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Fractional Integration and the Persistence of UK Inflation, 1210–2016*

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This note examines the degree of persistence of UK inflation by applying fractional integration methods to historical data spanning the period 1210–2016; the chosen approach is more general than the popular ARMA models based on the classical I(0) vs. I(1) dichotomy. The full-sample results do not suggest that UK inflation is a persistent process; however, the recursive analysis indicates an increase in the degree of persistence in the 16th century and more recently after WWI and in the last quarter of the 20th century. On the whole, monetary and exchange rate regime changes do not appear to have had a significant impact on the stochastic behaviour of inflation if one takes a long-run, historical perspective.

Keywords: UK inflation, persistence, fractional integration.

1. Introduction

Inflation persistence is an important issue for both academics and central banks. The former is interested in understanding whether or not it can be deemed to be structural in the sense of Lucas (1976); for instance, Benati (2008) estimates AR models for a long span of UK data (from 1718 to 2006) to compare the relevance of reduced form and structural New-Keynesian models, respectively, and finds that the evidence does not support a structural interpretation of persistence. Central banks have a preference for low persistence as this reduces the output costs of disinflation; price and wage rigidities as well as the lack of transparency about monetary policy objectives instead tend to increase the degree of persistence (see Gali & Gertler, 1999, and Walsh, 2007).

Various empirical studies have analysed inflation persistence using different approaches; ARMA models are the most common (for the UK see, e.g. see Osborn & Sensier, 2009). A notable exception is a recent contribution by Caporale *et al.* (2018), who use long-memory methods based on fractional integration to measure persistence of UK inflation over the period 1660–2016 and find that it has been relatively stable since the end of WWI despite the adoption of different monetary regimes. The advantage of adopting such a framework is that it does not require imposing the assumption of a unit

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root or a simple AR process; it is therefore much more general in comparison with the popular ARMA modelling approach and allows for a variety of possible stochastic behaviours. The present note follows on from that paper; it also uses fractional integration techniques, but it extends the analysis by measuring persistence over a much longer sample going back to 1210; in addition, it applies recursive methods to capture the possibly gradual evolution of persistence over time.

The remainder of this note is organised as follows. Section 2 describes the empirical model. Section 3 discusses the data and the empirical findings. Section 4 offers some concluding remarks.

2. Econometric Framework

The estimated model is the following:

$$y_t = \alpha + \beta t + x_t, \quad (1-L)^d x_t = u_t, \quad t = 1, 2, \ldots, T, \tag{1}$$

where y_t stands for the rate of inflation, α and β are unknown coefficients corresponding, respectively, to the intercept and a linear time trend, the de-trended series x_t and the error u_t are assumed to be I (d) and I(0), respectively, and the differencing parameter, d, is unknown and to be estimated together with α and β.

We assume the errors to be uncorrelated (white noise) and autocorrelated (Bloomfield, 1973) in turn and consider three different specifications of the model: (i) without deterministic terms, setting $\alpha = \beta = 0$ *a priori*, in Equation (1); (ii) with an intercept, with α being unknown and $\beta = 0$ *a priori*; and (iii) with a linear time trend, with α and β in Equation (1) both being unknown and estimated from the data.

The process y_t is stationary if $d < 0.5$; by contrast, for $d \geq 0.5$, it is not covariance stationary and is highly persistent; further, it is mean-reverting if $d < 1$. The parameter d is a measure of persistence and is estimated here following the Whittle parametric procedure also adopted by Robinson (1994) in the frequency domain (Dahlhaus, 1989); this approach is the most efficient in the Pitman sense against local departures, and, unlike other methods, it remains valid even in non-stationary contexts ($d \geq 0.5$).

In addition to the full-sample analysis, we also estimate d recursively, starting with a window of 90 years and then adding one more observation at a time.

