Persistence, Mean Reversion and Nonlinearities in Inflation Rates of Developed and Developing Countries Using Over One Century of Data

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Abstract

This study examines inflation over one century of data for 29 countries based on fractional integration incorporating nonlinearities to account for structural breaks and asymmetry in the process of inflation. The results suggest that the degree of persistence is that, while there is evidence of long-memory behavior in the inflation rates of 17 countries, barring Russia, none of the remaining 28 countries indicate evidence of unit roots. The result implies that monetary authorities in these countries can play a role in controlling inflation, though the extent of intervention required will tend to vary, with the strongest being in Russia.

JEL classification: C22; E31.
Keywords: Inflation; developed and developing countries; long span annual data; long memory; nonlinearity.

1 Introduction

The persistence property of inflation is an important issue not only for central bankers but also for economists, since at the theoretical level, inflation persistence is associated with the theory of inflationary expectations and nominal anchors. New-Keynesian dynamic stochastic general equilibrium models that incorporate lags of inflation in the New-Keynesian Phillips curve identify inflationary expectations as the main determinant of inflation persistence, and hence, suggests that inflation persistence may decline through enhanced anchoring of inflation expectations. Hence, an accurate estimate of inflation persistence will help us understand to what extent these macroeconomic models are consistent with the empirical evidence (Antonakakis *et al.*, 2016). The degree of inflation persistence determines the extent to which central banks can control inflation, as it measures the speed at which the inflation rate returns to its equilibrium level after an inflationary shock (Boubaker *et al.*, 2017). Thus, speaking statistically, it is

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important to determine whether inflation is a random walk (i.e. an $I(1)$ process) or it is a stationary $I(0)$ process. Note that in the former scenario, central banks need to continuously reverse inflationary shocks even their own ones, since the shocks will have a permanent nature, but in the latter case, inflation reverts to its equilibrium level rapidly after a shock occurs, and hence, the response to the inflationary shock may not require an active monetary policy. As a consequence, the optimal timing and size of monetary policy crucially depend on the knowledge of how shocks affect the dynamics of inflation, i.e. its degree of persistence.

In light of the importance of accurately gauging the persistence of inflation, understandably, a voluminous literature exists (and is still growing) that analyses the inflation persistence property of world economies—developed and developing (see e.g. Balcilar *et al.*, 2016; Caporin and Gupta, 2016; Gil-Alana *et al.*, 2016 for detailed literature reviews). Though various approaches (e.g. unit root tests, state-space-based time-varying autoregressive models, and more recently, quantile regressions) have been used to analyze the degree of inflation persistence (as discussed in detail in Martins and Rodrigues, 2014; Plakandaras *et al.*, 2015; Gupta *et al.*, 2016), autoregressive fractionally integrated moving average models is, perhaps, the most popular approach (Caporin and Gupta, 2016). This is simply because of the fact that the model nests the unit root and stationarity properties of the data given its generalized form, and provides an exact estimate of the degree of persistence.

However, despite the vast literature directed towards estimating the integration order or persistence of inflation, the results are not yet conclusive (Antonakakis *et al.*, 2016), and hence, provides the motivation to our paper. In this study, we take a long memory approach to estimate the persistence of inflation based on long spans (over a century) of data for a set of twenty-nine developed and developing countries, in an attempt to track the historical evolution of their inflation rates to date as far back in time as information is available. It is well-known that long memory models tend to overestimate the degree of persistence of the series in the presence of structural breaks (see e.g. Ben Nasr *et al.*, 2014 for a detailed discussion in this regard), which are very likely in our case as it covers long samples of data, with countries going through various monetary policy regimes and some countries also witnessing hyperinflationary episodes. Given this, we extend the standard long memory model to accommodate for nonlinearity as in Cuestas and Gil-Alana (2016), i.e. through the use of Chebyshev polynomials, which, in turn, are cosine functions of time. This approach has primarily two advantages: First, from a technical point of view, since we are using low-frequency data, structural breaks should ideally be modeled in a smooth rather than an abrupt fashion. And second, from a theoretical perspective, inflation is intrinsically considered to be a nonlinear process (Cuestas and Harrison, 2010; Chang *et al.*, 2013; Álvarez-Díaz and Gupta, 2016). This is not only due to prices being downward rigid (e.g. due to menu costs Ball and Mankiw, 1994), but also due to varied speed of adjustment toward the equilibrium contingent on the magnitude of the deviation of the current inflation rate from the equilibrium value (Arize and Malindretos, 2012; Zhou, 2013).

