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Antonio E. Noriega
Banco de México, Universidad de Guanajuato

Manuel Ramos-Francia
Banco de México

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On the Dynamics of Inflation Persistence Around the World*

Antonio E. Noriega†
Banco de México, Universidad de Guanajuato

Manuel Ramos-Francia‡
Banco de México

Abstract

We study the dynamics of inflation persistence in 45 countries for the period 1960-2008. We use a nonparametric unit root test robust to nonlinearities, error distributions, structural breaks and outliers, many of them typical features of inflation data, and a test for multiple changes in persistence, which decomposes the sample information between adjacent I(0) and I(1) periods. We find that (1) With very few exceptions, inflation around the world rejects a unit root, (2) for several countries there is evidence of significant changes in persistence, (3) bursts and drops in the level of inflation and in inflation persistence tend to coincide, (4) these drops occurred during "the Great Moderation" and during the adoption of inflation targeting. We conclude that inflation is characterized by either a stationary behaviour throughout the sample, or by switches of the type I(0)-I(1)-I(0). For all countries in our sample, any indication of nonstationarity seems to be temporary.

Keywords: Inflation, Multiple persistence change, Stationarity, Unit root tests, Unknown direction of change, Monetary policy.
JEL Classification: C12, C22, E31, E52, E58.

Resumen

Estudiamos la dinámica de la persistencia de la inflación en 45 países para el periodo 1960-2008. Utilizamos inicialmente una prueba no paramétrica de raíz unitaria robusta a muchas de las características típicas de los datos de inflación: no linealidades, distribución de los errores, cambios estructurales y observaciones atípicas. En seguida utilizamos una prueba de cambios múltiples en persistencia, que descompone la información muestral en periodos adyacentes I(0) e I(1). Encontramos que (1) Con muy pocas excepciones, la inflación alrededor del mundo rechaza la presencia de una raíz unitaria, (2) Para varios países existe evidencia de cambios significativos en persistencia, (3) Estallidos y caídas en el nivel y en la persistencia de la inflación tienden a coincidir, (4) Estas caídas ocurrieron durante "la Gran Moderación" y durante la adopción del esquema de objetivos de inflación. Concluimos que la inflación se caracteriza por tener un comportamiento ya sea estacionario a lo largo de la muestra, o por observar cambios del tipo I(0)-I(1)-I(0). Para todos los países en nuestra muestra, cualquier indicación de no estacionariedad parece ser temporal.

Palabras Clave: Inflación, Cambios múltiples en persistencia, Estacionariedad, Pruebas de raíz unitaria, Dirección desconocida de cambio, Política monetaria.

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† Dirección General de Investigación Económica. Email: anoriega@banxico.org.mx.
‡ Dirección General de Investigación Económica. Email: mrfran@banxico.org.mx.

1 Introduction

One aspect of the behavior of inflation that has attracted attention among academics and policy makers is that of persistence, which refers to the reaction of inflation to shocks, or in other words, to the speed (or lag) with which inflation reacts to monetary or non-monetary disturbances. At a theoretical level, the concept of inflation persistence has been linked to central bank preferences[1], the design of robust monetary policy[2], and has even been 'hardwired' into theoretical macro models (see Benati (2002)). At the empirical level, the study of inflation persistence is in a state of flux. As recently put by Santos and Oliveira (2007, p. 4), "In conclusion, the empirical studies do not seem to provide a solid foundation on which to build a claim with respect to inflation persistence, neither in the US nor, more generally, in most OECD economies. More empirical research ... seems to be fundamental for this debate."

In practice, what we observe is that inflation across countries has experienced epochs of *1)* stable behavior, which has been associated with low inflation levels, *2)* sudden bursts of rather short-run duration, and *3)* periods of high instability, usually associated to high inflation levels.[3] [4]

Out of these three possibilities, there are several reasons on why inflation should behave in a stationary fashion, specially after the experience of the US 'Great Inflation' of the 1970s. First, as Hall (1999) argues, "...at least since 1979, there seems little doubt that policy has tried and succeeded in making inflation mean reverting. Any hint of an upsurge in inflation results in the Fed stepping on the brake to bring inflation back to target." (p. 432) A second reason to expect mean reversion in the inflation rate (also discussed in Hall (1999)) is that one of the main sources of price disturbances -large shocks to the price of oil- seem to revert. Third, production technologies have changed and have become more energy efficient, so that the pass-through from increases in oil prices to consumer prices has diminished. Fourth,

[1] See the model of Beechey and Osterholm (2007), which imply that variation in inflation persistence serves as an indicator of evolving central bank preferences between stabilizing inflation at the cost of stabilizing output.

[2] Coenen (2007), warns on the risks of relying on monetary policy rules when the assumption on the degree of inflation persistence does not conform to reality.

[3] Monetary policy, responsible for this schizophrenia, has been through a number of shifts as well during the last fifty years. Indeed, results in the literature have suggested a causal relationship between identified periods of change in persistence and periods of change in the operating rules of monetary policy. On this see Benati, L. (2002), who presents evidence for the US (from 1793) and the UK (from 1662), Kontonikas (2004) for UK data (from 1972), Capistrán and Ramos-Francia (2006), for the case of Latin American economies (from 1980), and Chiquiar et. al. (2007) for the case of Mexico (from 1995).

[4] There have been instances in the economics literature, for example from a public finance perspective, where inflation should follow (in some sense) optimally a martingale process. See for example Trehan and Walsh (1988, 1990). However, it would be difficult today to try to model inflation this way.

societies have developed a taste for price stability, which has resulted in empowering central banks to combat inflation.[5] Finally, globalization could also have played a role in bringing down inflation worldwide.[6]

These arguments imply that, whenever inflation gets out of control, we should observe a highly persistent period of inflation being followed by a stationary (or low persistent) one. In other words, any nonstationary behaviour of inflation should be observed only temporarily. Thus, any switch of inflation from, say, $I(0)$ to $I(1)$ should be followed by a return to $I(0)$. This is precisely what we intend to analyze in this paper, by applying a technique designed to detect mixtures of $I(1)$ and $I(0)$ behavior in a time series.

We believe that our results make an important contribution to understanding inflation dynamics. First, the tests that we use are much more robust to a larger set of alternatives than many others that have been applied in the literature. In particular, they allow for what we believe are the salient features of inflation processes quite well. Second, we believe that they make sense in terms of what we think should be expected from inflation processes. Most industrialized countries have experienced low and stable inflation for long periods of time, although in some cases they have registered episodes of higher inflation. In these cases, we believe that the dominant feature should be of inflation behaving as an $I(0)$ process, although the presence of some episodes of higher inflation will make it difficult for many tests to be able to characterize inflation as an $I(0)$ process for long samples that include these shorter periods. In the case of many emerging economies, in particular those in Latin America, these have operated in the last few decades over long periods of time under conditions of seigniorage financing of the public deficit, leading to fiscal dominance and highly unstable inflation processes. Most tests will thus not be able to reject the presence of unit roots in the inflation process, even though these episodes of high chronic inflation are, as would be expected in most cases, stabilized sooner or later for political survival reasons. Summing up, when studying the persistence of inflation, in developed or emerging economies, we believe that one has to allow for behavior of the type $I(0)/I(1)/I(0)$.

In line with these ideas, this paper identifies and dates the different $I(1)/I(0)$ epochs through which inflation has evolved around the world for the last fifty years (or so). Our results seem to support the idea that inflation is, in many cases, neither stationary nor nonstationary, but a combination of both. Inflation persistence is, then, an evolving feature, changing from, say, low to high and then switching back to low persistence levels. Unit root tests are not able to detect these changes. In fact, Leybourne, Kim and Taylor (2007, LKT

[5] See for instance Beechey and Osterholm (2007), Sargent, Williams and Zha (2004) and Primiceri (2005).

