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An assessment of the inflation targeting experience

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Abstract

An effective inflation targeting (IT) regime assumes both a change in the stationarity properties of inflation and a lower variability. Within a framework that does not make a priori assumptions about the order of integration, we examine whether there is a change in the inflation persistence in forty-five, developed and developing, countries and in three groups of countries, the G7, the OECD, and OECD Europe. For the inflation targeters, we find that the endogenously identified break dates are not consistent with the formal adoption of the IT regime. We employ a test for the variability of inflation that tracks how frequently inflation variability is in control. Logit analysis reveals that inflation targeters do not experience a greater probability than non-inflation targeters of inflation persistence changing, and they are not more in control of their inflation variability. The quality of institutions emerges as being more significant for taming inflation.

JEL Codes: C12, E4, E5

Keywords: structural change, persistence change, inflation targeting

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Non-technical summary

Inflation targeting was introduced in the early 1990s. We revisit the effectiveness of inflation targeting three decades later. We employ a methodological framework that does not make an a priori assumption about the order of integration. We examine whether there is a change in the inflation persistence in forty-five developed and developing countries and in three groups of countries, the G7, the OECD, and OECD Europe. For the inflation targeters, we find that the endogenously identified break dates are not consistent with the formal adoption of the IT regime. We employ a test for the variability of inflation that tracks how frequently inflation variability is under control. Logit analysis reveals that inflation targeters do not experience a greater probability than non-inflation targeters of inflation persistence changing, and they are not more in control of their inflation variability. The quality of institutions emerges as being more significant for taming inflation.

Overall, the evidence provided suggests that (i) a change in the persistence of inflation and (ii) lower variability in inflation have both occurred but inflation targeting did not make a statistically significant contribution to either. The quality of institutions emerges as a more significant driver of the change in the persistence of inflation and of lower inflation variability. Our results do not argue against inflation targeting policies, but rather we view the quality of central banks and institutions as a vital element in ensuring economic and financial stability since the recent financial crisis, where near-zero interest rates are observed.

Contents

1. Introduction

There has been considerable debate about how effective inflation targeting (IT) is, since it was first introduced in the early 1990s. The three decades that have passed since then provide a long enough time span for this policy to be assessed more objectively. In October 2011, Ben Bernanke, the then Chairman of the Board of Governors of the Federal Reserve System, noted that central bankers and academics had reached a consensus during the two decades preceding the recent financial crisis on the intellectual and institutional framework of monetary policy, and that this broad framework, often called flexible inflation targeting, "increased the effective scope of monetary policy" (Bernanke, 2011). Recognising that the financial crisis will leave a lasting imprint on the theory and practice of central banking, Bernanke (2011) also noted that "with respect to monetary policy, the basic principles of flexible inflation targeting – the commitment to a medium-term inflation objective, the flexibility to address deviations from full employment, and an emphasis on communication and transparency – seem destined to survive". Reflecting on twenty years of inflation targeting experience, the former Bank of England Governor Mervyn King (2012) said that "...the results in terms of low and stable inflation have been impressive. There have been pronounced reductions in the mean, variance and persistence of inflation in Britain and elsewhere".[1] More recently, however, Bank of England Governor Mark Carney (2014) argued "that fight [against inflation] culminated in the adoption of an inflation target, which helped secure 15 years of price stability and sustained economic growth. However, with time, a healthy focus became a dangerous distraction". The debate on the effectiveness of IT is not yet resolved. We approach it as an empirical issue.

Recent academic work[2] has attempted to assess empirically the effectiveness of adopting an inflation-targeting regime.[3] The seminal work of Ball and Sheridan (2005) focuses on twenty major developed OECD countries, seven of which had adopted an IT regime, and by using the standard differences in differences approach, conclude that the IT regime does not seem to affect inflation or inflation variability in a significant way. The observed inflation drop in the targeting economies is mainly ascribed to the mean reversion effect. Inherent in this literature is the challenge that the introduction of IT coincides with the great moderation, and distinguishing between the two is far from a trivial issue.

Goncalves and Salles (2008) call the Ball and Sheridan (2005) empirical results "baffling", given that the group of countries investigated is solely comprised of developed economies, and consequently, they argue that sample selection bias has contaminated the reported results. Goncalves and Salles (2008), using the same methodological framework, attempt to overcome the selection bias problem by examining a sample of thirty-six emerging economies, thirteen of which have adopted an IT regime. The findings of Goncalves and Salles (2008) stood in contrast to those suggested by Ball and Sheridan (2005), as they conclude that IT delivers irrefutable gains in inflation and growth volatility for developing economies.

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[1] An official announcement of the target increases the credibility of the policy of the Central Bank, alleviates the dynamic incontinency problem, anchors expectations, and secures price stability.

[2] The literature on IT is extensive and reviewing it is outside the scope of this paper. For a comprehensive review, see Svensson (2010). For more recent literature on the relationship between macroprudential policy and IT see Kim and Mehrotra (2017), for the effect of IT on the housing market see Frappa and Mésonnier (2010) and the references therein.

[3] Opponents of IT argue that it is merely conservative window dressing (Romer, 2006; p532), or it reflects a more general process of reforms (Gertler, 2005) such as central bank independence (Kohn, 2005) or the Central Bank's communication policy (Mankiw, 2005).

Lin and Ye (2007) apply a variety of propensity score matching methods to twenty-two major industrial countries[4], taking this way into account the problem of self-selection in the adoption of the IT regime. Additionally, they show, for industrial countries, that the IT policy has no effect on inflation, inflation variability, long-term interest rates or the income velocity of money. Lin and Ye (2009) use the propensity score matching methodological framework again and focus on fifty-two developing countries for the period 1985 to 2005. They find that the IT regime is effective, since it appears to be a significant parameter in lowering both inflation and inflation variability in developing countries. Their results confirm the earlier empirical findings of Goncalves and Salles (2008). However, Brito and Bystedt (2010) fail to find any evidence that IT improves economic performance for developing countries.

Several studies have tested the level of inflation for stationarity by employing either linear or nonlinear unit root tests. This strand of the literature, which is more relevant for our line of work, draws from Svensson (1997), who argues that IT implies the base drift of the price level, suggesting that the price level has a unit root and inflation is stationary. Culver and Papell (1997) employ sequential break and panel unit root tests for the inflation rates of thirteen OECD countries. Based on individual country tests, they find stationarity in only four cases, while in the panel dimension, the non-rejection of the unit root for inflation is very fragile. Hassler and Wolters (1995) examine monthly inflation rates for five industrial countries and employ fractional unit root tests. In all cases, the difference parameter is different both from one and from zero. Gregoriou and Kontonikas (2006) look at five OECD countries (the UK, Canada, Sweden, Australia and New Zealand) and two high inflation non-OECD countries, Chile and Israel. The sample starts from the introduction of the IT regime in each country until 2004. The ADF test fails to reject the non-stationarity hypothesis, but the Exponential Smooth Transition Autoregressive (ESTAR) unit root test points towards stationarity (in non-linear mean reversion) which indicates that targeting has been successful. Altissimo *et al*. (2006) provide evidence that the properties of the sectoral and aggregate inflation dynamics in the euro area have changed over time. Arestis *et al*. (2014) examine the stationarity properties of inflation differentials and find that they converge irrespective of the monetary policy framework.

This paper takes a different approach, as we do not make any assumption about the stationarity properties of the entire sample but rather, we examine a possible change both in the persistence of inflation and in the variability of inflation. In the spirit of Svensson (1997), we search for changes in persistence where the following four scenarios may occur and can be tested: (i) inflation is integrated of order one (denoted I(1)) throughout the sample; (ii) inflation is integrated of order zero (denoted I(0)) and it remains so; (iii) there is a change in persistence from I(0) to I(1); and (iv) there is change from I(1) to I(0). In the latter two scenarios, the employed testing procedure can date the break, meaning it can be compared with the date inflation targeting was formally introduced.

The starting point for our analysis is like that of Halunga *et al*. (2009), as they employ a change in persistence test for inflation in the US and the UK. They find a change in the persistence of inflation from I(0) to I(1) in the early 1970s, with a subsequent reversion in the early 1980s. Within this framework, we examine forty-five countries, twenty-five of which are IT countries,[5] operating in a sequential way. Our analysis begins with tests for a change in inflation persistence. Once we verify a significant change from I(1) to I(0), we then compare the Estimated Break Date (EBD) with

[4] Seven of the industrial countries examined were inflation targeters.

[5] In different frameworks, Ball and Sheridan (2005) use data from twenty industrialised countries, Lin and Ye (2007) from twenty-two industrialised countries, and Lin and Ye (2009) from thirteen developing countries. Fazio *et al*. (2015) look at seventy countries and compare the banking sectors of IT countries and non-IT countries.

the date that corresponds to the formal adoption (FAD) of the inflation targeting regime. We then proceed by employing a logit model to assess whether IT affects the probability of a change in persistence occurring in the inflation rate. We find no evidence in favour of IT being significant.

In line with the seminal contribution of North (1990) and the subsequent literature, we also consider the quality of institutions as a potential driver of the change in the persistence of inflation. The quality of institutions emerges as more significant for taming inflation than IT is. Additionally, we compare the variability of inflation in the targeters against the non-targeters. Logit analysis again reveals that inflation targeters are not more in control with respect to the variability of inflation than non-targeters are. In short, the quality of institutions appears to be more important for inflation and the variability of inflation.

We do not interpret our results as an argument against inflation targeting. We can reiterate the concluding remark of Ball and Sheridan (2005): "Our results do not provide an argument *against* inflation targeting, for we have not found that it does any harm". Rather, we view the quality of central banks and institutions as a vital element in ensuring economic and financial stability. Indeed, central banks need to work more closely with a range of institutions, including the government, in the aftermath of the financial crisis and given the presence of near-zero interest rates.

The plan of the paper is as follows. Section 2 presents the econometric methodology. Section 3 presents the data and Section 4 reports the empirical results. Finally, Section 5 concludes.

2. Methodology

2.1 Change in inflation persistence

To examine formally whether there has been a change in the inflation persistence from I(1) to I(0) and vice versa, we use the modified Busetti and Taylor (2004) test statistics, suggested by Harvey *et al*. (2006) and implemented empirically on US and UK inflation by Halunga *et al*. (2009). To test the null hypothesis of a constant I(0) process against a change in persistence from I(0) to I(1) for an unknown breakpoint, Busetti and Taylor (2004) originally proposed the following statistics:

$$H_1\left(\mathscr{K}_M(\bullet)\right) \equiv \max_{\tau\in[\tau_l,\tau_u]} \mathscr{K}_M(\tau) \tag{1}$$

$$H_2\left(\mathscr{K}_M(\bullet)\right) \equiv \int_{\tau\in[\tau_l,\tau_u]} \mathscr{K}_M(\tau)d\tau \tag{2}$$

$$H_3\left(\mathscr{K}_M(\bullet)\right) \equiv \log\left\{\int_{\tau\in[\tau_l,\tau_u]} \exp\left(\mathscr{K}_M(\tau)\right)d\tau\right\} \tag{3}$$

with

$$\mathscr{K}_M(\tau) = \frac{[(1-\tau)T]^{-2}\sum_{t=[\tau T]+1}^{T}\left(\sum_{i=[\tau T]+1}^{t}\hat{\varepsilon}_{1,i}\right)^2}{[\tau T]^{-2}\sum_{t=1}^{[\tau T]}\left(\sum_{i=1}^{t}\hat{\varepsilon}_{0,i}\right)^2} \tag{4}$$

where, $\boldsymbol{\tau} \in (0,1)$, $[\boldsymbol{\tau}_l , \boldsymbol{\tau}_u]$ is a sub-interval of (0,1), T is the sample size and $\hat{\varepsilon}_{0,i}$ and $\hat{\varepsilon}_{1,i}$ are the OLS residuals from the regression of the series being examined on a constant for the samples t = 1,…,$[\boldsymbol{\tau}T]$ and t= $[\boldsymbol{\tau}T]$,…,T, respectively.