To the best of our knowledge, this is the first attempt to analyze inflation persistence of both developed and developing countries using a long-memory approach that accounts for nonlinearity, and hence, allows us to provide credible estimates of inflation persistence by studying the historical evolution of inflation in these economies. The remainder of the paper is organized as follows: Section 2 presents the methodology, while Section 3 discusses the data and results, with Section 4 concluding the paper.

2 Methodology

We use an approach developed by Cuestas and Gil-Alana (2016) that allows us to test the degree of persistence of the series throughout the fractional differencing parameter, and including at the same time nonlinear deterministic trends of the form of Chebyshev polynomials in time. In particular, the specific model to be examined is the following:

$$y_t = \sum_{i=0}^{m} \theta_i P_{iT}(t) + x_t, \quad (1 - L)^d x_t = u_t, \quad t = 1, 2, \ldots, \tag{1}$$

where y_t is the observed (univariate) time series, in our case, the inflation rate for each country; d is the fractionally differencing parameter, indicating the degree of persistence of the series; u_t is an $I(0)$ process; and P_{iT} are the Chebyshev time polynomials defined by:

$$P_{0,T}(t) = 1, \; P_{i,T}(t) = \sqrt{2}\cos\left(i\pi(t - 0.5)/T\right),$$
$$t = 1, 2, \ldots, T; \quad i = 1, 2, \ldots,$$

where m indicates the degree on nonlinearity. A detailed description of these polynomials can be found in Hamming (1973) and Smyth (1998) and Bierens (1997) and Tomasevic and Stanivuk (2009) argue that it is possible to approximate highly nonlinear trends with rather low degree polynomials. In this context, if $m = 0$ the model contains an intercept, if $m = 1$ it adds a linear trend, and if $m > 1$ the model becomes nonlinear, and the higher m is the less linear the approximated deterministic component becomes. In this paper, to allow for some degree of generalization, we take $m = 3$, and the data will contain nonlinear structures if θ_2 and/or θ_3 are statistically significant. Also, note that the interaction of the two equalities in equation (1) produces a single (linear) equation of the form:

$$y_t^* = \sum_{i=0}^{m} \theta_i P_{i,T}^*(t) + u_t, \qquad t = 1, 2, \ldots,$$

where $y_t^* = (1 - L)^d y_t$; and $P_{i,T}^*(t) = (1 - L)^d P_{i,T}(t)$, and therefore, the θ-coefficients can be consistently estimated by standard OLS methods. For more details, see Cuestas and Gil-Alana (2016).

3 Data and Results

Our data consists of annual inflation rates for 29 developed and developing countries, with the variable sourced from Jordà *et al*. (2017) (available for download at: http://www.macrohistory.net/data/) for the period 1871–2013, primarily for the developed countries, with the data updated till 2016 from the macroeconomic indicators database of the Organisation for Economic Co-operation and Development (OECD). Except for Russia and South Africa, Data for the developing economies till 2010 are derived from Eberhardt (forthcoming) (with the data available for download from: https://sites.google.com/site/medevecon/publications-and-working-papers). Data for Russia and South Africa comes from the Global Financial Database. Again, we updated the data updated till 2016 using the OECD's macroeconomic indicators database, and International Financial Statistics of the International Monetary Fund. Data prior to 1871 is obtained from https://www.measuringworth.com/for the UK, website of Professor Scott James (http://www.sscnet.ucla.edu/polisci/faculty/james/) for the United States, and Eberhardt (forthcoming) for the other countries. The countries considered and their corresponding sample periods (specified in the parentheses) are: Argentina (1800–2016); Australia (1819–2016); Austria (1800–2016); Belgium (1800–2016); Brazil (1800–2016); Canada (1868–2016); Chile (1800–2016); Colombia (1863–2016); Denmark (1816–2016); Finland (1871–2016); France (1800–2016); Germany (1800–2016); Greece (1834–2016); India (1819–2016); Italy (1800–2016); Japan (1819–2016); The Netherlands (1800–2016); New Zealand (1857–2016); Norway (1800–2016); Peru (1800–2016); Portugal (1800–2016); Russia (1917–2016); South Africa (1896–2016); Spain (1800–2016); Sweden (1800–2016); Switzerland (1851–2016); UK (1210–2016); US (1666–2016) and Uruguay (1871–2016). Note, the choice of these countries is based on data availability of inflation rates for over at least a century for each of the economies considered. The inflation rates for these 29 countries have been plotted in Fig. 1.