[6] There is an ongoing debate on whether this is indeed the case. See for example Rogoff (2003) and Ball (2006).

in what follows) argue that the ADF test will not be consistent when applied to persistence change series, since the $I(1)$ part will dominate asymptotically. Furthermore, tests for a *single* change in persistence (as those of Kim (2000), Harvey, *et. al.* (2006) and Leybourne, *et. al.* (2006)) are inconsistent against processes which display multiple changes in persistence.

To deal with this issue, we apply a procedure specifically designed to test multiple changes in persistence while estimating the dates of change in a consistent way. As a result we get, either: a set of adjacent $I(0)$ and $I(1)$ periods, a set of adjacent $I(0)$ periods, or a single $I(0)$ period (we found no evidence of a single $I(1)$ period for any country in our sample). Furthermore, the procedure we apply, due to LKT, is consistent under the presence of level breaks, both asymptotically, and in finite samples. In fact, our results indicate that the timing of changes in persistence and changes in level tend to coincide. We discuss below this issue in more detail.

We start by applying a (new) nonparametric unit root test which is robust to nonlinearities, error distributions, structural breaks and outliers, many of them typical features of inflation data. Once an initial (or benchmark) order of integration has been determined for each inflation series, we apply a test that identifies any $I(0)$ periods within the sample, effectively decomposing the data into stationary and nonstationary sub-samples. When no $I(1)$ behaviour is detected, the series is stationary throughout. Results from this test help evaluate whether there are changes in the order of integration not detected by the unit root test. The identified $I(1)/I(0)$ periods can then be analyzed both in terms of timing and operating rules of monetary policy for each country.

We apply these tests to 45 countries around the world. In 40 cases, the unit root is rejected (mostly) at the 1% level. This result contradicts the stylized fact that inflation seems to be characterized by a persistent process[7] (we call this the **SF1).** However, the persistence change test does detect mixtures of $I(1)$ and $I(0)$ behaviour within the sample for a group of countries, giving support to another stylized fact: Inflation persistence has not been constant through time[8] (**SF2)**. Furthermore, we find that inflation persistence has decreased, and in several cases, the most prominent stationary period (to be defined below) is found towards the end of the sample. We also find that, in many cases, the level of inflation

[7] Using different techniques and definitions of persistence, this stylized fact arises from results in Pivetta and Reis (2006) for the US over 1947-2001, O'Reilly and Whelan (2004) for the Euro-area (1970s onwards), Gadea and Mayoral (2006), for 21 OECD countries (1957-2003), Batini (2002) for the Euro Area and individual European countries (1970s onwards), and Batini and Nelson (2002) for the UK and US over 1953-2001.

[8] Using models with time varying parameters, several authors suggest that inflation persistence has diminished along with its overall level. See Cogley and Sargent (2001), Benati (2002), Levin and Piger (2006), Capistrán and Ramos-Francia (2006), Harvey, et. al. (2006), Beechey and Osterholm (2007), Caggiano and Castelnuovo (2007), Kumar and Okimoto (2007), and Noriega and Ramos-Francia (2008). This stylized fact can also be interpreted as *Inflation persistence responds to monetary regimes.*

corresponding to the most recent stationary periods is the lowest level within the sample. These findings can be attributed to several factors, including 'the Great Moderation', the end of fiscal dominance in many economies, the introduction of flexible exchange rate regimes, and the introduction of an inflation targeting framework for monetary policy.

2 Data

The inflation series we investigate are monthly, seasonally adjusted, with the exception of Australia and New Zealand, which are quarterly. The data are based on the CPI, from the IMF's International Financial Statistics (IFS), available at http://www.imfstatistics.org/imf/.[9] Exceptions are data for Germany, Ireland, Iceland and Korea, which were taken from the Main Economic Indicators of the OECD, available at http://oecd-stats.ingenta.com.

We measure inflation as the annualized monthly (quarterly) change in the CPI, calculated as $1200ln(P_t/P_{t-1})$ ($400ln(P_t/P_{t-1})$ for the case of Australia and New Zealand). For the majority of countries, the sample spans the period 1960:01 to 2008:06, for a total sample size of $T = 569$. However, there are 12 countries for which the starting point is not 1960:01.[10] Data is available from the authors upon request.

3 Testing procedures

Due to the variety of definitions of inflation persistence, this phenomenon has been analyzed using diverse statistical tools.[11] Many of these techniques have been applied either to detect the mere presence of persistence, or to detect changes in it. Surprisingly, there are virtually no applications of procedures specifically designed to test for a change in persistence, as the one we use in this paper.[12]

The testing procedures in this paper are of two types. The first is aimed at testing for the presence of a unit root in the data, under which inflation would be a persistent process. This type uses the methods developed by Aparicio, Escribano and Sipols (2006, AES in what

[9] For the UK, the Bank of England and the IMF both report the Retail Price Index, as a proxy to the CPI.

[10] These countries are Brazil (1980:01), Denmark (1967:02), Germany (1960:02), Hong Kong (1980:11), Hungary (1976:02), Indonesia (1968:02), Ireland (1975:12), Iceland (1976:02), Korea (1960:02), Singapore (1961:02), Thailand (1965:02) and Turkey (1969:02).

[11] For instance, the largest AR root, the sum of the AR coefficients, half-lives, VARs, tests for structural breaks in level, fractional integration, unit root tests (standard, rolling and panel), ARMA models with time varying parameters, GARCH models, impulse saturation break tests, structural models of the NKPC type, and DSGE models.

[12] The only exceptions are Noriega and Ramos-Francia (2008), and the applied sections of the papers in which the methods were developed, i.e., Harvey, *et. al.* (2006), and Leybourne, *et. al.* (2007).

follows). The second type aims at testing for changes in persistence, that is, changes that partition the data into separate $I(1)$ and $I(0)$ regimes. The relevant methods were developed by LKT.[13]

We start our empirical investigation by applying the unit root test, in order to establish the (initial, or benchmark) order of integration of the series. We then implement a test to detect (possibly multiple) changes in persistence, in order to uncover any potential changes in the order of integration not detected by the unit root test. The next subsections give a brief account of each of these tests. Following Culver and Papell (1997), we do not include a time trend under the various tests because a trend would not be consistent with long-run positive, but non-accelerating, inflation.