To test for a change from I(1) to I(0) under the same null hypothesis, Busetti and Taylor (2004) propose using the reciprocal of $\mathscr{K}_M(\tau)$. The equivalents of equations (1), (2) and (3) are denoted by $H_j\left(1/\mathscr{K}_M(\bullet)\right)$, with j= 1, 2, 3. However, these statistics are severely oversized when the true generating process is constantly I(1). For this reason, Harvey *et al*. (2006) suggested testing the null of a constant I(0) or I(1) generating process against a change from I(0) to I(1) with the following modification:

$$H_j\left(\mathscr{K}_M(\bullet)\right)_{j,\min} = \exp\left(-bJ_{\min}\right)H_j\left(\mathscr{K}_M(\bullet)\right) \quad \text{with } j = 1, 2, 3 \tag{5}$$

where $H_j\left(\mathscr{K}_M(\bullet)\right)_{j,\min}$ is the modified statistic, b is a constant provided by Harvey et al. (2006) and $J_{\min} = \min_{\tau\in[\tau_l,\tau_u]} J_{1,[\tau T]}$, with $J_{1,[\tau T]}$ equal to T^{-1} times the Wald statistic that corresponds to the test of the joint $\delta_{k+1} = ... = \delta_9 = 0$ hypothesis, in the regression that is illustrated below:

$$y_t = \mathbf{x}_t'\beta + \sum\nolimits_{i=k+1}^{9} \delta_i t^i + u_t, \quad t = 1,\ldots,[\tau T] \tag{6}$$

When the alternative hypothesis being examined is in the opposite direction, from I(1) to I(0), the $H_j\left(\mathscr{K}_M(\bullet)\right)$ statistic in equation (5) is substituted by $H_j\left(1/\mathscr{K}_M(\bullet)\right)$ and the $J_{1,[\tau T]}$ factor is replaced by $J^R_{\min} = \min_{\tau\in[\tau_l,\tau_u]} J_{[\tau T],T}$, where $J_{[\tau T],T}$ is defined as $J_{1,[\tau T]}$ with the exception that specification (6) is now estimated for t= $[\boldsymbol{\tau}T]$,…,T. The modified statistic is denoted by $H_j\left(1/\mathscr{K}_M(\bullet)\right)_{J,\min}$.

To estimate the location of the breakpoint for a change that might be either from I(0) to I(1) or from I(1) to I(0), Busetti and Taylor (2004) propose (7) and (8) respectively:

$$\hat{\tau} = \arg\max_{\tau\in[\tau_l,\tau_u]} \Lambda(\tau) \tag{7}$$

$$\hat{\tau} = \arg\min_{\tau\in[\tau_l,\tau_u]} \Lambda(\tau) \tag{8}$$

with

$$\Lambda(\tau) = \frac{\sum_{t=[\tau T]+1}^{T} \hat{\varepsilon}_{1,t}^2 \Big/ \left(T - [\tau T]\right)^2}{\sum_{t=1}^{[\tau T]} \hat{\varepsilon}_{0,t}^2 \Big/ [\tau T]^2} \quad \text{where } \hat{\varepsilon}_{0,t}^2 \text{ and } \hat{\varepsilon}_{1,t}^2 \text{ are defined as previously.} \tag{9}$$

At first, we set the search interval for the identification of the break point at [0.20, 0.80]. In cases where there is a significant change in the persistence but the breakpoint identified is located at an extreme of the search interval, we amend the search interval to [0.15, 0.85] and the tests for a change in persistence are re-estimated for the extended search interval. In cases where there is no evidence of a significant change in the persistence however, we disregard the extreme break point and the testing procedure does not proceed for the extended search interval.

2.2 Analysis of inflation variability

Following from the change in persistence testing, we identify shifts in variance, as IT could affect both the mean and the variance of inflation. To do this we follow on a rolling basis the methodology proposed by Hawkins and Zamba (2005). Specifically, for a given sample of size n and near normally distributed data, they utilise the generalised likelihood ratio principle to identify a possible change in variance at time τ by the maximum value of the $G_{k,n}$ statistic across the entire set of the possible values for k. Hence, the generalised likelihood ratio statistic of interest is:

$$G_{\max,n} = \max_{2\le k\le n-2} G_{k,n}, \qquad G_{k,n} = \left[(k-1)\ln\left(\frac{\hat{\sigma}^2}{\hat{\sigma}_1^2}\right) + (n-k-1)\ln\left(\frac{\hat{\sigma}^2}{\hat{\sigma}_1^2}\right)\right] / C \quad \text{with} \quad C = 1 + [(k-1)^{-1} + (n-k-1)^{-1} - (n-2)^{-1}]/3 \tag{10}$$

where $\hat{\sigma}^2$ is the estimate of the common variance for the two periods, $\hat{\sigma}_1^2$ and $\hat{\sigma}_2^2$ are the sample variances for the first and second period respectively, and C is the Bartlett correction factor.

This static setting is useful when we examine the in-control hypothesis for a sample of size n and has variance homogeneity. The same framework is also suitable for monitoring changes in variance when the sample is updated with new information and the variance change may occur at any point in time. As new information arrives, the $G_{\max,n}$ statistic is recalculated and it is compared to a critical limit $h_{\alpha,n}$. If $G_{\max,n} \le h_{\alpha,n}$, there is evidence that the process is in-control, whereas if $G_{\max,n} \ge h_{\alpha,n}$, the opposite is true and it is out of control. By simulating five million random samples ranging from 10 to 500 observations for several levels of significance (α), Hawkins and Zamba (2005) propose the following formula for approximating the critical limit $h_{\alpha,n}$:

$$h_{\alpha,n} = \begin{cases} -1.38 - 2.24\times\ln(\alpha) + \left(1.61 + 0.691\times\ln(\alpha)\right)\times(n-z)^{-1/2} & \text{if} \quad 0.001 \le \alpha < 0.05 \\ 5 + 0.066\times\ln(n-z) & \text{if} \quad \alpha = 0.05 \end{cases} \tag{11}$$

2.3 Logit analysis

Following from these two tests, we examine three additional hypotheses. First, we examine whether a significant change in the persistence from I(1) to I(0) is associated with those countries that follow an inflation-targeting policy. Second, we investigate whether the significant changes identified in the variability of inflation are less frequent in the inflation-targeting countries than in the rest. Third, we test whether inflation targeters can both achieve a change in the persistence of inflation and control the change of inflation variability at the same time. As a result, our analysis has some subsequent steps. In particular, we employ three distinct logit specifications to assess whether the probability of observing (i) a change in persistence for the inflation series from I(1) to I(0), (ii) more control in the changes of the inflation variability, and (iii) both (i) and (ii), depends on whether a country follows an inflation targeting policy.

These hypotheses, as already mentioned, can be investigated within a binary choice framework, modelled by a cross-section logit regression specified as:

$$\ln\left[\pi_{j,i}\Big/\left(1-\pi_{j,i}\right)\right]=b_{j,0}+b_{j,1}D_{IT,i}+b_{j,2}Q_i+\varepsilon_{j,i} \tag{12}$$

where i ($i=1,...,45$) denotes the country and j ($j=1,2,3$) denotes the hypothesis being examined each time. So for the first specification, $\pi_{1,i}$ is the probability of country i experiencing a significant change in persistence from I(1) to I(0) for the annualised inflation series, while the interpretation for $\pi_{2,i}$ and $\pi_{3,i}$ is similar.

Since the $\pi_{j,i}$ for each country is non-observable, we proceed by employing three binary variables $D_{j,i}$ ($j=1,2,3$). The dummy that corresponds to the first hypothesis, $D_{1,i}$, receives the value of 1 if a significant change in persistence for country i is confirmed jointly by the three statistics in equations (1), (2) and (3) at any conventional level of significance, and 0 otherwise. Similarly, the dummy that is associated with the second hypothesis, $D_{2,i}$, receives the value of 1 if country i has on average larger percentage of time, relative to other countries, under which the variability of inflation is in-control (more than the median) and 0 otherwise. The last dummy, $D_{3,i}$, which reflects the third hypothesis, is the product of $D_{1,i}$ and $D_{2,i}$, showing both the change in persistence and control over inflation variability. Furthermore, $D_{IT,i}$ is a dichotomous dummy variable that indicates whether country i is an inflation targeter or not, Q_i is the quality of institutions, $b_{j,0}$, $b_{j,1}$ and $b_{j,2}$ are coefficients to be estimated, and ε_i is the error term.

Naturally, significant and positive values for the $b_{j,1}$ coefficients would indicate that inflation-targeting countries perform better than non-inflation targeting countries in the three hypotheses being examined (that is, change in persistence, control over inflation variability, and jointly a change in persistence and control over variability). Moreover, all the alternative outcomes related to the sign and the significance of the $b_{j,1}$ coefficient provide evidence in favour of the great moderation proposition. A statistically significant $b_{j,2}$ would gauge the contribution of the quality of institutions at taming inflation. At this point it is also worth pointing out that no statement about causality can be derived.

Lastly, we will also consider alternative drivers that could explain the left-hand side variable in equation (12). North's (1990) seminal thesis provides the foundation for the role of institutions in economic performance. In our case, we will examine whether the quality of institutions can affect the stationarity properties (change in persistence) of inflation. As a result, we will augment the specification and consider the quality of institutions as quantified by the World Bank on the right-hand side.

3. Data

To investigate the effectiveness of inflation targeting policies, we focus on forty-five countries and on three groups of countries (the G7, the OECD, and OECD Europe), providing forty-eight series. We employ monthly time series data for annualised inflation over the period 1980:1 to 2010:6.[6,7] Annualised inflation is the logarithmic difference in the Consumer Price Index (CPI). The source of the data is the International Financial Statistics database of the International Monetary Fund and the Main Economic Indicators database of the OECD.[8] Annualised inflation rates are presented in Figure 1. The summary statistics for all inflation series together with the related ADF unit-root test results appear in Table 1.

We approximate the quality of institutions by the Government Effectiveness Index (GEI) obtained from the Worldwide Governance Indicators (WGI) database of the World Bank.[9] The GEI receives values from −2.5 (weak effectiveness) to 2.5 (strong effectiveness) and it is available from 1996. The index captures perceptions of the quality of public and civil services, and the degree of their independence from political pressures. It also reflects the quality of policy formulation and implementation and the credibility of the government's commitment to such policies. We capture the quality of institutions for each country by the average value of the GEI for the period 1996 to 2010. We report the GEI data in the Appendix (see Table A2).