We estimate model in equation (1) based on autocorrelated errors using the exponential spectral model of Bloomfield (1973). This is a nonparametric way of approximating highly parameterized ARMA structures. The

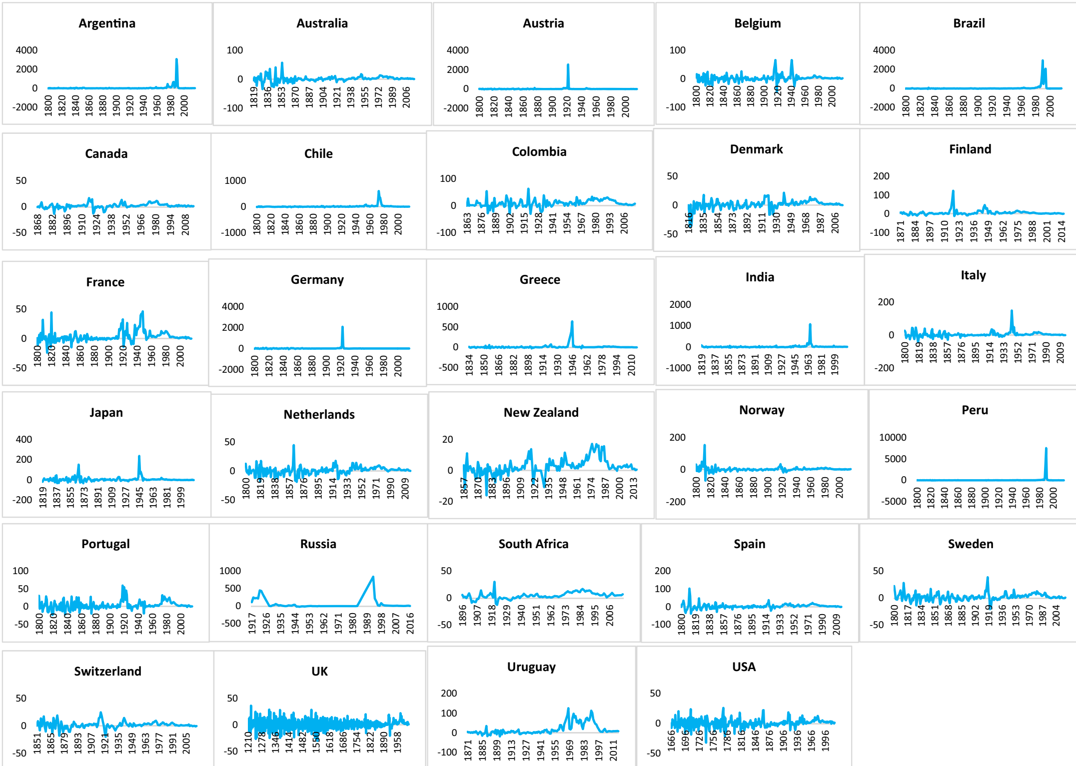

Fig 1. Plots of Inflation Rates

results are presented in Table 1.[1] Starting with the developed countries, we observe evidence of nonlinearity in many countries. Both, θ_2 and θ_3 are statistically significant in the cases of Belgium, Germany, Spain, Sweden and the UK, and one of the two is statistically significant in Austria, Finland, France, Italy, Japan, Netherlands, Norway, Switzerland and the United States. Focusing now on the degree of persistence, we can distinguish two main groups: (i) those showing evidence of antipersistence (i.e. $d < 0$) or short memory (i.e. $d = 0$) behavior, which happens to be Australia, Austria, Belgium, Canada, Norway, the UK and the United States; and (ii) the remaining thirteen countries showing statistical evidence of persistence and long memory patterns ($d > 0$), namely, The Netherlands (0.10), Germany (0.12), Spain (0.20), Denmark (0.22), Japan (0.27), Portugal (0.29), Switzerland and France (0.31), Finland (0.35), Italy (0.36), New Zealand (0.38), Sweden (0.40) and Greece (0.53). For the developing countries, significant non-linear coefficients (θ_2 and θ_3) are observed in Argentina and Peru, and θ_3 is also statistically significant in Colombia, India, Russia, South Africa and Uruguay. Evidence of antipersistence is found in Argentina; short memory or $I(0)$ behavior for Colombia, India, Peru and South Africa, and long memory with strong persistence for Brazil (0.28), Chile (0.30), Uruguay (0.38) and Russia (0.70). In fact for Russia, the null of unit root cannot be rejected, though the precision of the estimate for the long-memory parameter is weak as indicated by the large width of the confidence interval (0.29, 1.27).[2] More importantly, whether developed or developing, barring the case of Russia, there is no evidence of the inflation rate being nonstationary $I(1)$ in any single case.[3]

Given the long span of the database, an important question that arises is how do the estimates of the long-memory parameter behave across monetary regimes within a country? Ideally, to answer this question, we would need to

[1]We also estimated the model without nonlinearity, and with and without autocorrelated errors, but the fit of the model was better with nonlinearity and autocorrelation in errors. Diagnostic tests were conducted on the estimated errors. In particular, we use tests of no serial correlation (Durbin, 1970; Godfrey, 1978a, 1978b), homoscedasticity (Koenker, 1981) and functional form (Ramsey, 1969) and the results support the specification displayed in Table 1. Complete details of these results are available on request from the authors.