3.1 Unit root test

We apply a non-parametric unit root test due to Aparicio, Escribano and Sipols (2006, AES henceforth), which is robust against nonlinearities, error distributions, structural breaks and outliers. This test is based on a monotonically increasing sequence of ranges, defined as $R_t^{(y)} = y_{t,t} - y_{1,t}$, $t = 1, 2, ..., T$, where the statistics $y_{t,t} = \max\{y_1, ..., y_t\}$ and $y_{1,t} = \min\{y_1, ..., y_t\}$ are the t^{th} extremes of the inflation series, y_t. AES base their test statistic on a function of the total number of 'new extremes' or 'new records' within the sample size, $\sum_{t=1}^{T} \mathbf{1}(\Delta R_t^{(y)} > 0)$, where $\mathbf{1}(\cdot)$ is the indicator function and Δ is the difference operator. In particular, the statistic for testing the null hypothesis of a unit root, $\Delta y_t = \varepsilon_t$, with $\{\varepsilon_t\}_{t\geq 1}$ a sequence of zero-mean, constant variance *iid* random variables, is defined as follows:

$$J_0^{(T)} = T^{-1/2} \sum_{t=1}^{T} \mathbf{1}(\Delta R_t^{(y)} > 0)$$

AES call this the Range Unit-Root (RUR) test, and note that, under the null, it converges to a random variable, while under the alternative (i.e. $y_t \sim I(0)$), $J_0^{(T)} \longrightarrow 0$, as $T \longrightarrow \infty$. Hence, larger (smaller) values of the RUR test will be indicative of $I(1)$ ($I(0)$) behaviour. They further propose an extension of $J_0^{(T)}$, the Foreward-Backward RUR (FB-RUR) test. This extension reduces size distortions and increases the power of the RUR test in the presence of additive outliers. It consists of running $J_0^{(T)}$ forwards, and then backwards. The improved size and power performance comes from the fact that the total jump counts correspond to a sample size twice the original one. The FB-RUR test is defined as:

[13] All calculations were carried out using a GAUSS code, available from the authors upon request.

$$J_*^{(T)} = \frac{1}{\sqrt{2T}} \sum_{t=1}^{T} \left[\mathbf{1}(\Delta R_t^{(y)} > 0) + \mathbf{1}(\Delta R_t^{(y')} > 0) \right]$$

where $y'_t = y_{T-t+1}$, that is, the time-reversed series. AES provide critical values for this test in their Table 1. Several Monte Carlo experiments reported in AES show that this test is robust against a variety of typical features of inflation behaviour, like outliers and level breaks. We use this (unit root) fixed-persistence test in empirical applications below as a benchmark to our later results in which *changes* in persistence are allowed.

3.2 Test for a change in persistence

We apply methods developed by LKT, who propose a test for changes in the order of integration of a time series, and at the same time considers consistent estimation of the change dates. Furthermore, this is the only methodology in the literature which is valid in the presence of multiple changes in persistence. The data generation process (DGP) is the following Time-Varying (TV) $AR(p)$:

$$\begin{aligned} y_t &= d_t + u_t \qquad (1) \\ u_t &= \rho_i u_{t-1} + \sum_{j=1}^{k_i} \phi_{i,j} \Delta u_{t-j} + \varepsilon_t, \qquad t = 1, ..., T \end{aligned}$$

where y_t is the inflation rate, $d_t = z'_t \beta$ is the deterministic kernel, with $z_t = (1, t)'$ and $\beta = (\beta_0, \beta_1)$, which includes two leading cases: non-zero, non-accelerating inflation ($\beta_0 \neq 0, \beta_1 = 0$), and accelerating inflation ($\beta_0 \lesseqgtr 0, \beta_1 > 0$), and ε_t is a martingale difference sequence.[14] In (1), u_t is taken to be a TV $AR(p)$ process, rewritten such that $k_i = p_i - 1, i = 1, ..., m+1$, where m is the number of changes in persistence. Note that (1) permits that the dominant AR root, ρ_i, and the lag coefficients, ϕ_{ij}, differ across the $m+1$ separate regimes.

LKT consider two hypotheses: the null, $H_0 : y_t \sim I(1)$ throughout, that is, $\rho = 1 \; \forall t$, and the alternative, $H_1 : y_t$ *undergoes one or more regime shifts between* $I(1)$ *and* $I(0)$ *behaviour.* That is, under the alternative ρ is subject to $m \geq 1$ unknown persistence changes, giving rise to $m+1$ segments with change point fractions given by $\tau_1 < \tau_2 < ... < \tau_{m-1} < \tau_m$ (LKT follow the convention that $\tau_0 = \tau_{m+1} = 0$). Their approach ensures a 'joining up' of the consecutive $I(1)$ and $I(0)$ regimes in the series, that is, of the consecutive subsamples with $\rho = 1$ and $|\rho| < 1$ behaviour.

[14] As in LKT, we use this DGP for simplicity of presentation, but methods in LKT allow for breaks in the level and trend of d_t.

Hence, the procedure partitions $y_t, t = 1, ...T$ into its separate $I(0)$ and $I(1)$ regimes, and consistently estimates the associated change point fractions. LKT define the fraction $\tau \in (\lambda, 1)$, for a given λ in (0,1), and base their test H_0 vs. H_1 on the local GLS de-trended ADF unit root statistic, that uses the sample observations between λT and τT, called $DF_G(\lambda, \tau)$, obtained as the standard t-statistic associated with $\hat{\rho}$ in the fitted regression

$$\Delta y_t^d = \hat{\rho}_i y_{t-1}^d + \sum_{j=1}^{k_i} \hat{b}_{i,j} \Delta y_{t-j}^d + \hat{\varepsilon}_t, \qquad t = \lambda T, \lambda T + 1, ..., \tau T \tag{2}$$

for $i = 1, ..., m+1$, where $y_t^d \equiv y_t - z_t' \hat{\beta}$, with $\hat{\beta}$ the OLS estimate of β obtained from regressing $y_{\lambda,T}$ on $z_{\lambda,T}$, where $y_{\lambda,T} \equiv (y_{\lambda T}, y_{\lambda T+1} - \bar{\alpha} y_{\lambda T}, ..., y_{\tau T} - \bar{\alpha} y_{\tau T-1})'$ and $z_{\lambda,T} \equiv (z_{\lambda T}, z_{\lambda T+1} - \bar{\alpha} z_{\lambda T}, ..., z_{\tau T} - \bar{\alpha} z_{\tau T-1})'$, with $\overline{\alpha} = 1 + \overline{c}/T$, and $\overline{c} = -10$. In the empirical applications below, we set $\lambda = 1/T$ such that $\lambda T = 1$ always. As in LKT, we use $\tau = 0.20$.[15]

For estimating the autoregressive component k_i in (2), we ran the procedure for values of $1 \leq k_i \max \leq 4, i = 1, ..., m + 1$. The estimated value is the one which minimizes the BIC, which consistently estimates the lag length for values of k_i between 1 and 4, for every sample or sub-sample regression computed.[16]

The proposed test is based on doubly-recursive sequences of DF type unit root statistics:

$$M \equiv \inf_{\lambda \in (0,1)} \inf_{\tau \in (\lambda, 1)} DF_G(\lambda, \tau) \tag{3}$$

with corresponding estimators $(\hat{\lambda}, \hat{\tau}) \equiv \arg \inf_{\lambda \in (0,1)} \inf_{\tau \in (\lambda,1)} DF_G(\lambda, \tau)$. Application of the M test yields the start and end points (i.e. the the interval $[\hat{\lambda}, \hat{\tau}]$) of the 'most prominent' $I(0)$ regime over the whole sample. As discussed in LKT, the presence of any further $I(0)$ regimes can be detected sequentially by applying the M statistic to each of the resulting subintervals $[0, \hat{\lambda}]$ and $[\hat{\tau}, 1]$. Of course it could be the case that the $I(0)$ period indicated by the test lies at one extreme of the sample. In this case, the test can be applied to the resulting segment $[0, \hat{\lambda}]$ *or* $[\hat{\tau}, 1]$. Continuing in this way, all $I(0)$ regimes together with their start and end points can be identified. As noted by LKT, the period between the end point of one $I(0)$ regime and the start point of the next $I(0)$ regime must represent an $I(1)$ regime. Finally, using large sample arguments as well as Monte Carlo simulations, LKT show that a level change in the deterministics (a change in the parameter β) has little impact on either the size or power of their test procedure.