[6] Exceptions are Australia and New Zealand since monthly observations are not available. For these two countries, we use annualised inflation at quarterly frequency for the period 1980:Q1 to 2010:Q2.

[7] The sample does not incorporate the more recent period where unconventional monetary policies were in operation. In the aftermath of the financial crisis, many commentators have argued that inflation targeting is an idea whose time has passed and that it has proven inadequate in turbulent times (Frankel, 2012 and El-Erian, 2012). Carney (2012) explained the advantages of a nominal GDP target; see also McCallum (2015).

[8] The MEI database has been used as source of data only for the following countries or groups of countries: OECD total, OECD Europe, G7 countries, China, Germany and Ireland.

[9] According to WGI: "The GEI reflects perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies."

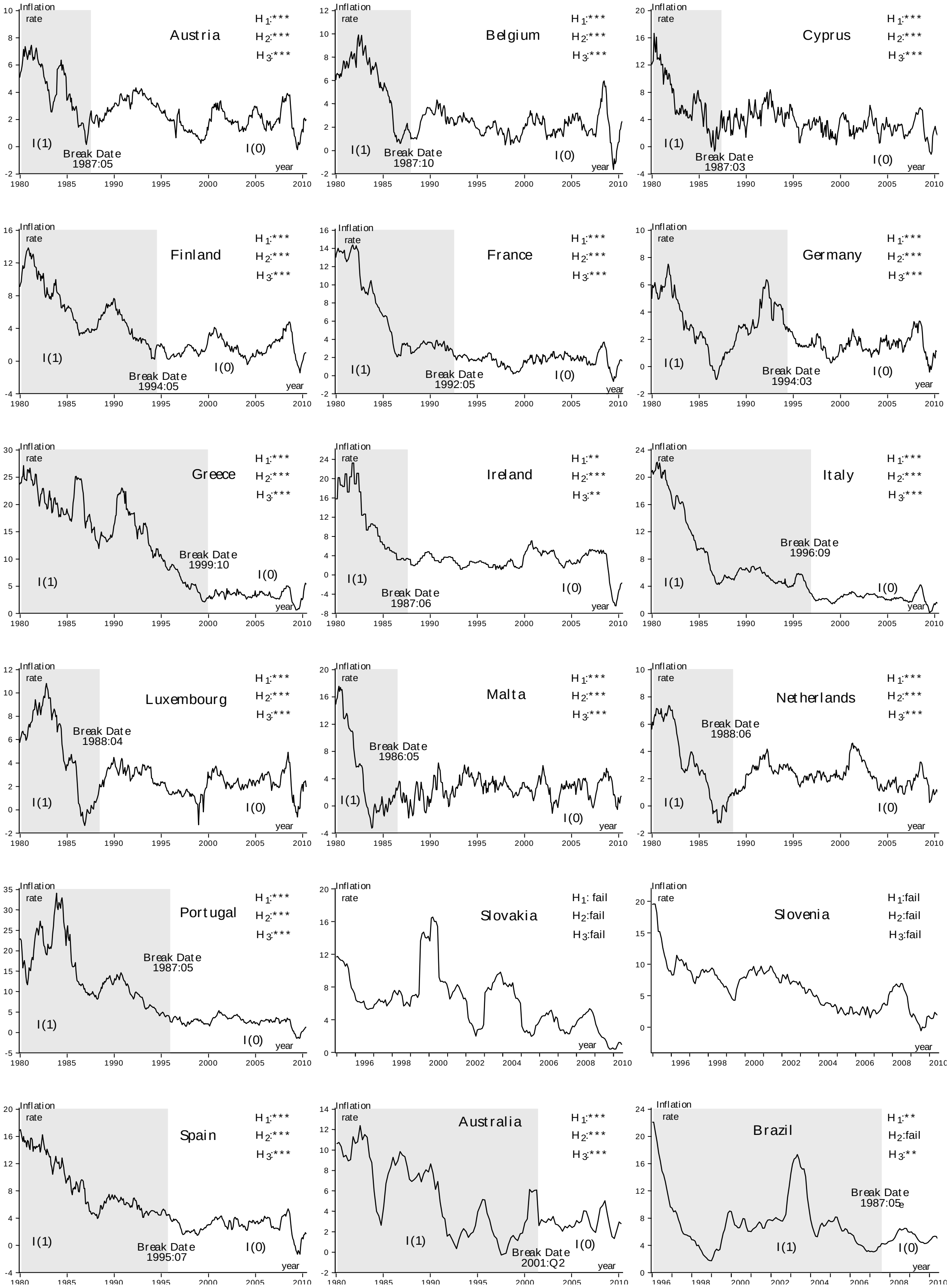

Figure 1: Annualised inflation

Notes: see below.

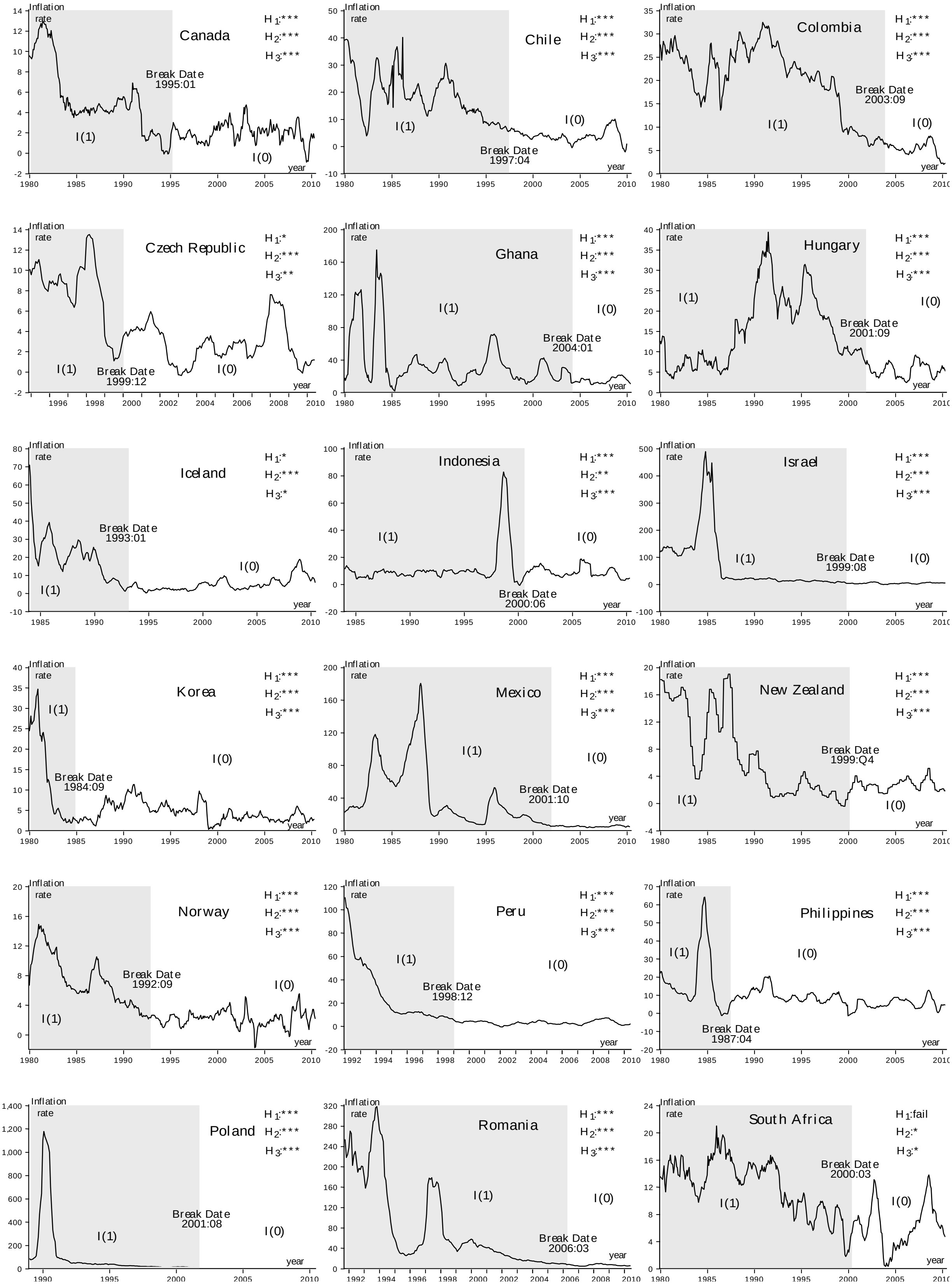

Figure 1: Annualised inflation, continued

Notes: see below.