[2]Based on the suggestions of an anonymous referee, we also estimated the persistence parameter using a linear ARFIMA model, and across various bandwidths under a semiparametric Whittle framework. In both these cases, the estimates of the long-memory parameter were higher than those reported in Table 1, indicating the possibility of spurious long-memory picked up by these models as they failed to account for structural breaks in particular, unlike our current approach, which does so via the usage of Chebyshev polynomials. Complete details of these results are available on request from the authors.

[3]Interestingly, the Augmented Dickey–Fuller (Dickey and Fuller, 1979) unit root tests, results of which are available on request from the authors, also indicated that, barring the case of Russia, all other inflation rates are stationary. But long-memory models are preferred in terms of analyzing persistence since the $I(d)$ model nests the unit root $I(1)$ and $I(0)$ stationarity properties of the data given its generalized form, and provides an exact estimate of the degree of persistence. In other words, long-memory models, unlike unit root tests, also allows us to analyse stationarity with short- and long-memories, which clearly have implications in terms of the size of monetary policy intervention.

Table 1. Estimates of Long-Memory Parameter (d) in a Nonlinear Framework Under Autocorrelation

Country	*d*	θ_0	θ_1	θ_2	θ_3
Developed countries					
Australia	−0.39 (−0.62, −0.06)	**2.1779 (17.87)**	**−2.1356 (−11.47)**	0.2847 (1.30)	**0.7485 (3.02)**
Austria	−0.02 (−0.21, 0.21)	**10.6622 (1.76)**	−5.0084 (−0.46)	**−20.2968 (−1.85)**	12.7447 (1.16)
Belgium	−0.27 (−0.46, 0.00)	**2.7238 (11.61)**	**−1.5534 (−4.83)**	**−1.0466 (−2.90)**	**1.4866 (3.78)**
Canada	0.08 (−0.12, 0.36)	**2.1781 (4.51)**	**−1.2790 (−2.92)**	−0.4955 (−1.17)	0.5716 (1.38)
Denmark	0.22 (0.04, 0.44)	**1.1145 (1.64)**	**−2.7436 (−2.72)**	−1.1394 (−1.24)	−0.0142 (−0.01)
Finland	0.35 (0.20, 0.54)	**5.4607 (8.16)**	−0.5742 (−0.74)	**−3.4815 (−4.27)**	−0.5264 (−0.62)
France	0.31 (0.21, 0.43)	**3.6245 (1.68)**	**−2.5721 (−1.67)**	−1.3704 (−1.00)	**2.8351 (2.28)**
Germany	0.12 (0.01, 0.26)	**14.7057 (2.68)**	−3.3227 (−0.52)	**−16.2243 (−2.43)**	**10.9544 (1.68)**
Greece	0.53 (0.39, 0.69)	**15.1521 (1.85)**	−6.9150 (−0.76)	−11.2824 (−1.37)	11.2215 (1.48)
Italy	0.36 (0.22, 0.56)	**4.7208 (12.50)**	**−2.7990 (−5.99)**	−0.7316 (−1.31)	**3.1372 (5.23)**
Japan	0.27 (0.15, 0.42)	**6.5178 (3.44)**	−0.2422 (−0.13)	−2.2816 (−1.24)	**3.2284 (1.77)**
Netherlands	0.10 (0.02, 0.24)	**1.2070 (5.05)**	**−1.8207 (−6.51)**	0.0451 (0.15)	**0.8141 (2.63)**
New Zealand	0.38 (0.20, 0.66)	**2.6761 (2.48)**	**−2.1773 (−1.83)**	−0.7050 (−0.70)	1.2475 (1.42)
Norway	0.06 (−0.03, 0.17)	**3.38524 (1.87)**	0.1750 (0.11)	1.9274 (1.30)	**2.2656 (1.69)**
Portugal	0.29 (0.20, 0.41)	**4.4217 (1.88)**	**−2.3455 (−2.31)**	−0.5167 (−0.31)	1.2504 (0.83)
Spain	0.20 (0.00, 0.46)	**3.6803 (42.52)**	**−2.4678 (−17.02)**	**0.7565 (4.21)**	**1.5073 (7.06)**
Sweden	0.40 (0.21, 0.46)	**2.5291 (17.78)**	**−0.9906 (−5.14)**	**0.8183 (3.80)**	**0.9902 (4.23)**
Switzerland	0.31 (0.16, 0.51)	**1.7021 (12.08)**	**−0.5853 (−2.97)**	−0.2144 (−0.96)	**0.71942 (2.94)**
United Kingdom	−0.04 (−0.08, 0.02)	**0.8571 (8.99)**	**−0.6608 (−5.65)**	**0.4941 (3.92)**	**−0.5891 (−4.43)**
United States	0.04 (−0.04, 0.14)	**1.0082 (3.47)**	**−1.0242 (−3.36)**	**0.8731 (2.81)**	−0.2222 (−0.70)
Developing countries					
Argentina	−0.22 (−0.39, −0.03)	**54.1118 (7.64)**	**−62.0141 (−6.74)**	**44.8985 (4.44)**	**−17.7070 (−1.83)**
Brazil	0.28 (0.05, 0.52)	**53.5654 (2.82)**	**−67.2277 (−1.73)**	49.8621 (1.19)	−23.7272 (−0.62)
Chile	0.30 (0.10, 0.60)	**13.5872 (1.77)**	**−15.6280 (−1.77)**	1.9365 (0.24)	7.4898 (1.05)
Colombia	0.05 (−0.13, 0.26)	**9.3257 (7.10)**	**−4.0103 (−3.25)**	−0.0019 (−0.01)	**2.0289 (1.70)**
India	0.13 (−0.05, 0.40)	**17.1189 (1.67)**	**−14.3537 (−1.65)**	0.0555 (0.06)	**15.0119 (1.90)**
Peru	−0.20 (−0.40, 0.05)	**68.2393 (4.43)**	**−86.2901 (−4.41)**	**64.2953 (3.02)**	**−36.2090 (−1.79)**
Russia	0.70 (0.29, 1.27)	**38.1764 (2.27)**	−19.6392 (−0.25)	28.7649 (0.53)	**80.9737 (1.96)**
South Africa	0.19 (−0.06, 0.52)	**4.6871 (4.95)**	**−2.9041 (−3.86)**	−0.0668 (−0.09)	**1.5832 (2.42)**
Uruguay	0.38 (0.23, 0.59)	**15.1549 (2.14)**	**−15.4517 (−3.35)**	−1.7549 (−0.44)	**11.5885 (3.36)**