A practical summary of the whole procedure is the following. Fix λ such that the pro-

[15] As a robustness check in the empirical applications of next section, we used different values of τ and $\overline{c}$ and obtained qualitatively similar results.

[16] On the consistency of the BIC see for instance Burridge and Hristova (2008).

cedure starts from the first observation (i.e., fix $\lambda = 1/T$, which implies that $\lambda T = 1$) and τ such that enough observations are available for the estimation (we used 20% of the data, as in LKT: $\tau T = 0.2 \times T$). Compute $y_{\lambda,T}$ and $z_{\lambda,T}$, and obtain $\hat{\beta}$, the OLS estimate of β in the regression of $y_{\lambda,T}$ on $z_{\lambda,T}$. With $\hat{\beta}$, compute residuals $y_t^d \equiv y_t - z_t'\hat{\beta}$, which are the data for estimating equation (2), over the subsample $t = \lambda T, \lambda T + 1, ..., \tau T$. Once regression (2) is estimated, store the t-statistic associated with $\hat{\rho}$, which would be the $DF_G(T^{-1}, 0.2)$ statistic. Repeat this process using $\tau T + 1 = 0.2 \times T + 1$, that is, allowing one additional observation in the estimation. Continue in this fashion for all values of $\lambda \in (0, 1)$ and $\tau \in (\lambda, 1)$, always storing the corresponding t-statistic associated with $\hat{\rho}$, and obtain the most prominent $I(0)$ period as the one corresponding to the minimum of these t-statistics. Apply this procedure to any remaining subsamples.

4 Empirical results

4.1 Latin America

For all countries but Argentina, Brazil, and Peru, a unit root is rejected by the AES J_* test, as can be seen from Table 1.[17] Thus, results seem to indicate that for the last fifty years, inflation has behaved in a stationary fashion, in the sense of not behaving as a unit root process, for most of Latin American economies. This result contradicts **SF1**. However, given the changing nature of inflation for several of these countries, it seems difficult to believe that a constant order of integration is an adequate description of the *dynamics* of inflation. We now study the possibility of changes in persistence in the inflation rate for all 14 LA countries using the M test of LKT.

[17] Results from the application of Ng and Perron´s (2001) unit root tests (as modified by Perron and Qu (2007)) indicate rejection of a unit root in all cases, under all four test statistics. All empirical results discussed but not presented, are available from the authors upon request.

Table 1
Results of AES Unit Root Test on LA Countries

Country	J_*	*Inference*
Argentina	**1.553**	**I(1)**
Bolivia	1.202 **	I(0)
Brazil	**2.218**	**I(1)**
Chile	1.026 **	I(0)
Colombia	0.938 ***	I(0)
Ecuador	1.114 **	I(0)
El Salvador	0.762 ***	I(0)
Guatemala	0.821 ***	I(0)
Honduras	0.879 ***	I(0)
Mexico	1.319 *	I(0)
Paraguay	0.528 ***	I(0)
Peru	**1.466**	**I(1)**
Uruguay	0.938 ***	I(0)
Venezuela	0.674 ***	I(0)

***, **,* denote rejection at the 1%, 5% and 10% level, respectively.

Results are presented in Table 2. We run the procedure for values of $k_i \max = 1, 2, 3, 4$ for each country, and found that for almost all countries results are robust to the value of $k_i \max$.

Table 2 reports results for $k_i \max = 2$ for all countries but Argentina and Venezuela, for which we set $k_i \max$ to zero, and one, respectively. The selection of $k_i \max$ for these two countries was made on the basis of how well the procedure picks the apparent level breaks present in the data, by making changes in persistence and changes in level to coincide. On this point, LKT argue that "In practice it is probably not unreasonable to assume that structural breaks in the deterministic kernel d_t occur at the same point(s) in the sample as changes in persistence" (p.20), and discuss some evidence on the occurrence of this coincidence (see Kurozumi (2005)).[18]

[18] For the case of Argentina, this value of $k_i \max = 0$ gives similar results to those of $k_i \max = 3, 4$. We discard results for $k_i \max = 1, 2$ since they do not correspond to the fiscal and monetary policy arrangementes made, and contradicts previous research results (Capistrán and Ramos-Francia (2006)). A similar reasoning applies to Venezuela.

Table 2
Results of the LKT test for Latin American Inflation

Country	Sample	Sample Size	$\hat{k}_i$	M	I(0) Periods Start	I(0) Periods End
Argentina	1960:01- 2008:06	582	0	-8.35***	1960:11	1974:08
	1974:09- 2008:06	406	0	-6.68***	1995:02	2001:12
	2002:01- 2008:06	78	0	-4.90***	2004:06	2008:06
Bolivia	1960:01- 2008:06	582	0	-13.12***	1960:01	1973:06
	1973:07- 2008:06	420	0	-8.39***	1974:04	1982:01
	1982:02- 2008:06	317	2	-8.78***	1985:11	1992:04
	1992:05- 2008:06	194	0	-8.94***	2003:03	2007:01
	1992:05- 2003:02	130	0	-6.47***	1996:06	2000:10
	1992:05- 1996:05	49	0	-5.40***	1992:06	1995:09
	2000:11- 2003:02[a]	28	0	-5.04**	2000:12	2003:02
	2007:02- 2008:06[a]	17	1	-18.81***	2007:06	2007:11
Brazil	1980:01- 2008:06	342	2	-4.40**	1996:03	2008:06
	1980:01- 1996:02	194	0	-4.75***	1980:01	1983:04
Chile	1960:01- 2008:06	582	0	-18.09***	1981:02	1998:06
	1960:01- 1981:01	253	0	-12.59***	1963:06	1972:06
	1960:01- 1963:05	41	1	-4.59**	1960:11	1961:12
	1998:07- 2008:06	120	0	-6.29***	1998:08	2003:05
	2003:06- 2008:06	61	0	-4.23*	2004:06	2006:07
	2006:08- 2008:06[a]	23	1	-17.18***	2007:09	2008:02
Colombia	1960:01- 2008:06	582	0	-11.39***	1963:12	2000:03
	1960:01- 1963:11	47	1	-5.29***	1960:03	1961:01
	1961:02- 1963:11	34	2	-4.75*	1961:03	1962:05
	2000:04- 2008:06	99	0	-8.62***	2000:05	2008:04
Ecuador	1960:01- 2008:06	582	0	-14.53***	1962:08	1980:02
	1960:01- 1962:07	31	2	-14.12***	1960:03	1960:10
	1960:11- 1962:07[a]	21	0	-6.27**	1961:10	1962:07
	1980:03- 2008:06	340	0	-8.01***	1982:11	1999:10
	1980:03- 1982:10	32	1	-5.35**	1981:04	1982:03
	1999:11- 2008:06	104	0	-6.47***	2003:10	2007:06
El Salvador	1960:01- 2008:06	582	0	-16.95***	1960:02	1973:03
	1973:04- 2008:06	423	0	-11.44***	1999:07	2008:01
	1973:04- 1999:06	303	0	-11.33***	1973:10	1994:11
	1994:12- 1999:06	55	0	-5.07**	1994:12	1998:12
Guatemala	1960:01- 2008:06	582	0	-20.98***	1961:04	2007:04
Honduras	1960:01- 2008:06	582	0	-17.37***	1961:03	1989:12
	1960:01- 1961:02[a]	14	0	-5.88**	1960:04	1960:09
	1990:01- 2008:06	222	2	-38.18***	1999:02	2007:10
	1990:01- 1999:01	109	0	-5.20***	1993:04	1997:08

***, ** and * denote significance at the 1%, 5% and 10%, respectively.

[a] For this sample Kmax<2, due to limited degrees of freedom.