3. Data and Empirical Results

The series examined is annual headline CPI inflation; the source is the Bank of England's historical macroeconomic dataset ("a millennium of macroeconomic data," version 3.1); the sample period goes from 1210 to 2016 (see Broadberry *et al.*, 2015, for useful background information about the British

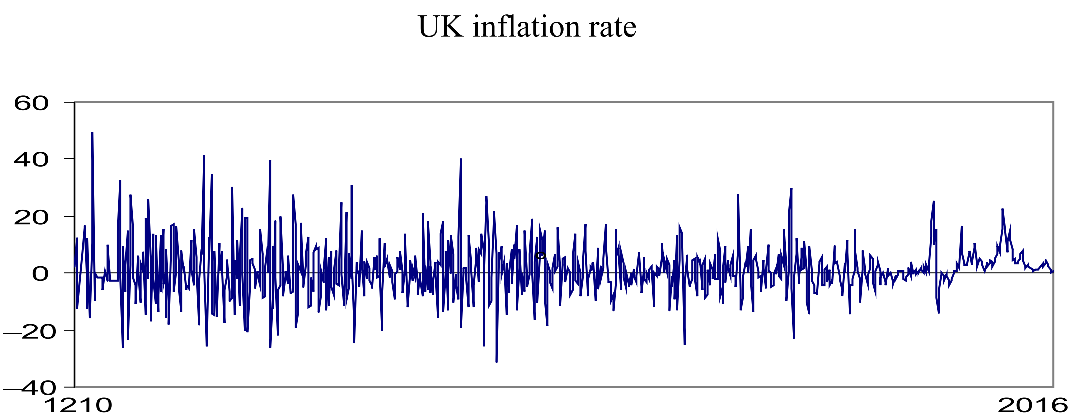

Figure 1. *Time-series plot [Colour figure can be viewed at wileyonlinelibrary.com]*

Table 1. *Estimates of d for the UK inflation rate*

No regressors	An intercept	A linear time trend
i) White noise errors		
−0.03 (−0.07, 0.03)	−0.03 (−0.07, 0.03)	−0.04 (−0.08, 0.02)
ii) Autocorrelated errors		
−0.14 (−0.18, −0.09)	−0.14 (−0.18, −0.09)	−0.15 (−0.20, −0.10)

Table 2. *Estimated coefficients*

d	Intercept	Linear time trend
i) White noise errors		
−0.04 (−0.08, 0.02)	0.4211 (2.78)	0.0021 (1.86)
ii) Autocorrelated errors		
−0.15 (−0.20, 0.10)	0.4468 (2.52)	0.0019 (2.98)