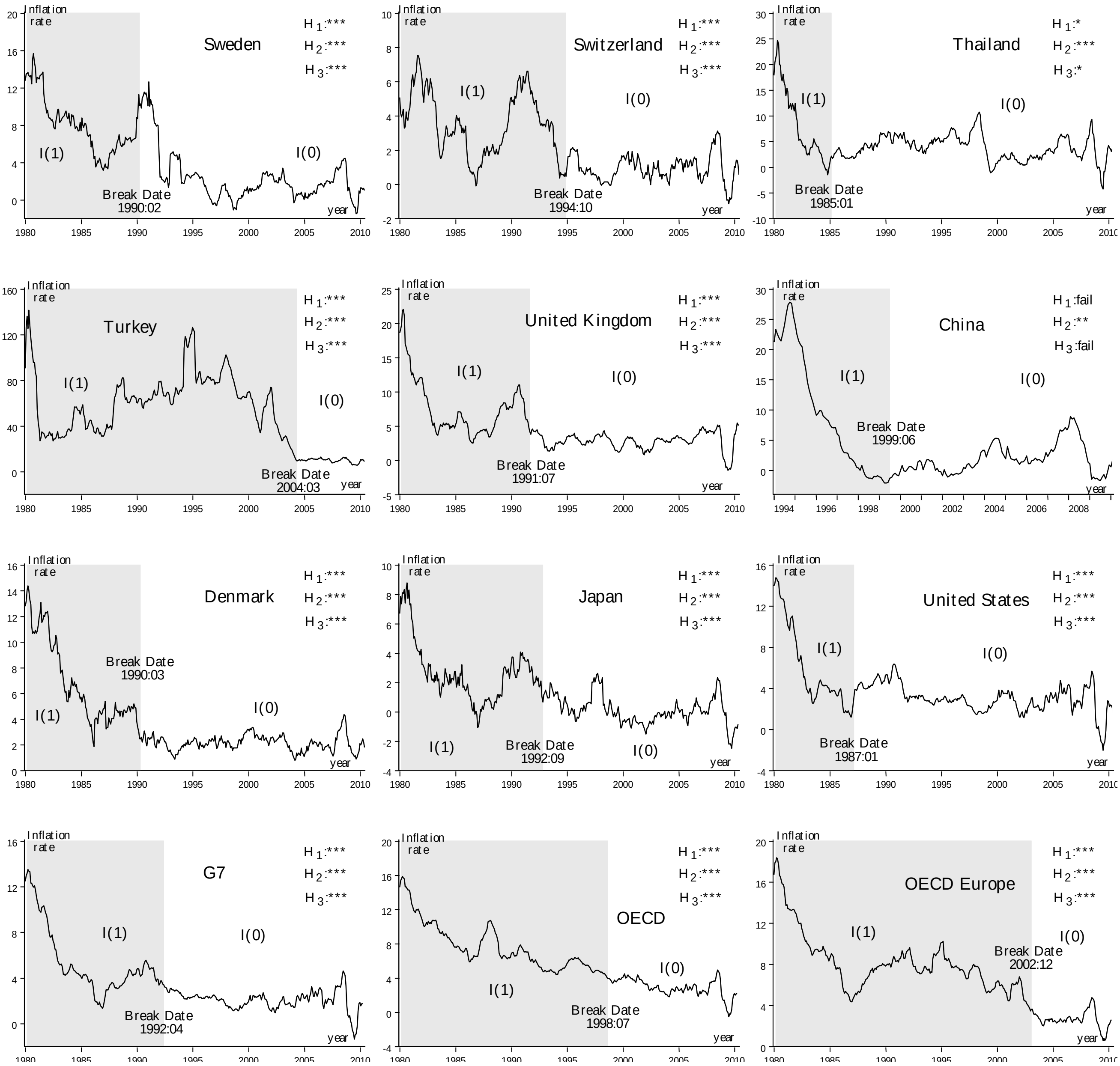

Figure 1: Annualised inflation, continued

Notes: a) For the vast majority of the countries, the sample we examine extends from 1980:01 to 2010:06 (monthly frequency) and includes 366 observations. Exceptions, due to a lack of data, are the following countries: Slovakia (1994:01 to 2010:06), Slovenia (1991:01 to 2010:06), Czech Republic (1994:01 to 2010:06), Iceland (1984:01 to 2010:06), Romania (1991:10 to 2010:06) and China (1994:01 to 2010:06). b) For Australia and New Zealand, no monthly observations are available. Therefore, we use quarterly data for the period 1980:Q1 to 2010:Q2. c) the vertical axis, in each graph, measures the percentage change in the CPI and the horizontal axis measures time. d) H_1, H_2, and H_3 denote the three alternative statistics we use to test for a change in persistence. We present these statistics analytically in Section 2 (see equations 1, 2 and 3). e) I(1) implies non-stationary for the series of interest (the grey area in the graph), while I(0) suggests stationarity (the white area in the graph). f) The symbols ***, ** and * signify a change in persistence from I(1) to I(0) at the 0.01, 0.05 and 0.10 significance level respectively. g) To estimate the location of the break date for a change from I(1) to I(0) we use equation 8 (see section 2). h) Finally, we also communicate in more detail the test results for a change in persistence in Table 2 below.

Table 1: Full sample summary statistics and ADF unit-root testing

Country	Sample	Mean	Max.	Min.	St. Dev.	ADF-stat. (*p*-value)
			euro area countries			
Austria	1980m01–2010m06	2.72	7.40	–0.27	1.62	–2.68 (0.077)
Belgium	1980m01–2010m06	3.03	9.85	–1.68	2.26	–1.86 (0.351)
Cyprus	1980m01–2010m06	4.12	16.55	–1.22	2.82	–3.62 (0.006)
Finland	1980m01–2010m06	3.68	13.76	–1.55	3.33	–2.92 (0.043)
France	1980m01–2010m06	3.63	14.31	–0.72	3.67	–3.46 (0.009)
Germany	1980m01–2010m06	2.33	7.45	–0.99	1.68	–2.39 (0.143)
Greece	1980m01–2010m06	11.14	26.99	0.49	7.90	–1.56 (0.498)
Ireland	1980m01–2010m06	4.81	23.15	–6.56	5.32	–2.48 (0.121)
Italy	1980m01–2010m06	5.85	22.08	0.00	5.32	–3.73 (0.004)
Luxembourg	1980m01–2010m06	3.08	10.75	–1.41	2.39	–1.89 (0.334)
Malta	1980m01–2010m05	2.98	17.44	–3.36	3.42	–4.41 (0.000)
Netherlands	1980m01–2010m06	2.45	7.32	–1.29	1.67	–2.86 (0.050)
Portugal	1980m01–2010m06	8.61	33.88	–1.59	8.01	–1.25 (0.653)
Slovakia	1994m01–2010m06	6.55	16.54	0.40	3.80	–2.42 (0.136)
Slovenia	1991m01–2010m06	25.54	323.70	–0.58	59.03	–20.53 (0.000)
Spain	1980m01–2010m06	5.73	16.90	–1.40	4.07	–2.34 (0.159)
			Inflation-targeting countries			
Australia	1980Q01–2010Q02	4.66	12.32	–0.33	3.24	–1.91 (0.324)
Brazil	1980m12–2010m06	447.28	6821.28	1.64	1012.41	–3.84 (0.002)
Canada	1980m01–2010m06	3.58	12.86	–0.94	2.96	–2.89 (0.047)
Chile	1980m01–2010m06	12.22	39.90	–2.26	9.86	–2.37 (0.150)
Colombia	1980m01–2010m06	17.06	32.36	1.82	9.01	–0.67 (0.849)
Czech Rep.	1994m01–2010m06	4.72	13.44	–0.40	3.61	–1.49 (0.535)
Ghana	1980m01–2010m06	31.61	174.14	1.13	29.71	–3.32 (0.014)
Hungary	1980m01–2010m06	12.33	39.20	2.28	8.61	–1.40 (0.580)
Iceland	1984m01–2010m06	9.88	70.79	–0.05	10.46	–3.18 (0.022)
Indonesia	1980m01–2010m06	10.95	82.40	–1.09	11.32	–3.84 (0.002)
Israel	1980m01–2010m06	47.74	486.22	–2.74	92.77	–2.35 (0.156)
Korea	1980m01–2010m06	5.72	34.55	0.16	5.78	–4.97 (0.000)
Mexico	1980m01–2010m06	31.49	179.73	2.91	37.01	–2.11 (0.238)
New Zealand	1980Q01–2010Q02	5.50	18.94	–0.49	5.45	–2.14 (0.228)
Norway	1980m01–2010m06	4.26	14.80	–1.83	3.42	–2.76 (0.063)
Peru	1980m01–2010m06	434.89	12377.80	–1.11	1491.95	–3.57 (0.006)
Philippines	1980m01–2010m06	9.69	63.81	–1.77	9.78	–3.14 (0.024)
Poland	1989m01–2010m06	62.48	1173.27	0.07	192.69	–9.27 (0.000)
Romania	1991m10–2010m06	63.21	316.97	3.65	80.29	–2.26 (0.184)
South Africa	1980m01–2010m06	10.14	20.94	0.16	4.65	–1.31 (0.621)
Sweden	1980m01–2010m06	4.19	15.57	–1.55	3.92	–2.16 (0.219)
Switzerland	1980m01–2010m06	2.17	7.48	–1.18	1.90	–2.14 (0.227)
Thailand	1980m01–2010m06	4.40	24.51	–4.38	4.04	–4.12 (0.001)
Turkey	1980m01–2010m06	50.31	140.91	5.07	30.72	–0.97 (0.761)
UK	1980m01–2010m06	4.58	21.93	–1.56	3.64	–3.69 (0.004)
			Other countries & Groups			
China	1994m01–2010m02	4.26	27.70	–2.20	7.00	–4.09 (0.001)
Denmark	1980m01–2010m06	3.68	14.32	0.74	2.97	–3.47 (0.009)
Japan	1980m01–2010m06	1.13	8.73	–2.53	1.95	–3.77 (0.003)
US	1980m01–2010m06	3.68	14.68	–2.09	2.62	–3.88 (0.002)
G7	1980m01–2010m06	3.37	13.43	–1.43	2.58	–4.13 (0.001)
OECD EU	1980m01–2010m06	6.75	18.30	0.50	3.42	–2.28 (0.178)
OECD	1980m01–2010m06	5.74	15.78	–0.62	3.22	–2.48 (0.119)

Notes: a) in the sample column, the first date is the start of the sample while the second is the end of the sample. b) m denotes data at monthly frequency and Q denotes data at quarterly frequency. The subsequent number denotes the month or quarter that the sample starts or ends in. c) ADF is the augmented Dickey-Fuller test. d) in the implementation of the ADF test we assume no-trend in the test equation and for the selection of the lag-length we use the Schwarz information criterion.

4. Empirical results

4.1 Change in inflation persistence

Our analysis starts with the full sample unit root tests. Given the mixed results of the ADF test in Table 1 (literature finds that the stationarity properties of inflation are not constant, see Halunga *et al*. 2009), we test for a change in persistence. We show the results in Table 2. These results include the sample employed and the three statistics for the two hypotheses of (i) change from I(0) to I(1) and (ii) change from I(1) to I(0), together with the estimated break date. In fourteen out of sixteen euro-area countries, there is a change from I(1) to I(0), with Slovenia and Slovakia the exceptions. The next group is the IT countries, and the I(1) to I(0) change is supported in twenty out of twenty-five of them, while the results are mixed in the remaining countries (Columbia, Hungary, Indonesia, S. Africa and Turkey). The last section in Table 2 includes China, Denmark, Japan and the US, and the three groups of countries G7, OECD Europe, and OECD. The results for China are inconclusive as the sample is limited, but in the other six cases, evidence for a change from I(1) to I(0) emerges.

Overall, inflation appears as I(1) in the early part of the sample (80s) and becomes I(0) after a critical point, which is referred to as the Estimated Break Date (EBD). In Figure 2 we compare the differences in months between the EBD and the Formal Adoption Date (FAD) for the IT countries. If the EBD and the FAD are close, it would translate into short horizontal bars. In twelve countries, the EBD precedes the FAD, doing so by 109 months in New Zealand for instance, while it lags the FAD in the rest twelve countries. Extreme cases are Thailand, the Philippines, and Korea, where the EBD lags the FAD by 184, 177 and 163 months. Obviously, these results do not give conclusive evidence on how the two dates overlap. In total, we find equal numbers of countries where the EBD precedes the FAD and where it lags the FAD.[10] Visual inspection of Figure 2 suggests that there is only proximity in the two dates for Romania and Hungary. We also supplement Figure 2 with some summary statistics in Table A1 in the Appendix.

[10] Brazil is not included as the EBD is an extreme point. For Australia and New Zealand, quarters are converted to months.

