaluation of time series, to the context of long range dependence, and show that the break point estimator proposed by LTK is consistent under long memory although at a slower rate of convergence (which depends on d). Sibbertsen and Kruse (2009) observe that the LTK procedure suffers from serious size distortions if the DGP has a long memory and therefore provides new critical values, appropriate for the $I(d)$ framework, which depend on the memory parameter d.

Hassler and Meller (2011) introduced a test procedure that builds on the regression-based Lagrange Multiplier [LM] test of Demetrescu et al. (2008). In particular, they use dummy variables in the test regression with the objective of accounting for possible breaks in long-memory. The procedure consists of the comparison of the maximum of a sequence of F-statistics to critical values in Bai and Perron (1998, 2003) and Andrews (1993). Hassler and Meller (2011) show, through Monte Carlo simulations, that this procedure presents good finite sample performance.

In this paper, a new method to detect persistence change in fractionally integrated models is proposed based on recursive forward and reverse estimation of the Breitung and Hassler (2002) test, in the spirit of the approach of Leybourne et al. LKSN (2003). Asymptotic results are derived and the performance of the new procedures are evaluated in a Monte Carlo exercise. In particular, special attention is devoted to the case of d unknown, for which few results exist in the literature. The finite sample size and power performance of the procedures are encouraging and compare favorably to the tests proposed by Hassler and Scheithauer (2011) and Sibbertsen and Kruse (2009). The performance of the test together with its simplicity of application make it an interesting approach for empirical analysis. We apply the new test statistics to several world inflation rates and find evidence of persistence change for most series, in particular, a change from $d = 1$ to $d < 1$ is generally observed.

This paper is organized as follows. Section 2 introduces the new procedures, their limit distributions and local power functions. Section 3 discusses the finite sample properties of the test statistics and Section 4 presents an empirical application which investigates persistence change in inflation series. Finally, Section 5 concludes the paper and an Appendix collects the proofs.

2. Fractional persistence change

Consider data generated from a fractionally integrated process of order d_t, such that,

$$(1-L)^{d_t} y_t = \varepsilon_t, \tag{1}$$

where $y_t = 0$ for $t \leq 0$, and ε_t satisfies a set of assumptions that will be discussed below. Under the null hypothesis we assume that the fractional integration parameter d_t is constant over the sample, *i.e.*, $d_t = d_0$. However, under the alternative, considering two fractional integration parameters, such that d_0 corresponds to the first subsample and d_1 to the second, two situations are considered: (i) a decrease in persistence ($d_0 > d_1$), which is denoted as H_{01} and (ii) an increase in persistence ($d_0 < d_1$), which is denoted as H_{10}. Under both alternatives the change in persistence occurs at time $[\tau^* T]$, with τ^* unknown in $[\Lambda_l, \Lambda_u] \subset (0, 1)$ and $\Lambda_u = 1 - \Lambda_l$.

In terms of the assumptions underlying ε_t in (1) we consider the following:

Assumptions.

($\mathcal{A}$.1) The innovation process $\{\varepsilon_t\}$ is independent and identically distributed with $E\left(\varepsilon_t^2\right) = \sigma^2 < \infty$ and $E\left(|\varepsilon_t^4|^{1+r}\right)$ bounded for some $r > 0$.

($\mathcal{A}$.2) The innovation process satisfies $a(L)\varepsilon_t = v_t$, where $a(L) = 1 - \sum_j^p a_j L^j$, $p \geq 0$, such that $a(z)$ has all its roots outside the unit circle and v_t satisfies Assumption $\mathcal{A}$.1.

Assumption $\mathcal{A}$.1 can be weakened by requiring that, conditional on the σ-field of events, moments up to the fourth-order (and suitable cross-products of elements of ε_t) equal the corresponding unconditional moments, so that $\{\varepsilon_t\}$ is only required to behave as an i.i.d. process up to the fourth-order moment; see, for instance, Hassler et al. (2009).

In our analysis we will also relax Assumption $\mathcal{A}$.1 by allowing for stationary AR(p) dynamics in the DGP as indicated in Assumption $\mathcal{A}$.2. For practical purposes, the short-run dynamics may be characterized by a stationary and invertible linear