Table 2
Results of the LKT Test for Latin American Inflation (Cont.)

Country	*Sample*	*Sample Size*	$\hat{k}_i$	*M*	*I(0) Periods Start*	*End*
Mexico	1960:01- 2008:06	582	0	-12.43***	1961:04	1972:12
	1973:01- 2008:06	426	0	-5.02***	1973:04	1981:11
	1981:12- 2008:06	319	1	-6.33***	2002:09	2008:04
Paraguay	1960:01- 2008:06	582	0	-15.86***	1971:06	2003:05
	1960:01- 1971:05	137	0	-13.84***	1961:09	1971:03
	1960:01- 1961:08	20	0	-7.69***	1960:02	1960:07
	2003:06- 2008:06	61	0	-9.17***	2005:02	2008:06
	2003:06- 2005:01[a]	20	0	-5.96**	2003:12	2004:09
Peru	1960:01- 2008:06	582	0	-10.71***	1960:10	1977:05
	1977:06- 2008:06	373	0	-7.25***	1997:01	2008:05
	1977:06- 1996:12	235	0	-7.82***	1978:02	1982:09
Uruguay	1960:01- 2008:06	582	0	-12.91***	1972:05	1990:01
	1960:01- 1972:04	148	0	-6.79***	1960:04	1972:02
	1990:02- 2008:06	221	0	-6.23***	2003:08	2008:04
	1990:02- 2003:07	162	0	-5.79***	1991:02	1994:01
	1994:02- 2003:07	114	0	-5.65***	1998:12	2002:01
	1994:02- 1998:11	58	1	-4.84**	1995:07	1996:11
Venezuela	1960:01- 2008:06	582	1	-11.15***	1962:08	1973:08
	1960:01- 1962:07	31	1	-5.75**	1960:02	1962:07
	1973:09- 2008:06	418	1	-9.64***	1989:02	1996:02
	1973:09- 1989:01	185	1	-6.88***	1975:04	1978:12
	1973:09- 1975:03	19	1	-15.98***	1974:10	1975:03
	1979:01- 1989:01	121	1	-5.88***	1981:02	1986:12
	1996:03- 2008:06	148	0	-6.48***	1998:06	2007:09

***, ** and * denote significance at the 1%, 5% and 10%, respectively

[a]For this sample Kmax<2, due to limited degrees of freedom.

In Table 2, the second column refers to the sample or subsample over which the testing procedure is applied. $\widehat{k}_i$ indicates the estimated value of k_i in (2), according to the BIC, while M indicates the estimated value of the test statistic in (3). The last two columns report the beginning and end of the $I(0)$ regions identified by the procedure. Figure 1 in the Appendix gives a graphical representation of the results; it shows the inflation data together with horizontal lines, which indicate an $I(0)$ period, as identified by the LKT test. For convenience, these lines are drawn at the mean of each of the $I(0)$ periods they define.

In order to show the use of Table 2, let us examine some examples. The simplest case is that of Guatemala, for which the test rejects a unit root at the 1% level from a single application of the M test ($M = -20.98$, which is significant at the 1% level, using critical values from LKT[19]), indicating that inflation is $I(0)$ throughout (almost) the whole sample, that is, from 1961:04 to 2007:04.[20] As can be seen from Figure 1, for the case of Guatemala, the test identifies one $I(0)$ period, covering almost the whole sample.[21] This conclusion is in line with results from the AES unit root test.

A slightly different result obtains for El Salvador. The M test is initially applied over the whole sample (1960:01-2008:06), detecting an interior $I(0)$ regime between 1960:02 and 1973:03, for which the unit root null is rejected at the 1% level. This represents the 'most prominent' $I(0)$ region in the data. The test is then applied over 1973:04-2008:06 and the M statistic rejects again at the 1% level, identifying the second $I(0)$ regime between 1999:07 and 2008:01. This represents, in turn, the 'most prominent' $I(0)$ region within this subsample.

The search for a further stationary regime continues by applying the test over the sample 1973:04-1999:06, which yields a third $I(0)$ regime corresponding to the period 1973:10-1994:11. A fourth $I(0)$ regime is uncovered (at the 5% level) over 1994:12-1998:12 when the test procedure is applied over the subsample 1994:12-1999:06. Hence, the procedure detects a total of 4 $I(0)$ regimes, which cover virtually the hole sample. We conclude that, when allowing for the possibility of multiple changes in persistence, inflation in El Salvador can be represented as a set of adjacent stationary periods, each fluctuating around different mean values (see Figure 1). This is also consistent with the findings of the AES test.

As a final example consider the case of Mexico. Results from Table 2 indicate that, after applying the procedure over the whole sample, the first $I(0)$ regime is detected between 1961:04 and 1972:12, with a unit root being rejected at the 1% level. Searching over the period 1973:01-2008:06 produces another rejection at the 1% level, uncovering a second $I(0)$ period over 1973:04-1981:11. When the procedure is applied over 1981:12-2008:06, a third $I(0)$ regime is detected between 2002:09 and 2008:04. Finally, no other subsamples yielded significant tests when applied between 1981:12 and 2002:08, which implies that inflation in Mexico switched from $I(0)$ to $I(1)$ in the early 1980s, switching back to $I(0)$ in the early 2000s. Part of these results support those reported in Chiquiar et. al. (2007).

Results from Table 2 allow us to classify countries in three groups. For the first, inflation rates are $I(0)$ throughout, that is, with no $I(1)$ subperiods, or, in other words, with no changes in persistence. This is the case of Colombia, El Salvador, Guatemala and Paraguay. In the second group there are countries for which inflation was hit by short-lived shocks,

[19]The critical value for $T = 400$ -the sample size closest to $T = 582$- is -4.438 at the 1% level.

[20]Sometimes the procedure leaves out some observations, which do not contribute in attaining the double infimum of $DF_G(\lambda, \tau)$ according to (3). Each subsample formed by these observations is always very small, wich makes it difficult, and in many cases imposible, to apply the procedure.

[21]Note that the procedure canot be applied over the small segments of data not covered by this $I(0)$ period (1960:01-1961:03 and 2007:05-2008:06), due to the limited number of available observations.

identified as (short) $I(1)$ subperiods. This is the case of Bolivia (1982-1985), Ecuador (1980-1982, 2000-2003), Honduras (1990-1993), Uruguay (1994-1998), and Venezuela (1960-1961, 1973-1975, 1979-1981). The last group consists of economies in which shocks had longer-term effects, inducing $I(1)$ behavior on inflation along periods of several years: Argentina (1975-1994), Brazil (1983-1996), Chile (1972-1980), Mexico (1982-2002), and Peru (1982-1996).[22] Table 7 in Section 5 summarizes these results; as can be seen, 10 out of 14 cases (71% of LA countries in our sample) experienced persistence changes. This gives strong support to **SF2**.

4.2 OECD

For all countries but Australia and Iceland, a unit root is rejected by the AES J_* test, as can be seen from Table 3.