Table 2: Change in persistence testing

Country	Break date	Statistics for testing I(0)→I(1)			Break date	Statistics for testing I(1)→I(0)		
		$H_1(K_M(.))_{min}$	$H_2(K_M(.))_{min}$	$H_3(K_M(.))_{min}$		$H_1(K_M(.))_{min}$	$H_2(K_M(.))_{min}$	$H_3(K_M(.))_{min}$
Euro-zone countries								
Austria	2004m06 $_e$	0.134	0.038	0.014	1987m05	87.073***	30.455***	39.343***
Belgium	2004m06 $_e$	0.028	0.006	0.002	1987m10	144.839***	75.477***	67.742***
Cyprus	2004m06 $_e$	0.058	0.027	0.010	1987m03	79.357***	35.680***	35.732***
Finland	2004m06 $_e$	0.095	0.015	0.004	1994m05	83.397***	45.496***	36.660***
France	2004m06 $_e$	0.009	0.001	0.000	1992m05	478.584***	232.202***	229.055***
Germany	2004m06 $_e$	0.057	0.025	0.008	1994m03	40.115***	17.167***	16.927***
Greece	1986m02 $_e$	11.102	2.923	3.914	1999m10	247.639***	48.409***	108.655***
Ireland	2004m06 $_e$	0.013	0.008	0.002	1987m06	18.452**	13.561***	7.513**
Italy	1986m02 $_e$	0.002	0.000	0.000	1996m09	664.274***	235.192***	328.272***
Luxembourg	2004m06 $_e$	0.018	0.004	0.001	1988m04	147.160***	62.256***	67.814***
Malta	2004m06 $_e$	0.002	0.001	0.000	1986m05	181.266***	90.587***	85.549***
Netherlands	2000m12	0.012	0.008	0.001	1988m06	60.488***	13.874***	26.200***
Portugal	1986m02 $_e$	2.871	0.287	0.334	1995m10	76.208***	30.398***	32.446***
Slovakia	1999m06	9.634	2.294	2.862	2004m12	2.191	0.560	0.407
Slovenia	2007m06 $_e$	0.439	0.173	0.063	1998m01 $_e$	2.454	1.438	0.786
Spain	2004m06 $_e$	0.317	0.039	0.014	1995m07	78.909***	37.857***	35.696***
Inflation-targeting countries								
Australia	1986Q03	0.918	0.142	0.074	2001Q02	799.178***	140.774***	392.197***
Brazil †	2002m11	0.359	0.141	0.050	2007m07 $_e$	22.772**	3.471	8.597**
Canada	2004m06 $_e$	0.003	0.001	0.000	1995m01	163.941***	77.138***	77.101***
Chile	1989m11	13.390	3.123	4.755	1997m04	67.754***	29.205***	29.743***
Colombia	1988m03	43.726***	13.075***	18.853***	2003m09	113.813***	11.254***	49.018***
Czech Rep.	1998m01 $_e$	7.077	0.257	1.155	1999m12	16.628*	7.914***	6.387**
Ghana	1995m03	0.265	0.104	0.051	2004m01	307.032***	35.878***	145.705***
Hungary	1987m07	768.189***	65.894***	367.710***	2001m09	295.583***	42.756***	136.369***
Iceland	2005m03 $_e$	0.377	0.089	0.039	1993m01	14.401*	7.581***	5.069*
Indonesia	1997m12	24.433**	4.255*	8.278**	2000m06	45.793***	5.721**	18.221***

Notes: (a) ***, ** and * denote a change in persistence at the 0.01, 0.05 and 0.10 significance level respectively. (b) The subscript e signifies that the identified breakpoint is located on an extreme of the initial search interval [0.20–0.80]. (c) The superscript † implies that an extreme breakpoint is also combined with a significant change in the persistence. In these cases, we amend the search interval to [0.15–0.85] and the tests for a change in persistence are implemented from the beginning. (d) On those cases where there is no evidence of a significant change in the persistence, given the identification of an extreme breakpoint, then the extreme breakpoint is disregarded and the testing procedure is not repeated for the extended search interval.

Table 2: Change in persistence testing, continued

Country	Break date	Statistics for testing I(0)→I(1)			Break date	Statistics for testing I(1)→I(0)		
		$H_1(K_M(.))_{min}$	$H_2(K_M(.))_{min}$	$H_3(K_M(.))_{min}$		$H_1(K_M(.))_{min}$	$H_2(K_M(.))_{min}$	$H_3(K_M(.))_{min}$
Inflation-targeting countries (continued)								
Israel	1986m02 e	0.016	0.003	0.001	1999m08	926.556***	586.374***	676.896***
Korea†	2005m11 e	0.024	0.002	0.004	1984m09	581.440***	142.162***	281.137***
Mexico	1986m05	3.838	0.339	0.429	2001m10	724.031***	337.753***	373.500***
N. Zealand	1986Q03	1.486	0.115	0.073	1999Q04	958.553***	256.141***	564.051***
Norway	2003m12	0.033	0.005	0.001	1992m09	258.789***	139.025***	125.209***
Peru	2006m11 e	0.000	0.000	0.000	1998m12	641.159***	208.118***	227.242***
Philippines	2004m06 e	0.434	0.132	0.066	1987m04	162.917***	41.325***	76.607***
Poland	1993m05 e	0.004	0.005	0.000	2001m08	261.734***	306.316***	192.123***
Romania	1995m07 e	0.197	0.033	0.012	2006m03	102.608***	154.718***	37.065***
S. Africa†	1985m01	67.162***	5.794**	28.631***	2000m03	10.548	3.726*	3.568*
Sweden	1986m02 e	0.528	0.089	0.036	1990m02	192.208***	62.820***	88.167***
Switzerland	1986m02 e	1.461	0.294	0.155	1994m10	131.723***	45.908***	61.252***
Thailand†	2005m11 e	0.012	0.013	0.003	1985m01	17.372*	7.760***	6.030**
Turkey	1994m03	10.746	4.555*	3.029	2004m03	263.594***	97.625***	123.579***
UK	2004m06 e	0.016	0.006	0.001	1991m07	100.182***	60.403***	46.175***
Other countries & Groups								
China	2006m12 e	0.000	0.000	0.000	1999m06	10.250	7.069**	3.678
Denmark	2004m06 e	0.009	0.001	0.000	1990m03	545.549***	302.392***	263.543***
Japan	2004m06 e	0.081	0.035	0.010	1992m09	52.361***	16.131***	22.663***
US	2004m06 e	0.002	0.001	0.000	1987m01	71.582***	38.464***	32.731***
G7	2004m04 e	0.000	0.000	0.000	1992m04	175.663***	84.571***	82.724***
OECD EU	1994m07	0.025	0.025	0.004	2002m12	116.406***	12.696***	52.345***
OECD	1986m02 e	0.184	0.064	0.018	1998m07	136.591***	27.647***	62.882***

Notes: (a) ***, ** and * denote a change in persistence at the 0.01, 0.05 and 0.10 significance level respectively. (b) The subscript e signifies that the identified breakpoint is located on an extreme of the initial search interval [0.20–0.80]. (c) The superscript † implies that an extreme breakpoint is also combined with a significant change in the persistence. In these cases, we amend the search interval to [0.15–0.85] and the tests for a change in persistence are implemented from the beginning. (d) On those cases where there is no evidence of a significant change in the persistence, given the identification of an extreme breakpoint, then the extreme breakpoint is disregarded and the testing procedure is not repeated for the extended search interval.

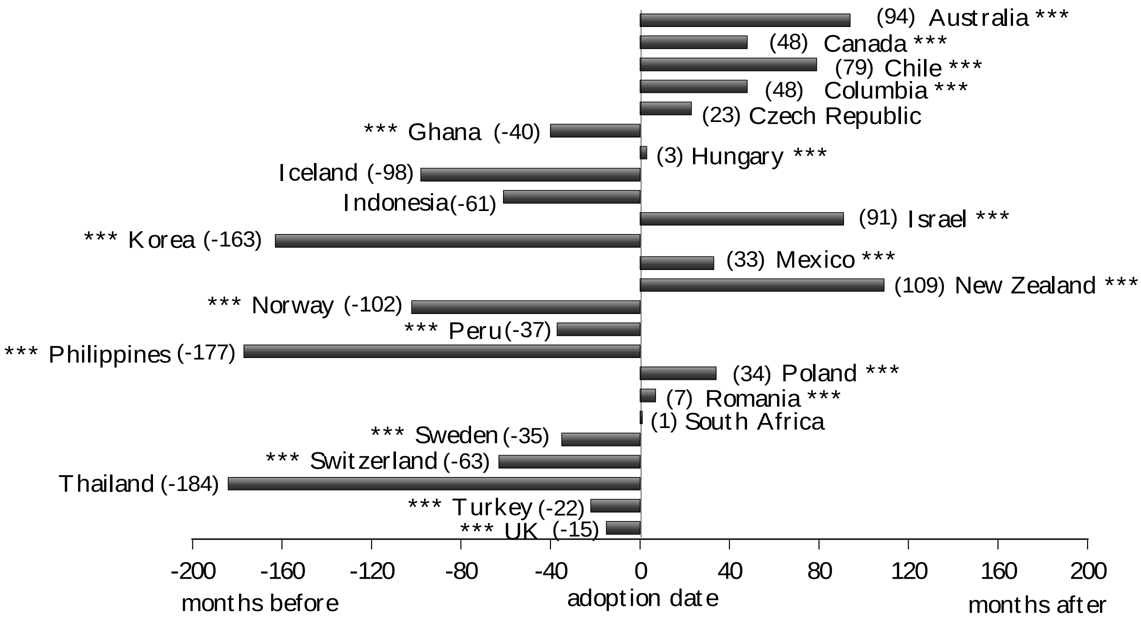

Figure 2: Difference between the formal adoption date and the estimated break date

Notes: (a) Figures within parentheses denote the time difference in months between the formal adoption date and the estimated break date for all the inflation targeting countries, (b) *** denotes a 0.01 significant change in persistence provided that there is agreement among the three alternative tests, (c) Brazil is excluded since the estimated break date has been found to be an extreme breakpoint.

4.2 Analysis of inflation variability

We proceed by analysing inflation variability, which is summarised in Table A1 (see the Appendix). This table presents the observations and the variance of inflation before and after the FAD and the EBD for both IT and non-IT countries. In the same table, we also test for a possible change in the observed variance of inflation. For the IT countries, the pre-specified point in time is the FAD, while for the remaining countries we use the EBD.[11] As the standard *F*-test requires normality and the inflation series are far from normal,[12] we test for change in the variance of inflation using the statistic proposed by Brown and Forsythe (1974). The Brown and Forsythe (1974) test employs the median as a measure of central tendency instead of the mean. The test remains robust against non-normality, preserving at the same time a desirable level of statistical power (Conover *et al*., 1981). Overall, the results in Table A1 provide overwhelming support for a change in the variance of inflation that is related to FAD or EBD as the pre-specified point in time.

All the countries except Indonesia appear to experience a significant decrease in the variance of inflation that can be taken as related to the great moderation. This means we cannot compare IT and non-IT countries to look at how effective the IT regime is in controlling the variance of inflation. Hence, we focus on the changes in the variability of inflation and use the methodology proposed by Hawkins and Zamba (2005). This allows us to determine the percentage of time that the changes in the variability of inflation are in-control. If IT is an effective policy framework, it would be expected that inflation targeters can control more effectively the change in the variability of

[11] For countries with no significant change in the persistence of inflation, we split the sample into two equal parts.

[12] Looking at the empirical distribution of the data, we test for normality in the inflation series with Watson's (1961) U^2 test statistic. See Table A1 in the Appendix.

inflation, as measured by MAD, than other countries do. As such, the variability of inflation should be in-control in inflation targeters for a higher proportion of time on average than it is in the other countries.