***Note*:** Significant coefficients at the 5 per cent level; *t*-values in parenthesis for columns 3–6. Bold values mean significancy of the estimated coefficients at the 5% level.

estimate a time-varying model of long memory. However, given the lack of information of monetary policy regimes, barring the recent periods, in these economies over such a historical dataset, would make it difficult to relate the possible changes in persistence with (exact) dates of changes in monetary policy decision making. Given this limitation, we took an alternative (indirect route). We decided to split the inflation rate series of each country into above and below-median over the period of analysis, and then reestimate our model. The idea is that, while there are other possible shocks (e.g. positive supply and negative demand), lower levels of inflation (i.e. below the median) on a prolonged basis, is more likely to emerge from better management of monetary policy. So we wanted to check, if the persistence for the below-median inflation rate series is lower than the above-median case for each country. If that is so, we can tentatively associate lower persistence with better/tighter monetary policies in these countries. The results have been reported in Table 2. We continue to observe strong evidence of nonlinearity as in Table 1, but more importantly, the order of integration is smaller in 'below median' cases for majority of the economies. The exceptions are Australia, Austria and South Africa, but in these economies, the estimate of persistence is not significantly different in a statistical fashion across the above and below-median cases. For the rest of the countries, i.e. Belgium, Canada, Denmark, France, Greece, Italy, Japan, New Zealand, Norway, Portugal, Switzerland, U.K., U.S., Argentina, Brazil, Chile, India, Russia, Uruguay, the estimated values of d are statistically higher in the 'above median' series relative to the 'below median' series; and for the seven remaining countries (Finland, Germany, The Netherlands, Spain, Sweden, Colombia and Peru), the estimates of d are also higher (though not statistically significantly) in the above median series. Moreover, the null of $I(0)$ behavior cannot be rejected in the majority of the 'below median' series, with it being however, rejected in favor of $d > 0$ (i.e. existence of long memory) in practically all 'above median' series. Our results, in general, tend to suggest that lower persistence of inflation rates, can in general be associated with monetary policy episodes that were associated with better management of the monetary policy instrument and possibly, tighter monetary policy.[4]