Table 3

Results of AES Unit Root Test on OECD Countries

Country	J_*	*Inference*
Australia	**1.574**	**I(1)**
Austria	0.967 ***	I(0)
Belgium	0.850 ***	I(0)
Canada	0.733 ***	I(0)
Denmark	0.856 ***	I(0)
Finland	1.172 **	I(0)
France	0.850 ***	I(0)
Germany	0.587 ***	I(0)
Greece	1.231 *	I(0)
Hungary	0.932 ***	I(0)
Iceland	**1.434**	**I(1)**
Ireland	1.216 *	I(0)
Italy	0.997 ***	I(0)
Luxembourg	0.821 ***	I(0)
Netherlands	0.821 ***	I(0)
New Zealand	1.218 *	I(0)
Norway	0.733 ***	I(0)
Portugal	0.997 ***	I(0)
Spain	0.997 ***	I(0)
Sweden	0.760 ***	I(0)
Switzerland	0.762 ***	I(0)
Turkey	1.040 **	I(0)
UK	0.850 ***	I(0)
USA	0.909 ***	I(0)

***, **,* denote rejection at the 1%, 5% and 10% level respectively.

[22] This last group also experienced smaller shocks as those of group two: Argentina (2002-2004), Chile (1962-1963, 2006-2008), Mexico (1960-1961).

As with LA countries, results seem to indicate that inflation in most of the OECD economies has behaved in a stationary fashion, in the sense of not behaving as a unit root process. Again, this result contradicts **SF1**.

We next investigate whether there are any possible changes in persistence within the sample for all 24 OECD countries. As with LA economies, we ran the procedure for $k_i \max = 1, ..., 4$. We obtained similar results across values of $k_i \max$ for all countries but Australia and Iceland. For these two cases, the selection of $k_i \max$ followed the same criterion as the one discussed for the case of LA economies. Following this criterion, the chosen value of $k_i \max$ was three for Australia and one for Iceland.

Table 4 shows results from the application of the M test of LKT, and Figure 2 plots the inflation data and the corresponding $I(0)$ segments, as detected by the test, drawn at their mean values, just as for the case of the LA countries above.

Again, let us study our results under groups of countries. Consider the very simple case of Austria: inflation is $I(0)$ throughout, upon a single application of the procedure. Next consider the cases of Belgium, Canada, Denmark, Finland, Germany, Greece, Hungary, Norway, New Zealand, the Netherlands, Portugal, Spain, Sweden, Switzerland, Turkey, and the UK. For these countries, inflation is $I(0)$ throughout, but at different mean levels, which coincide with the set of non-overlaping $I(0)$ segments detected by the procedure. We gather these countries together with Austria and form Group 1. Group 3 is formed by the rest of the countries (Australia, France, Ireland, Iceland, Italy, Luxembourg, and the US), all of which experimented significant changes in persistence.[23] For all countries in this group but Australia, an $I(1)$ segment is found between the early-to-mid 1970s and the 1980s. Figure 2 presents a clear graphical picture of the results, while Table 7 collects results by groups of countries.

Our results seem to support less than for the LA economies the **SF2:** 29% of the countries experienced changes in persistence; for many of them, the $I(1)$ periods occurred around the so called 'Great Inflation' of the US. On the other hand, for the rest of OECD countries, inflation persistence was absent throughout the sample. The stationary behavior of inflation for these countries is conformed by $I(0)$ non-overlaping segments, the beginning and end of which seem to correspond to level changes in the data.

[23] Note that for OECD countries, group 2 is empty, since the identified $I(1)$ segments were rather long-lived, and therefore were allocated into Group 3 in Table 7.

Table 4
Results of the LKT Test for OECD Inflation

Country	Sample	Sample Size	$\hat{k}_i$	M	I(0) Periods Start	End
Australia	1960:01- 2008:02	194	0	-5.55***	1991:04	2007:03
	1960:01- 1991:03	127	1	-6.08***	1976:03	1983:04
Austria	1960:01- 2008:06	582	0	-19.39***	1960:02	2008:06
Belgium	1960:01- 2008:06	582	0	-14.44***	1985:05	2007:09
	1960:01- 1985:04	304	0	-9.34***	1961:08	1985:04
	1960:01- 1961:07[a]	19	1	-45.36***	1961:01	1961:05
Canada	1960:01- 2008:06	582	0	-14.30***	1988:01	2008:03
	1960:01- 1987:12	336	0	-8.86***	1962:05	1972:07
	1960:01- 1962:04	28	2	-12.02***	1960:02	1960:08
	1960:09- 1962:04[a]	20	0	-5.40**	1961:08	1962:03
	1972:08- 1987:12	185	0	-11.49***	1982:12	1987:11
	1972:08- 1982:11	124	0	-9.26***	1977:01	1982:07
	1972:08- 1976:12	53	0	-5.37***	1973:01	1975:11
Denmark	1967:02- 2008:06	497	0	-15.21***	1985:05	2008:05
	1967:02- 1985:04	219	0	-13.29***	1967:02	1985:04
Finland	1960:01- 2008:06	582	0	-13.32***	1992:01	2008:04
	1960:01- 1991:12	384	0	-12.19***	1972:11	1982:06
	1960:01- 1972:11	154	0	-7.94***	1961:10	1968:12
	1969:01- 1972:11	47	0	-5.87***	1969:04	1972:10
	1982:07- 1991:12	114	0	-9.18***	1983:08	1991:12
France	1960:01- 2008:06	582	0	-13.80***	1985:08	2008:04
	1960:01- 1985:07	307	0	-11.13***	1962:05	1972:04
Germany	1960:02- 2008:06	581	0	-15.84***	1993:05	2008:05
	1960:02- 1993:04	399	2	-10.96***	1960:05	1972:06
	1972:07- 1993:04	250	0	-9.38***	1972:10	1981:12
	1983:01- 1993:04	124	0	-7.07***	1987:01	1993:04
	1983:01- 1986:12	48	0	-4.44**	1983:12	1985:12
Greece	1960:01- 2008:06	582	0	-12.24***	1960:04	1979:06
	1979:07- 2008:06	348	0	-12.20***	1997:03	2008:06
	1979:07- 1997:02	212	0	-7.95***	1981:04	1991:04
	1979:07- 1981:03[a]	21	0	-6.49**	1980:01	1980:07
	1991:05- 1997:02	70	0	-6.55***	1993:05	1996:06
	1991:05- 1993:04[a]	24	0	-7.32***	1992:02	1992:07

***, ** and * denote significance at the 1%, 5% and 10%, respectively

[a] For this sample Kmax<2, due to limited degrees of freedom.

Table 4

Results of the LKT Test for OECD Inflation (Cont.)