It is worth noting that the number of countries in the two groups we examine are relatively balanced, with 25 inflation targeters and 20 non-inflation targeters. Given this, if we define a central cut-off point in the distribution of the percentages in which the process is in-control, we would expect most of countries in the upper half of the distribution to be inflation targeters. In this case the cut-off point at the median becomes a critical threshold that separates the countries into two groups. The first group, in the upper part of the distribution, contains countries that control inflation variability more effectively and as such, IT countries might be expected to be over-represented in this group. The lower part of the distribution, which is less effective at controlling inflation variability, is expected to contain more non-IT countries.

We apply this framework to our case as follows. First, we estimate the variability of inflation on a rolling basis by employing a fixed window of 24 observations and taking the Median Absolute Deviation (MAD). We select the MAD over other alternatives like standard deviation since it remains robust to outliers. Having obtained the rolling estimates of MAD, we calculate the $G_{max,n}$ statistic for the log-change of MAD to identify a possible shift in variance using an initial benchmark window of 48 observations.[13] Once the first $G_{max,n}$ statistic is obtained, we monitor the changes in variance by rolling the window and retaining the size fixed. As the window moves towards the end of the sample, we evaluate a new $G_{max,n}$ statistic for every new observation that enters the window. Provided that $G_{max,n} \leq h_{\alpha,n}$, the process is in-control and we can compute the percentage of time that the process is in-control for each country. The results for each country are presented in Figure 3.[14] To determine the central cut-off point in the distribution of the percentages we use the median. The central cut-off point that separates the countries into two groups is 79%, meaning that countries are in control of inflation variability 79% of the time.[15] We may argue, therefore, that countries with a percentage greater than 79% are those that control the variability of inflation more effectively than the other countries.

4.3 Logit analysis

To examine the three hypotheses introduced in section 2.3, we estimate equation (12) using the appropriate binary variable as a dependent variable. From a sample of 45 countries, we present the estimates of the three cross-sectional specifications in Table 3. For the first hypothesis of a significant change in the persistence associated with the IT countries, the coefficient of the IT dummy ($D_{IT,i}$) is positive (2.647) and insignificant at the conventional levels of significance (specification 1 in Table 3). These results suggest that IT countries face a similar probability of a significant change in inflation persistence from I(1) to I(0) to that faced by non-IT countries. The quality of institutions emerges as significant for the changes observed in the persistence of inflation at the 0.05 significance level.

[13] By taking account of the existence of outliers (MAD is robust to outliers) and by removing trends using the change in MAD, the series that are finally obtained are made approximately normal.

[14] We also present the percentage of time that the changes in the variability of inflation are in-control for each country in Table A2 in the Appendix.

[15] By using the mean to determine the central cut-off point, the value is 79.2%.

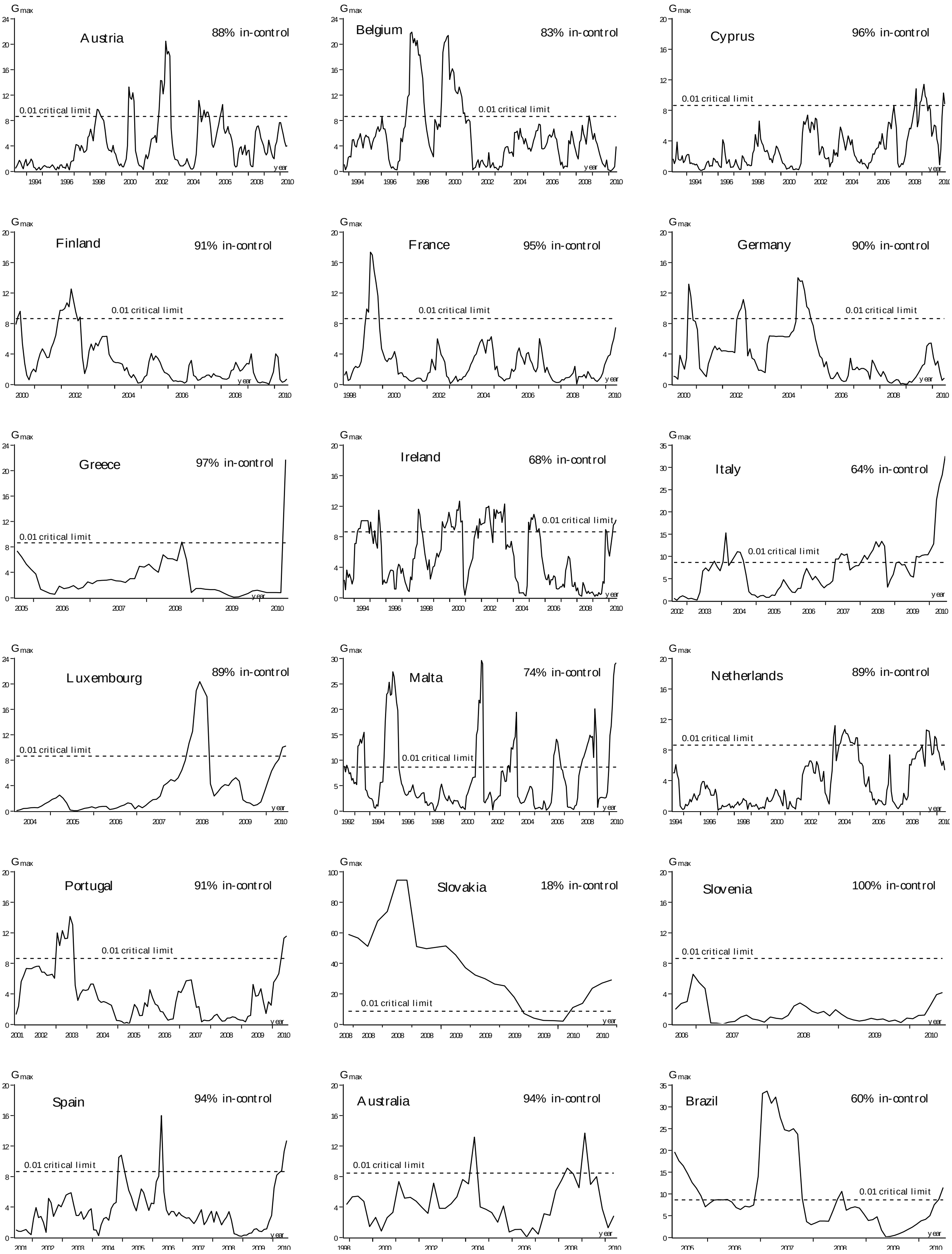

Figure 3: Rolling test for variance homogeneity in the MAD change of inflation

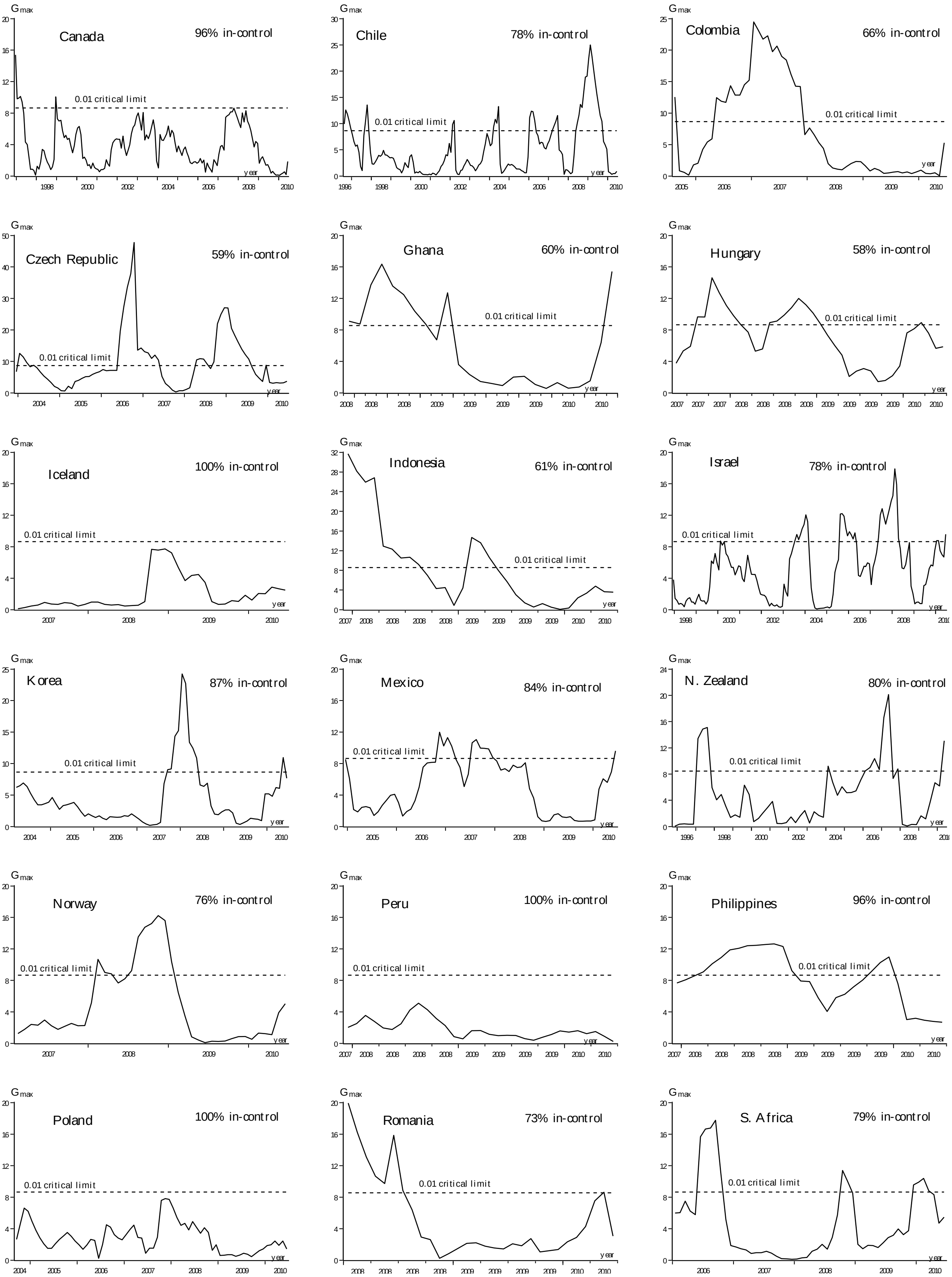

Figure 3: Rolling test for variance homogeneity in the MAD change of inflation, continued