[4]To corroborate our conclusions, we also carried out an alternative analysis, whereby, we estimated structural breaks in the inflation rates using Bai and Perron's (2003) test of multiple regime changes. Once we identified the subsamples based on break dates, we estimated the long-memory parameter across the subsamples, details of which are available on request from the authors. An interesting pattern emerged, whereby persistence increases across the breaks at the earlier subsamples, but started to decline in the recent subsamples. Given that these economies became either inflation targeters or part of a monetary union toward the latter part of the sample, especially after World War II, which in turn had initial requirements of reducing inflation through better monetary policy management, tend to suggest that the decline in persistence in general, can be associated with a better monetary policy framework. This result, in the process is aligned with those obtained under the below- and above-median cases reported in Table 2.

Table 2. Estimates of Long-Memory Parameter (d) in a Nonlinear Framework Under Autocorrelation for Above- and Below-Median Inflation Rates

Country	*Type*	*d*	θ_0	θ_1	θ_2	θ_3
Developed countries						
Australia	Above Median	0.10 (−0.01, 0.24)	**3.8098 (4.92)**	0.2160 (0.31)	**1.2250 (1.87)**	**1.3015 (2.05)**
	Below Median	0.14 (0.02, 0.30)	**−1.7316 (−2.64)**	**−2.2344 (−4.04)**	**−1.0753 (−2.06)**	−0.4625 (−0.93)
Austria	Above Median	0.01 (−0.08, 0.11)	**21.1943 (1.73)**	−2.0201 (−0.16)	**19.3235 (−1.67)**	**12.3373 (1.73)**
	Below Median	0.09 (−0.04, 0.25)	**−2.3710 (−3.70)**	**−3.0212 (−5.27)**	**−0.8185 (−1.77)**	0.3878 (0.72)
*Belgium**	Above Median	0.48 (0.32, 0.68)	4.9894 (0.87)	0.0383 (0.01)	−1.1475 (−0.40)	2.3217 (0.98)
	Below Median	−0.03 (−0.13, 0.10)	**−2.1598 (−6.73)**	**−1.6354 (−4.91)**	0.1634 (−0.48)	**−0.8415 (−2.47)**
*Canada**	Above Median	0.54 (0.40, 0.71)	2.0723 (0.82)	−0.6101 (−0.41)	−0.6714 (−0.58)	0.4612 (0.48)
	Below Median	0.20 (0.04, 0.41)	−0.3678 (−0.79)	**−0.7084 (−1.95)**	0.0576 (0.17)	0.0930 (0.30)
*Denmark**	Above Median	0.46 (0.34, 0.61)	2.4854 (1.08)	−0.9107 (−0.64)	−0.7128 (−0.61)	0.8073 (0.82)
	Below Median	0.17 (0.09, 0.27)	**−1.7723 (−2.51)**	**−1.9017 (−3.31)**	−0.5186 (0.97)	**−0.8481 (−1.67)**
Finland	Above Median	0.41 (0.25, 0.61)	6.3656 (1.04)	0.7793 (0.20)	−3.1269 (−0.96)	**−0.1141 (−4.04)**
	Below Median	0.20 (0.03, 0.45)	−0.3975 (−0.87)	**−0.9110 (−3.54)**	−0.1412 (−0.42)	−0.1594 (−0.51)
*France**	Above Median	0.41 (0.31, 0.53)	4.0872 (1.24)	−1.8680 (−0.89)	−1.2422 (−0.70)	**3.2272 (2.11)**
	Below Median	0.02 (0.08, 0.15)	**−0.9480 (−4.54)**	**−0.9525 (−4.67)**	**−0.2718 (−1.84)**	**−0.5092 (−2.53)**
Germany	Above Median	0.12 (0.01, 0.26)	18.2277 (1.05)	−0.3520 (−0.02)	−13.8793 (−0.98)	11.2018 (0.82)
	Below Median	−0.03 (−0.17, 0.16)	**−2.9821 (−6.10)**	**−3.6846 (−7.26)**	**−1.8424 (−3.58)**	**−0.7559 (−1.65)**
*Greece**	Above Median	0.54 (0.41, 0.71)	16.6045 (0.37)	−5.3997 (−0.20)	−11.1112 (−0.53)	**11.0103 (−1.65)**
	Below Median	−0.03 (−0.14, 0.11)	**−1.3485 (−4.45)**	**−1.9910 (−6.33)**	−0.0145 (−0.04)	0.1016 (0.31)
*Italy**	Above Median	0.44 (0.30, 0.65)	7.2757 (1.00)	0.1513 (0.03)	0.4041 (0.10)	4.1179 (1.29)
	Below Median	−0.03 (−0.16, 0.14)	**−1.9572 (−6.55)**	**−2.3546 (−7.59)**	**−0.9345 (−2.97)**	**−0.6192 (−1.95)**
*Japan**	Above Median	0.32 (0.21, 0.45)	7.7561 (1.10)	1.2932 (0.26)	−2.3724 (−0.56)	2.5557 (0.67)
	Below Median	0.03 (−0.07, 0.16)	**−2.1753 (−4.56)**	**−2.2035 (−4.79)**	−0.3073 (−0.67)	0.3224 (0.71)
Netherlands	Above Median	0.22 (0.09, 0.35)	**2.8772 (3.18)**	−0.2630 (−0.38)	−0.1253 (−0.19)	0.7220 (1.22)
	Below Median	0.06 (−0.05, 0.19)	**−1.6556 (−5.512)**	**−1.4133 (−4.71)**	0.1884 (0.64)	0.2016 (0.70)
*New Zealand**	Above Median	0.54 (0.44, 0.65)	3.2420 (1.22)	−1.2783 (−0.82)	−0.6615 (−0.54)	1.4345 (1.44)
	Below Median	0.06 (−0.05, 0.19)	**−0.4544 (−1.86)**	**−0.7941 (−3.49)**	−0.0165 (−0.07)	−0.1560 (−0.71)
*Norway**	Above Median	0.23 (0.12, 0.35)	**5.3328 (2.16)**	2.1698 (1.16)	2.6006 (1.52)	**3.2834 (2.08)**
	Below Median	−0.04 (−0.12, 0.07)	**−1.8000 (−5.67)**	**−1.9291 (−5.79)**	**−0.6222 (−1.83)**	**−0.9999 (−2.91)**
*Portugal**	Above Median	0.38 (0.29, 0.49)	**6.9946 (1.85)**	0.1009 (0.04)	0.1553 (0.07)	1.8049 (0.98)
	Below Median	−0.03 (−0.16, 0.14)	−2.1034 (−0.33)	**−2.0741 (−7.92)**	**−0.5496 (−2.07)**	**−0.3861 (−1.64)**