		Sample			*I(0) Periods*	
Country	*Sample*	*Size*	$\hat{k}_i$	*M*	*Start*	*End*
Hungary	1976:02- 2008:06	389	0	-10.57***	1976:02	1988:12
	1989:01- 2008:06	234	0	-7.79***	1989:04	1998:05
	1998:06- 2008:06	121	0	-7.32***	1998:06	2008:06
Iceland	1976:02- 2008:06	389	1	-6.41***	1990:10	2007:07
Ireland	1975:12- 2008:06	391	0	-9.01***	1990:02	2006:05
Italy	1960:01- 2008:06	582	0	-11.54***	1960:01	1972:06
	1972:07- 2008:06	432	0	-11.34***	1996:08	2006:09
	1972:07- 1996:07	289	0	-8.79***	1991:08	1996:06
	2006:10- 2008:06[a]	21	0	-5.06*	2006:10	2008:05
Luxembourg	1960:01- 2008:06	582	0	-17.69***	1990:12	2007:09
	1960:01- 1990:11	371	0	-11.65***	1960:06	1973:10
Netherlands	1960:01- 2008:06	582	2	-83.79***	1986:12	1999:08
	1960:01- 1986:11	323	2	-48.85***	1980:11	1986:04
	1960:01- 1980:10	250	0	-18.98***	1961:10	1980:10
	1960:01- 1961:09[a]	21	0	-4.77*	1960:02	1961:04
	1999:09- 2008:06	106	0	-7.82***	2001:06	2008:04
New Zealand	1960:01- 2008:06	194	0	-5.91***	1991:01	2008:01
	1960:01- 1990:04	124	1	-5.67***	1960:04	1969:04
	1970:01- 1990:04	84	0	-4.99***	1970:01	1990:02
Norway	1960:01- 2008:06	582	0	-12.62***	1964:02	1978:12
	1960:01- 1964:01	49	2	-6.78***	1962:05	1963:04
	1960:01- 1962:04	28	2	-20.32***	1960:05	1960:11
	1979:01- 2008:06	354	0	-11.47***	1988:07	2007:10
	1979:01- 1988:06	114	0	-7.34***	1983:02	1986:05
	1979:01- 1983:01	49	0	-6.37***	1979:10	1983:01
Portugal	1960:01- 2008:06	582	0	-14.16***	1966:09	1992:08
	1960:01- 1966:08	80	0	-9.89***	1960:01	1966:08
	1992:09- 2008:06	190	0	-11.56***	1993:12	2008:05
Spain	1960:01- 2008:06	582	0	-10.45***	1986:03	2008:05
	1960:01- 1986:02	314	0	-9.64***	1972:07	1985:04
	1960:01- 1972:06	150	0	-8.66***	1960:09	1972:06
Sweden	1960:01- 2008:06	582	0	-15.77***	1964:07	1993:04
	1960:01- 1964:06	54	0	-6.70***	1960:02	1964:06
	1993:05- 2008:06	182	0	-11.36***	1993:07	2007:09
Switzerland	1960:01- 2008:06	582	0	-13.23***	1992:12	2007:09
	1960:01- 1992:11	395	0	-9.85***	1976:12	1992:10

***, ** and * denote significance at the 1%, 5% and 10%, respectively

[a] For this sample Kmax$<$2, due to limited degrees of freedom.

Table 4
Results of the LKT Test for OECD Inflation (Cont.)

Country	*Sample*	*Sample Size*	$\hat{k}_i$	*M*	*I(0) Periods Start*	*End*
	1960:01- 1976:11	203	0	-8.00***	1961:05	1971:10
	1960:01- 1961:04[a]	16	0	-4.90*	1960:06	1960:10
	1971:11- 1976:11	61	0	-5.15***	1971:11	1975:06
Turkey	1969:02- 2008:06	473	0	-10.89***	1974:03	2003:03
	1969:02- 1974:02	61	0	-6.98***	1969:12	1973:11
	2003:04- 2008:06	63	1	-5.19***	2003:09	2008:03
UK	1960:01- 2008:06	582	0	-12.24***	1991:05	2008:03
	1960:01- 1991:04	376	0	-11.49***	1960:07	1970:08
	1970:09- 1991:04	248	0	-7.46***	1977:07	1991:04
	1970:09- 1977:06	82	0	-4.40**	1970:09	1977:06
USA	1960:01- 2008:06	582	1	-12.09***	1981:10	2007:12
	1960:01- 1981:09	261	2	-7.79***	1960:08	1965:11
	1965:12- 1981:09	190	0	-6.16***	1967:05	1973:01
	1965:12- 1967:04[a]	17	0	-5.03*	1965:12	1966:11

***, ** and * denote significance at the 1%, 5% and 10%, respectively

[a]For this sample Kmax<2, due to limited degrees of freedom.

4.3 Asia

For all Asian economies, the unit root is rejected by the J_* test of AES, as shown in Table 5.

Table 5
Results of AES Unit Root Test on Asian Inflation

Country	J_*	*Inference*
Hong Kong	0.970 **	I(0)
Indonesia	0.899 ***	I(0)
Japan	0.850 ***	I(0)
Korea	1.144 **	I(0)
Malaysia	0.674 ***	I(0)
Singapore	0.889 ***	I(0)
Thailand	0.991 ***	I(0)

***, **,* denote rejection at the 1%, 5% and 10% level respectively.

Since results from the M test were robust to the choice of k_i max, Table 6 reports results for k_i max $= 2$.

Table 6
Results of the LKT test for Asian Inflation

Country	Sample	Sample Size	$\hat{k}_i$	M	I(0) Periods Start	I(0) Periods End
Hong Kong	1980:11- 2008:06	332	0	-13.59***	1987:04	1995:09
	1980:11- 1987:03	77	0	-7.88***	1981:04	1987:03
	1995:10- 2008:06	153	2	-11.92***	2003:08	2007:09
	1995:10- 2003:07	94	0	-7.72***	1998:06	2003:05
	1995:10- 1998:05	32	0	-6.49**	1996:01	1997:12
Indonesia	1968:02- 2008:06	485	0	-10.63***	1970:06	2008:06
Japan	1960:01- 2008:06	582	0	-17.82***	1981:07	2008:05
	1960:01- 1981:06	258	0	-11.78***	1960:12	1981:06
Korea	1960:02- 2008:06	581	0	-17.36***	1960:05	2008:06
Malaysia	1960:01- 2008:06	582	0	-16.60***	1976:03	2008:05
	1960:01- 1976:02	194	0	-12.29***	1960:02	1972:11
Singapore	1961:02- 2008:06	569	0	-15.99***	1987:06	2007:06
	1961:02- 1987:05	316	0	-15.96***	1961:02	1972:07
	1972:08- 1987:05	178	0	-8.70***	1981:09	1987:05
	1972:08- 1981:08	109	0	-6.83***	1974:06	1981:03
	2007:07- 2008:06[a]	12	0	-4.82*	2007:09	2008:06
Thailand	1965:02- 2008:06	521	0	-13.98***	1981:05	2007:09
	1965:02- 1981:04	195	0	-8.81***	1965:03	1972:07
	1972:08- 1981:04	105	0	-8.17***	1974:06	1979:06

***, ** and * denote significance at the 1%, 5% and 10%, respectively

[a] For this sample Kmax$<$2, due to limited degrees of freedom.

As can be deducted from Table 6 (or Figure 3), Group 1 is formed by Hong Kong, Japan and Korea, for which inflation is $I(0)$ throughout. Group 2 is formed by Indonesia, Malaysia, Singapore and Thailand. For this group the only short spell of $I(1)$ behavior occurred during the early to mid 1970s. In the case of Asia, no big shocks seem to have hit inflation during the last decades, or, if they had, monetary policy was effective in avoiding long periods of persistence.

5 Discussion

First, for all countries for which a unit root is detected by the AES test, a prolonged $I(1)$ segment is detected by the M test. However, it is clear that the AES test is not designed to detect persistence change.

Table 7 summarizes the results when groups are formed according to whether inflation has been $I(0)$ throughout, or has switched $I(0)-I(1)-I(0)$ with short or long $I(1)$ segments. As can be seen from Table 7, Group 1 is the largest, comprising 24 countries, representing 53% of the whole sample of countries. LA countries are evenly distributed among the 3 groups. However, the majority of them has undergone either short or long changes in persistence. As for OECD countries, most of them has behaved as $I(0)$ throughout.