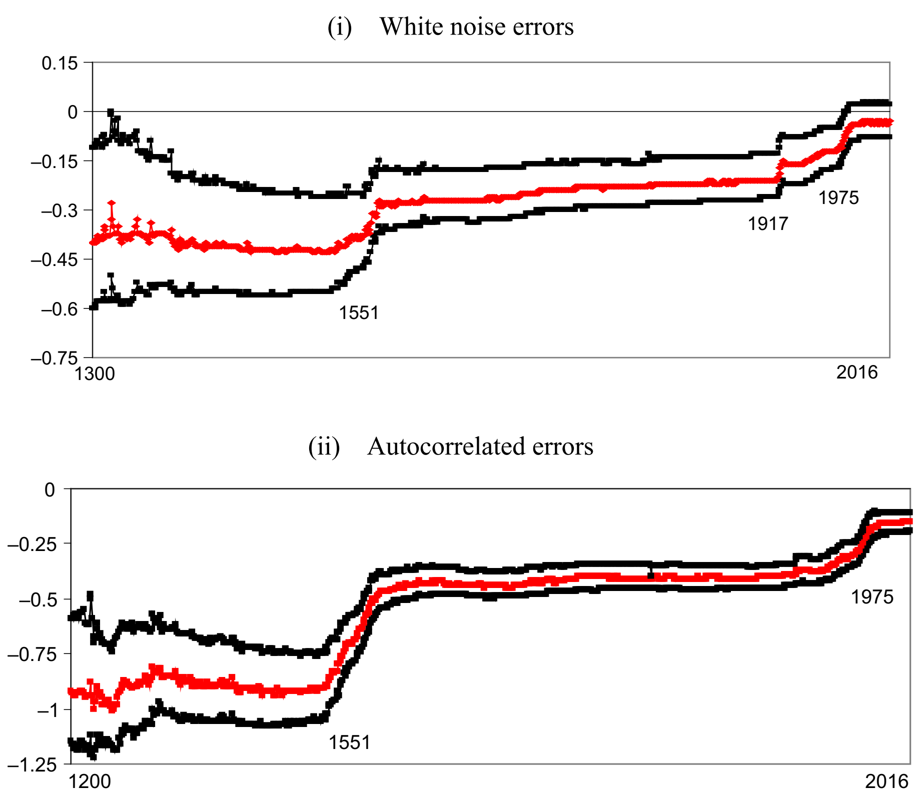

Figure 2. *Recursive estimates of d. The red lines are the estimates of d whilst the black ones represent the 95% confidence intervals [Colour figure can be viewed at wileyonlinelibrary.com]*

economy during the period from 1270 to 1870). Figure 1 plots the data. It is noticeable that volatility is much higher over the first few centuries of data, measurement errors being a possible reason; such issues have been highlighted for other series spanning long time periods: for instance, Romer (1986a, 1986b) shows how excess volatility results from errors in the construction of the series in the case of the US industrial production, unemployment and GNP.

Table 1 reports the estimates of d for the different specifications considered. The model selected on the basis of the statistical significance of the estimated parameters is the one with an intercept only, regardless of whether the residuals are assumed to be a white noise or an autocorrelated process. The estimated values of d are -0.04 and -0.15 in those two cases, respectively. With white noise residuals, the I(0) hypothesis cannot be rejected, whilst d is significantly below 0 under the assumption of autocorrelation; the lower estimates in the latter case reflect the competition between the fractional parameter and the autocorrelation structure in describing the degree of dependence of the data; therefore, more weight should be given to the white noise results, which suggest that over the sample as a whole UK inflation cannot be characterised as a persistent process. In terms of the price level, the implication of these results is that the I(1) hypothesis cannot be rejected with white noise residuals, whereas it is rejected in favour of mean reversion (I(d) with $d < 1$) with autocorrelated ones. Table 2 reports the other estimated coefficients.

The recursive estimates of d starting with a window for the period 1210–1300 and then increasing its size by one observation at a time are shown in Figure 2, together with the corresponding confidence intervals, again under the alternative assumptions of white noise and autocorrelated errors. The results are very similar in those two cases: there is a significant increase in the degree of persistence in the middle of the 16th century (1551), which is more marked with autocorrelated disturbances; further slight increases can be observed around 1917 and 1975; persistence then remains stable.

4. Conclusions

This note has provided new evidence on the degree of persistence of UK inflation by applying long-memory methods to analyse a much longer span of data than in previous studies, more specifically the period going from 1210 to 2016. The approach used is preferable to the standard ARMA framework based on the classical dichotomy between the I(0) non-stationary and I(1) stationary cases, since it allows the differencing parameter to take fractional values and thus captures a much wider range of stochastic behaviours. In addition, the classical methods have very low power if the alternatives are in fact fractional.

The full-sample results do not suggest that UK inflation is a persistent process; however, the recursive analysis indicates an increase in the degree of persistence in the 16th century and more recently after WWI and in the last quarter of the 20th century. The evidence for the latter part of the sample is consistent with the findings of Caporale *et al.* (2018), who had also reported that the main change in the behaviour of persistence in recent times had occurred after WWI. On the whole, in contrast to some previous studies (e.g. Chouliarakis *et al.*, 2016), we find no evidence that monetary and exchange rate regime changes have had a significant impact on the stochastic behaviour of inflation if one takes a long-run, historical perspective.

Conflict of Interest

Neither author has any conflict of interest.

Author Contribution

Professor Guglielmo Maria Caporale has contributed with the introduction, methodology, interpretation of the results and conclusions sections. Professor Luis A. Gil-Alana has contributed with the data, the methodology, the empirical results and their interpretation.

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