Country	*Type*	*d*	θ_0	θ_1	θ_2	θ_3
Spain	Above Median	0.26 (0.09, 0.47)	**5.4320 (2.30)**	0.2627 (0.15)	−1.5266 (−0.98)	**−2.6939 (1.89)**
	Below Median	0.07 (−0.08, 0.27)	**−2.1056 (−4.10)**	**−2.4003 (−5.10)**	**−1.1296 (−2.47)**	**−0.8965 (−2.00)**
Sweden	Above Median	0.40 (0.25, 0.62)	**4.3260 (1.93)**	0.736 (0.53)	0.9394 (0.77)	1.4072 (1.33)
	Below Median	0.22 (0.07, 0.42)	**−0.9606 (−1.66)**	**−0.8571 (−1.93)**	0.1969 (0.48)	0.1218 (0.32)
*Switzerland**	Above Median	0.42 (0.28, 0.66)	2.5394 (1.26)	0.5320 (0.41)	−0.2729 (−0.25)	0.6683 (1.26)
	Below Median	0.11 (−0.02, 0.27)	**−1.0751 (−2.74)**	**−1.0946 (−3.20)**	−0.0516 (−0.15)	0.0857 (0.27)
*U.K.**	Above Median	0.11 (0.06, 0.14)	**3.2519 (9.46)**	**0.4505 (1.80)**	**0.4392 (1.73)**	**−0.4609 (−1.66)**
	Below Median	−0.08 (−0.13,−0.02)	**−2.3641 (−25.66)**	**−1.1167 (−10.99)**	0.0826 (0.70)	−0.1270 (−1.17)
*U.S.**	Above Median	0.27 (0.18, 0.37)	**2.7347 (2.79)**	0.0938 (0.13)	0.3905 (0.61)	−0.3965 (−0.68)
	Below Median	−0.06 (−0.13, 0.03)	**−1.9203 (−13.27)**	**−1.1336 (−7.27)**	**0.3450 (2.15)**	0.1683 (1.03)
Developing countries						
*Argentina**	Above Median	0.47 (0.32, 0.72)	37.4554 (0.23)	−45.1467 (−0.46)	32.0441 (0.40)	−8.5542 (−0.12)
	Below Median	−0.01 (−0.12, 0.13)	−1.3627 (−4.71)	−0.8941 (−3.05)	0.6524 (2.22)	0.3055 (1.03)
*Brazil**	Above Median	0.51 (0.41, 0.64)	45.1081 (0.24)	−57.2157 (−0.51)	46.4759 (0.52)	−8.5542 (−0.12)
	Below Median	−0.01 (−0.10, 0.11)	−1.2659 (−3.61)	−1.8327 (−5.17)	−0.4156 (−1.16)	−0.3277 (−0.91)
*Chile**	Above Median	0.89 (0.73, 1.08)	6.0173 (0.03)	−13.9946 (−0.14)	2.4470 (0.04)	7.5750 (0.19)
	Below Median	0.01 (−0.11, 0.15)	**−0.7135 (−3.05)**	**−1.1645 (−5.05)**	0.1167 (0.50)	−0.1683 (−0.73)
Colombia	Above Median	0.22 (0.13, 0.33)	**9.3034 (3.76)**	−2.2456 (−1.18)	−1.0102 (−0.58)	1.7792 (1.10)
	Below Median	0.05 (−0.06, 0.19)	−0.3447 (−0.58)	**−1.6277 (−2.91)**	**0.7699 (1.70)**	0.3348 (0.62)
*India**	Above Median	0.32 (0.18, 0.45)	19.7605 (0.80)	−11.3542 (−0.66)	−0.05304 (−0.03)	15.6856 (1.17)
	Below Median	−0.04 (−0.15, 0.10)	**−2.3897 (−7.04)**	**−2.0348 (−5.70)**	**0.8443 (2.32)**	0.0786 (0.21)
Peru	Above Median	0.34 (0.19, 0.53)	53.2114 (0.28)	−66.1623 (−0.52)	50.7831 (0.46)	−22.2936 (−0.23)
	Below Median	0.17 (0.08, 0.27)	−0.6718 (−1.09)	**−1.0393 (−2.08)**	**−0.4375 (−1.94)**	**−1.1642 (−2.66)**
*Russia**	Above Median	1.06 (0.88, 1.24)	−64.7357 (−0.12)	−3.3730 (−0.01)	37.3752 (0.25)	86.1761 (0.90)
	Below Median	0.56 (0.40, 0.76)	0.2774 (0.10)	−1.1791 (−0.73)	0.7344 (0.59)	0.3686 (0.36)
South Africa	Above Median	0.35 (0.25, 0.49)	**4.2431 (2.54)**	**−2.5127 (−2.24)**	0.6458 (0.66)	**1.4889 (1.73)**
	Below Median	0.47 (0.29, 0.71)	0.6824 (0.46)	−0.2758 (−0.30)	−0.6559 (−0.90)	0.1412 (0.23)
*Uruguay**	Above Median	0.66 (0.53, 0.85)	9.9193 (0.46)	−15.1454 (−1.23)	−1.9739 (−0.22)	**11.5961 (1.70)**
	Below Median	0.16 (0.02, 0.34)	−0.0825 (−0.12)	−0.8521 (−1.55)	0.0091 (0.01)	−0.2030 (−0.41)