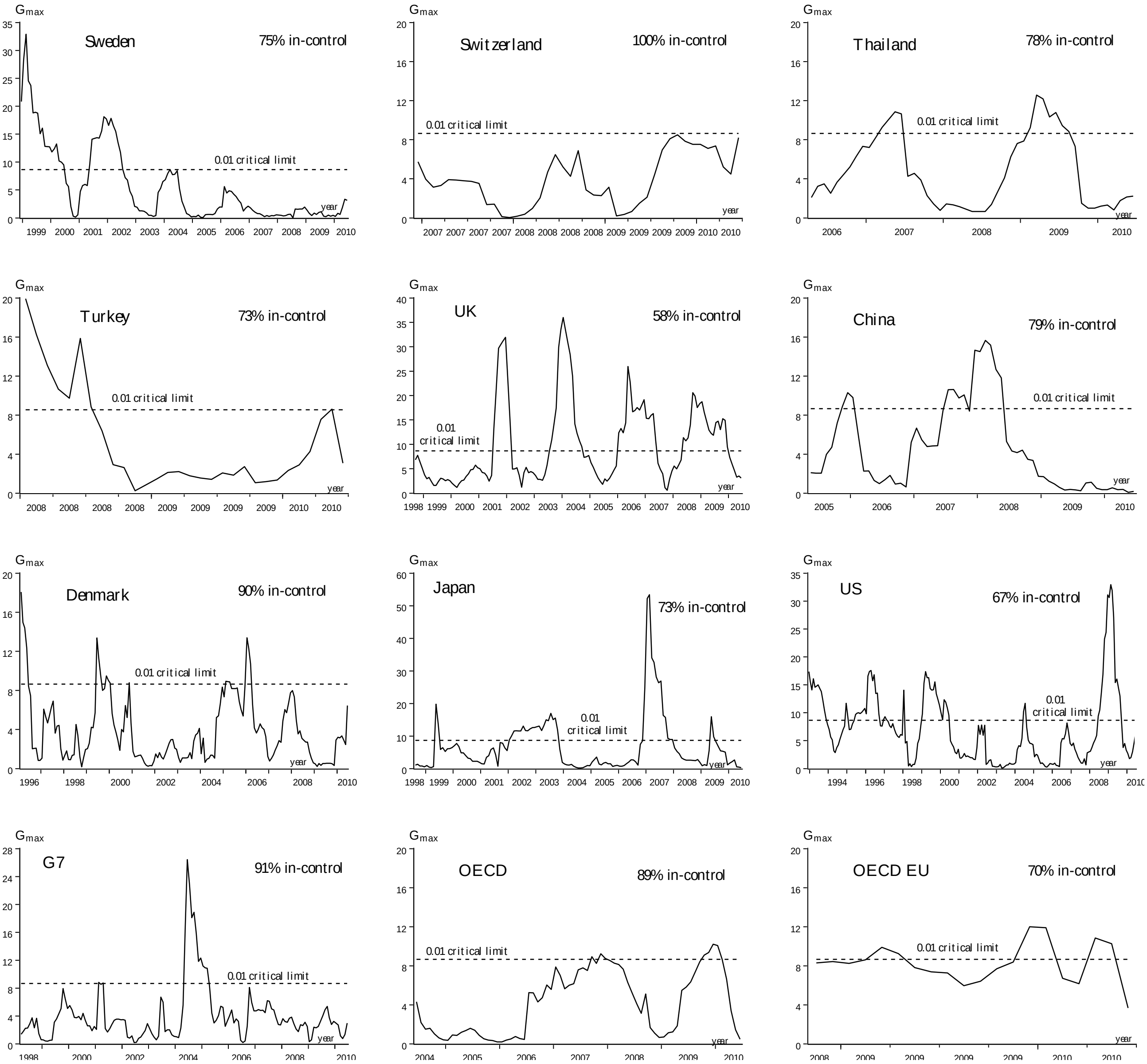

Figure 3: Rolling test for variance homogeneity in the MAD change of inflation, continued

Notes: The upper right percentage presented in each graph indicates the percentage of time that the process is in-control for each country or group of countries. When the line is below the 0.01 critical limit it is implied that the process is in-control, while if the opposite is true the process is out of control.

For the second hypothesis (significant changes in the variability of inflation are less frequent in IT countries), the coefficient of the IT dummy ($D_{IT,i}$) is now negative (–0.896) and again insignificant (see specification 2 in Table 3). This finding implies that IT countries do not appear to control changes in the variability of inflation in a more effective way than other countries do. Again, the quality of institutions (Q_i) is significant at the 0.1 significance level. Finally, for the third hypothesis discussed above (IT countries are significantly better than other countries at achieving jointly a change in the persistence and control in the variability of inflation), the emerging significance pattern is identical to that in the previous two cases. Specifically, the IT dummy ($D_{IT,i}$) is negative (–0.479) and insignificant, while the quality of institutions (Q_i) continues to be significant (see specification 3 in Table 3).

All these inferences could be questionable if the specifications estimated do not pass the necessary diagnostic tests. In other words, when we adopt the Maximum Likelihood approach to estimate a model's coefficients, certain types of misspecification, such as the assumed symmetry of the logistic function or the presence of heteroskedastic errors, may heavily influence the credibility of our inferences. Logit models are misspecified and deliver inconsistent estimates if the distribution of the error term does not meet the assumption of symmetry. Therefore, we use an LM type test (see Thomas, 1993) to examine the symmetry assumption imposed by the underlying logistic distribution. In all three specifications, we fail to reject the null hypothesis of symmetry (see the Burr Type 2 LM test in Table 3), revealing the use of the logit specification to be a rational choice. Additionally, we test the null hypothesis that the specification is the logistic over a more general functional form using a RESET type LM test, as proposed in Davidson and MacKinnon (1984; 2004). Again, for all three specifications, we fail to reject the null at the conventional levels of significance (see the RESET LM test in Table 3), further supporting the use of the logit model.

Another matter of concern is the possible presence of heteroskedasticity in the error term, an issue that may result in inconsistent estimates. For this reason, we carry out the LM type test for heteroskedasticity as illustrated in Davidson and MacKinnon (2004). The LM test is conducted for all three of the specifications (see in Table 3 the Hetero. LM test) and fails to reject the null hypothesis of homoskedasticity. Finally, we test for the exogeneity of the binary IT dummy ($D_{IT,i}$) by conducting a Hausman type LR test as described in Knapp and Seaks (1998).[16] To execute the test for the three specifications of interest (see section 2.3), we use an appropriate instrument for each specification. In the first specification, we instrument the IT dummy ($D_{IT,i}$) on the median value of inflation before the FAD or the EBD depending on whether the country is an IT country or not. In the second specification, we instrument the IT dummy ($D_{IT,i}$) on the MAD value of inflation before the FAD or the EBD depending on the country, while in the third specification both of these two instruments are employed jointly. In this manner, we create three distinct systems of equations, each of which contains two equations.[17] To attain consistent estimates for the parameters, we estimate each system through the Full Information Maximum Likelihood approach. Once we obtain the estimates, we test for the exogeneity ($\rho_{\varepsilon,u} = 0$)[18] of the IT dummy ($D_{IT,i}$) in the three systems. In all cases, we fail to reject the null hypothesis that the regressor of interest is exogenous.

Overall, we provide econometric evidence that the IT regime has no significant effect on the change in the persistence of the annualised inflation series from I(1) to I(0)[19]. Additionally, the IT regime seems to provide no advantage in controlling changes in the variability of inflation more effectively. Furthermore, our results imply that the quality of institutions matters more than the monetary policy announcement. The reported findings need to be treated with some degree of caution since many non-targeting countries in our sample implement policies that are close to those of the IT countries.

[16] Knapp and Seaks (1998) propose a method for testing exogeneity for a dichotomous right-hand side variable in a probit specification.

[17] We present the three systems analytically in the notes section of Table 3.

[18] $\rho_{\varepsilon,u}$ is the correlation of the error terms that correspond to the two equations of the system.

[19] Central Bank Independence was also proposed as a way to tame inflation. In a literature conceptually similar to IT, Forder (1998) points out that: "The test might appear to show a statistical regularity, say between the content of the statutes of a central bank and the rate of inflation, but in the absence of a theoretical connection that would be of no interest. We might note that the European German-speaking countries (Germany, Switzerland, and Austria) have low inflation. This does not mean that if we all started speaking German, inflation would fall".

Table 3: Binary Logit estimates

Independent variables	Dependent variable D_1 ML estimates specification (1)	Dependent variable D_2 ML estimates specification (2)	Dependent variable D_3 ML estimates specification (3)
c	–0.883**	–0.205	–1.261
D_{IT}	2.647	–0.896	–0.479
Q	2.291**	0.799*	1.248**
Regression diagnostics			
McFadden R^2	0.228	0.120	0.160
LR stat.	7.173	7.454	9.968
LR stat. *p*-value	0.027	0.024	0.006
Log-likelihood	–12.111	–27.364	–26.107
Burr Type 2 LM test	0.207	0.308	2.023
Burr Type 2 LM test *p*-value	0.648	0.578	0.155
Hetero. LM test	3.147	0.525	2.318
Hetero. LM test *p*-value	0.207	0.769	0.314
RESET LM test	–0.335	0.448	1.340
RESET LM test *p*-value	0.737	0.633	0.180
LR stat. for exogeneity (D_{IT})	2.654	0.228	0.101
LR stat. for exogeneity *p*-value	0.103	0.633	0.751

Notes: The system used to test for exogeneity in (1) is: $D_1 = b_{1,0} + b_{1,1}D_{IT,i} + b_{1,2}Q_i + \varepsilon_{1,i}$ and $D_{IT,i} = b_{1,3} + b_{1,4}M_i^b + u_{1,i}$. Similarly, the system in the specification (2) is: $D_2 = b_{2,0} + b_{2,1}D_{IT,i} + b_{2,2}Q_i + \varepsilon_{2,i}$ and $D_{IT,i} = b_{2,3} + b_{2,4}AD_i^b + u_{2,i}$, while for specification (3) is: $D_3 = b_{3,0} + b_{3,1}D_{IT,i} + b_{3,2}Q_i + \varepsilon_{3,i}$ and $D_{IT,i} = b_{3,3} + b_{3,4}M_i^b + b_{3,5}AD_i^b + u_{3,i}$.

5. Conclusions

Inflation targeting has become an important tool for monetary policy. There have been at least two possible explanations for the significant reduction in inflation and inflation variability that has been observed in the past decades. One argument is that it is an outcome of the great moderation, while the alternative is that inflation targeting was the catalyst for the change observed in the persistence of inflation.

This paper employs a test for change in persistence to examine whether the stationarity properties of inflation have changed. We use data from forty-five countries and three groups of countries (the G7, OECD Europe, and the OECD). We consider a change in persistence from I(0) to I(1) and vice versa. The evidence that emerges supports a change in persistence from I(1) to (0) in most of the cases. The methodology employed, allows us to date the break in the stationarity properties, and we then compare the estimated break date from the test for change in persistence with the formal adoption date of inflation targeting. Graphical analysis indicates that the two dates did not overlap. Logit analysis indicates that IT does not affect the change in persistence in a statistically significant way. Quality of government is examined as an alternative driver and it emerges as significant for the change in persistence.

The second part of the analysis employs a test to monitor whether inflation variability is in-control. IT adopters are compared with non-IT adopters. Logit analysis does not provide any evidence that inflation targeters are associated with more control of the variability of inflation. The quality of institutions seems to reduce inflation variability in a statistically significant way. When we consider both (i) a change in inflation persistence and (ii) being in-control of inflation variability, IT is again not found to be statistically significant, whereas the quality of institutions is.