***Note*:** Significant estimates are in bold, with those corresponding to nonlinearity being in the last two columns; countries that are in *italics* are the ones for which the above median estimates of d are higher than the below median estimates, with a * corresponding to the names of the countries for which these estimates are statistically significant.

4 Conclusions

Accurate estimate of the degree of persistence property of inflation is an important issue for both economists and central bankers. While there exists a large number of studies in this area based on various modeling techniques, the results are at best mixed. Given this, in this paper, we revisit this question for a set of 29 developed and developing economies using long spans of data covering over a century in each case. The idea is to provide a definitive answer based on the longest possible historical evolution of inflation for these economies, using long-memory models characterized by potential nonlinearity to account for structural breaks and the inherent nonlinear structure in inflation rates. Based on our analysis, we can draw the following conclusions: (i) Among the 29 countries considered, twelve countries (seven developed and five developing) show evidence of antipersistence or short memory, with the remaining seventeen depicting long-memory behavior in their inflation rates; (ii) More importantly though, barring the case of Russia, none of the other the 28 countries indicate evidence of the inflation rate in being a nonstationary $I(1)$ process, and; (iii) Preliminary analysis also tends to suggest that inflation persistence is (tentatively) associated with monetary policy regimes in these economies. Combining these results imply that monetary authorities in these countries can play a role in controlling inflation, though the extent of intervention required varies, with the strongest being for Russia.

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