Overall, the evidence provided suggests that (i) a change in the persistence of inflation and (ii) lower variability in inflation have both occurred but inflation targeting did not make a statistically significant contribution to either. The quality of institutions emerges as a more significant driver of the change in the persistence of inflation and of lower inflation variability. Our results do not argue against inflation targeting policies, but rather we view the quality of central banks and institutions as a vital element in ensuring economic and financial stability since the recent financial crisis, where near-zero interest rates are observed. This issue has recently been taken up by Balls *et al*. (2016) among others, and they argue that central banks need to work more closely with a range of institutions, including the government, at monetary-fiscal coordination, monetary-debt management coordination, and systemic risk monitoring. With this in mind, we also note fresh research by Fazio *et al*. (2015), who argue that IT national banking systems are more stable, possess sounder systemically important banks, and are less distressed than, or at least no more distressed than, other banking systems during periods where global liquidity shortages emerge. The research agenda on all these issues definitely has plenty to offer.

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Appendix

Table A1: Test for a shift in inflation variance

Country	Sample split date	Split date nature	Obs. before split date	Obs. after split date	Var. before split date	Var. after split date	Watson U^2 statistic (*p*-value)	Brown-Forsythe statistic (*p*-value)
Euro area countries								
Austria	1987m05	EBD	88	278	3.998	0.997	0.910 (0.000)	100.186 (0.000)
Belgium	1987m10	EBD	93	273	7.091	1.161	3.104 (0.000)	91.075 (0.000)
Cyprus	1987m03	EBD	86	280	16.551	2.649	1.529 (0.000)	112.394 (0.000)
Finland	1994m05	EBD	172	194	10.504	1.188	1.853 (0.000)	125.277 (0.000)
France	1992m05	EBD	148	218	17.785	0.527	6.933 (0.000)	145.564 (0.000)
Germany	1994m03	EBD	170	196	3.955	0.526	1.424 (0.000)	133.413 (0.000)
Greece	1999m10	EBD	237	129	42.721	0.856	2.503 (0.000)	207.013 (0.000)
Ireland	1987m06	EBD	89	277	42.484	2.194	5.703 (0.000)	235.616 (0.000)
Italy	1996m09	EBD	200	166	30.888	0.461	4.744 (0.000)	90.028 (0.000)
Luxembourg	1988m04	EBD	99	267	12.758	1.015	2.290 (0.000)	226.426 (0.000)
Malta	1986m05	EBD	76	290	42.410	1.535	2.717 (0.000)	194.774 (0.000)
Netherlands	1988m06	EBD	101	265	7.469	0.872	1.646 (0.000)	222.508 (0.000)
Portugal	1995m10	EBD	189	177	56.242	1.578	3.087 (0.000)	161.726 (0.000)
Slovakia	2002m04	MID	99	99	11.821	6.343	0.316 (0.001)	4.441 (0.036)
Slovenia	2000m10	MID	117	117	6096.528	6.769	10.446 (0.000)	26.086 (0.000)
Spain	1995m07	EBD	186	180	14.859	1.554	2.655 (0.000)	107.665 (0.000)
Inflation-targeting countries								
Australia	1993Q01	FAD	52	70	9.389	2.021	0.701 (0.000)	22.474 (0.000)
Brazil	1999m06	FAD	222	133	1.45×10^6	9.457	12.181 (0.000)	40.768 (0.000)
Canada	1991m01	FAD	132	234	9.537	1.576	2.654 (0.000)	49.366 (0.000)
Chile	1990m09	FAD	128	233	67.593	37.945	1.666 (0.000)	14.299 (0.000)
Colombia	1999m09	FAD	236	130	22.446	3.699	2.207 (0.000)	84.246 (0.000)
Czech Republic	1998m01	FAD	48	150	1.167	2.917	0.967 (0.000)	10.775 (0.000)
Ghana	2007m05	FAD	328	38	950.615	14.065	5.959 (0.000)	12.097 (0.000)
Hungary	2001m06	FAD	257	109	76.224	3.425	2.608 (0.000)	144.757 (0.000)
Iceland	2001m03	FAD	206	112	150.875	16.127	3.698 (0.000)	38.339 (0.000)
Indonesia	2005m07	FAD	306	60	147.849	21.711	9.284 (0.000)	0.820 (0.366)

Table A1: Test for a shift in inflation variance, continued

Country	Sample split date	Split date nature	Obs. before split date	Obs. after split date	Var. before split date	Var. after split date	Watson U^2 statistic (*p*-value)	Brown-Forsythe statistic (*p*-value)
Inflation-targeting countries (continued)								
Israel	1992m01	FAD	144	222	1.48×10^4	21.467	11.743 (0.000)	228.103 (0.000)
Korea	1998m04	FAD	219	147	46.978	2.331	6.475 (0.000)	30.689 (0.000)
Mexico	1999m01	FAD	228	138	1570.168	13.588	5.345 (0.000)	86.431 (0.000)
N. Zealand	1990Q01	FAD	40	82	26.295	2.008	1.833 (0.000)	115.382 (0.000)
Norway	2001m03	FAD	254	112	12.867	1.703	2.892 (0.000)	59.012 (0.000)
Peru	2002m01	FAD	264	102	1.27×10^6	3.446	20.708 (0.000)	11.592 (0.000)
Philippines	2002m01	FAD	264	102	119.039	2.669	5.066 (0.000)	16.252 (0.000)
Poland	1998m10	FAD	117	141	7.30×10^4	8.237	13.138 (0.000)	23.547 (0.000)
Romania	2005m08	FAD	166	59	7178.761	2.912	4.428 (0.000)	36.953 (0.000)
S. Africa	2000m02	FAD	241	125	14.983	10.147	0.495 (0.000)	8.433 (0.004)
Sweden	1993m01	FAD	156	210	10.585	1.979	1.902 (0.000)	93.385 (0.000)
Switzerland	2000m01	FAD	240	126	4.023	0.666	1.725 (0.000)	119.699 (0.000)
Thailand	2000m05	FAD	244	122	19.476	4.930	2.254 (0.000)	11.628 (0.001)
Turkey	2006m01	FAD	312	54	760.097	3.978	0.602 (0.000)	80.102 (0.000)
UK	1992m10	FAD	153	213	17.133	1.558	3.743 (0.000)	74.777 (0.000)
Other countries & Groups								
China	1999m06	EBD	65	133	95.179	6.125	2.727 (0.000)	141.764 (0.000)
Denmark	1990m03	EBD	122	244	10.592	0.378	5.286 (0.000)	181.461 (0.000)
Japan	1992m09	EBD	152	214	4.185	0.932	1.171 (0.000)	37.362 (0.000)
US	1987m01	EBD	84	282	16.322	1.757	3.975 (0.000)	95.337 (0.000)
G7	1992m04	EBD	147	219	8.942	0.722	3.645 (0.000)	62.568 (0.000)
OECD EU	2002m12	EBD	275	91	7.811	0.676	0.498 (0.000)	36.037 (0.000)
OECD	1998m07	EBD	222	144	7.467	1.064	0.736 (0.000)	58.016 (0.000)

Table A2: Rolling test for variance homogeneity (in-control) in the MAD change in inflation

Country	Institutions quality (1996–2010 average)	Sample size after the split date	MAD rolling window size	Rolling window size to test for shifts in variance	% of observations in-control at 0.01
Euro area countries					
Austria	1.856	1987m05–2010m06	24 months	48 months	88
Belgium	1.744	1987m10–2010m06	24 months	48 months	83
Cyprus	1.293	1987m03–2010m06	24 months	48 months	96
Finland	2.121	1994m05–2010m06	24 months	48 months	91
France	1.596	1992m05–2010m06	24 months	48 months	95
Germany	1.651	1994m03–2010m06	24 months	48 months	90
Greece	0.692	1994m10–2010m06	24 months	48 months	97
Ireland	1.582	1987m06–2010m06	24 months	48 months	68
Italy	0.589	1996m09–2010m06	24 months	48 months	64
Luxembourg	1.829	1988m04–2010m06	24 months	48 months	89
Malta	1.048	1986m05–2010m06	24 months	48 months	74
Netherlands	1.911	1988m06–2010m06	24 months	48 months	89
Portugal	1.072	1995m10–2010m06	24 months	48 months	91
Slovakia	0.751	2004m12–2010m06	24 months	48 months	18
Slovenia	0.964	2000m10–2010m06	24 months	48 months	100
Spain	1.368	1995m07–2010m06	24 months	48 months	94
Inflation-targeting countries					
Australia	1.765	1993Q01–2010Q02	08 quarters	16 quarters	94
Brazil	-0.057	1999m06–2010m06	24 months	48 months	60
Canada	1.885	1991m01–2010m06	24 months	48 months	96
Chile	1.198	1990m09–2010m06	24 months	48 months	78
Colombia	-0.164	1999m09–2010m06	24 months	48 months	66
Czech Republic	0.866	1998m01–2010m06	24 months	48 months	59
Ghana*	-0.061	2007m05–2010m06	06 months	24 months	60
Hungary	0.839	2001m06–2010m06	12 months	48 months	58
Iceland	1.892	2001m03–2010m06	12 months	48 months	100
Indonesia	-0.360	2005m07–2010m06	06 months	24 months	61

Table A2: Rolling test for variance homogeneity (in-control) in the MAD change, continued

Country	Institutions quality (1996–2010 average)	Sample size after the split date	MAD rolling window size	Rolling window size to test for shifts in variance	% of observations in-control at 0.01
Inflation-targeting countries (continued)					
Israel	1.206	1992m01–2010m06	24 months	48 months	78
Korea	0.926	1998m04–2010m06	24 months	48 months	87
Mexico	0.184	1999m01–2010m06	24 months	48 months	84
N. Zealand	1.765	1990Q01–2010Q02	08 quarters	16 quarters	80
Norway	1.933	2001m03–2010m06	24 months	48 months	76
Peru	–0.323	2002m01–2010m06	24 months	48 months	100
Philippines	–0.057	2002m01–2010m06	24 months	48 months	55
Poland	0.545	1998m10–2010m06	24 months	48 months	100
Romania	–0.330	2005m08–2010m06	06 months	24 months	73
S. Africa	0.599	2000m02–2010m06	24 months	48 months	79
Sweden	1.996	1993m01–2010m06	24 months	48 months	75
Switzerland	1.989	2000m01–2010m06	24 months	48 months	100
Thailand	0.294	2000m05–2010m06	24 months	48 months	78
Turkey	0.112	2006m01–2010m06	06 months	24 months	73
UK	1.756	1992m10–2010m06	24 months	48 months	58
Other countries & Groups					
China	0.002	1999m06–2010m06	24 months	48 months	79
Denmark	2.155	1990m03–2010m06	24 months	48 months	90
Japan	1.312	1992m09–2010m06	24 months	48 months	73
US	1.661	1987m01–2010m06	24 months	48 months	67
G7	-	1992m04–2010m06	24 months	48 months	91
OECD EU	-	2002m12–2010m06	24 months	48 months	70
OECD	-	1998m07–2010m06	24 months	48 months	89

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