Table 7
Summary of Results

Groups	*General result*
Group 1 *LA* (4): Colombia, El Salvador, Guatemala, Paraguay *OECD* (17): Austria, Belgium, Canada, Denmark, Finland, Germany, Greece, Hungary, Norway, New Zealand, the Netherlands, Portugal, Spain, Sweden, Switzerland, Turkey, the UK *ASIA* (3): Hong Kong, Japan, Korea	$I(0)$ throughout
Group 2 *LA* (5): Bolivia, Ecuador, Honduras, Uruguay, Venezuela *ASIA* (4): Indonesia, Malaysia, Singapore, Thailand	$I(0) - I(1) - I(0)$ with short $I(1)$ segments
Group 3 *LA* (5): Argentina, Brazil, Chile, Mexico, Peru *OECD* (7): Australia, France, Ireland, Iceland, Italy, Luxembourg, the US	$I(0) - I(1) - I(0)$ with long $I(1)$ segments

Under a different classification, for 1 country of LA (Brazil), 15 of the OECD[24] and 4 of Asia[25], the most recent $I(0)$ period is also the most prominent (or the first detected), according to the M test of LKT.[26] This means that, for these 20 economies, the period of the highest price stability occurred towards the end of the sample.

Finally, Tables 8-10 present the mean and standard deviation for each of the $I(0)/I(1)$ periods detected by the M test in chronological order for LA (Table 8), the OECD (Table 9), and Asia (Table 10). Take for instance the case of Brazil. The procedure detects an $I(0)$ segment between the beginning of the sample (1980:01) and 1983:04. For this period, the mean was calculated to be 71.07 with a standard deviation of 10.53. From 1983:05 to 1996:02 the LKT test detects an $I(1)$ segment with corresponding statistics of 182.89 and 135.90. Finally, for the period 1996:03-2008:06 an $I(0)$ period is detected with a mean of 6.52 and a standard deviation of 4.73.[27] Brazil is an example of a country for which *a)* the most recent $I(0)$ segment corresponds to the lowest values of the mean and the standard deviation, and *2)* the $I(1)$ segment corresponds to the highest values of the mean and standard deviation. In fact, these two features hold true not only for Brazil, but also for Chile, Iceland, Peru, France, Italy, Luxembourg, and Indonesia.

[24] Australia, Belgium, Canada, Denmark, Finland, France, Germany, Iceland, Ireland, Luxembourg, New Zealand, Spain, Switzerland, the UK, and the US.

[25] Japan, Malaysia, Singapore, and Thailand.

[26] To see this, note that in Tables 2, 4 and 6, the first reported $I(0)$ segment corresponds to the most prominent one.

[27] Note that this period is the one detected by the M test as the most prominent one; see Table 2.

It is interesting to note from Tables 8-10 that for 26 countries[28], the most recent $I(0)$ segment corresponds to the lowest value of the mean for each country. On the other hand, for 17 countries[29], the $I(1)$ segment corresponds to the highest values of the mean.[30] These findings seem to suggest that persistence and average inflation tend to fall -and increase- at the same time. This implies that good policies can induce both stability and low levels of inflation simultaneously -and viceversa.

From the twelve countries with prolonged $I(1)$ periods[31], 8 of them (Argentina, Chile, France, Ireland, Iceland, Italy, Luxembourg, and the US) experienced the beginning of high persistence around the early to mid 1970s. On the other end of this $I(1)$ segment, the period known as the 'Great Moderation' seems to correspond only to Chile, France, and the US, for which the end of their big inflations occurred around the first half of the 1980s.[32] For the LA countries in this group (Brazil, Mexico and Peru) the big inflations began during the early 1980s, and start to slow down not before the mid 1990s. For many LA and OECD countries, the estimated dates of change in both level and persistence, seem to have a relation to changes in the operating rules of monetary policy.[33]

Starting from the late 1980s, the newly gained independence (or autonomy) of many central banks, and their adherence to monetary policy schemes that explicitly advocated low stable inflation like inflation targeting, set the ground for an environment of stability and transparent monetary policy, which quickly began to spread around the globe. By 1995, eight countries (Australia, Canada, Chile, Finland, New Zealand, Spain, Sweden, and the UK) had fixed medium term targets for inflation, and several more (Brazil, Colombia, Indonesia, Korea, Mexico, Norway, and Thailand) joined the group during the next decade.

[28] Australia, Brazil, Chile, Colombia, Ecuador, Peru, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Italy, Luxembourg, New Zealand, Norway, Spain, Sweden, Switzerland, Turkey, the UK, Indonesia, and Japan.

[29] Argentina, Bolivia, Brazil, Chile, Mexico, Peru, Venezuela, France, Iceland, Ireland, Italy, Luxembourg, the US, Indonesia, Malaysia, Singapore, and Thailand.

[30] In the case of the Asian economies with persistence changes, the $I(1)$ segment correspond to the highest values of the mean *and* the standard deviation.

[31] Argentina, Brazil, Chile, Mexico, Peru, Australia, France, Ireland, Iceland, Italy, Luxembourg, and the US (see Table 7).

[32] Our results for France and the US are in line with other studies, based on different techniques, which document drops in inflation persistence, beginning around the early 1980s. For instance, Kumar and Okimoto (2007) compute for the G7 the Modified Feasible Exact Local Whittle estimator of the order of fractional integration, and document a decline in persistence in the early 1980s. For the US, Beechey and Osterholm (2007), use an AR process for inflation, derived from the central bank's optimization problem, and estimate the path of the time-varying inflation persistence parameter over the last 50 years. Using a state-space model and the Kalman filter, they find significant reductions in persistence, starting again in the early 80's. Benati (2002) reaches similar conclusions using random-coefficients AR models with GARCH effects for the UK and the US. Noriega and Ramos-Francia (2008) also find significant drops in inflation persistence for the US using both monthly and quarterly data for a larger sample. See Levin and Piger (2006) for a recent survey.

[33] For instance, Altissimo et. al. (2006) argue that "There is, ..., considerable evidence that breaks in the mean of inflation occurred at times of major shifts in the monetary policy regime. The early 1990s breaks correspond to either the adoption of inflation targeting (Benati 2006) or, ..., to the implementation of the Maastricht criterion of nominal convergence. By comparison, breaks in the early 1980s generally reflect the disinflation policies that occurred in the United States and the United Kingdom as well as the 1979 launch of the European Monetary System (EMS), at which point the Benelux monetary union, France, Italy, and the Netherlands, began to peg their currency to the Deutsche Mark." (p. 587). For a discussion on the case of LA, see Capistrán and Ramos-Francia (2006).

Our results seem to be consistent with the expectation of a relatively low inflation persistence outlook in recent years, resulting from the credibility of central banks' commitment to attain low inflation rates.

One theoretical implication of our findings is that the evaluation of alternative monetary policy frameworks, and the computation of optimal monetary policies based on models with built-in inflation persistence may deliver misleading indications (as indeed indicated by Benati (2002)), since inflation persistence does not seem to be a structural feature of the economy. However, our results can not shed light on the sources of inflation persistence, like information processing constraints faced by private agents, the structure of nominal contracts, and the process for the structural shock hitting the economy.

Table 8
Summary Statistics for Latin American Inflation

Country	*Sample*	*Mean*	*Std. Dev.*	*Order of Integration*
Argentina	1960:11 - 1974:08	24.46	21.28	I(0)
	1974:09 - 1995:01	120.51	143.57	I(1)
	1995:02 - 2001:12	-0.23	3.27	I(0)
	2002:01 - 2004:05	16.17	24.20	I(1)
	2004:06 - 2008:06	9.13	2.44	I(0)
Bolivia	1960:01 - 1973:06	6.78	22.97	I(0)
	1974:04 - 1982:01	15.73	28.99	I(0)
	1982:02 - 1985:10	271.08	241.73	I(1)
	1985:11 - 1992:04	22.80	41.64	I(0)
	1992:06 - 1995:09	8.32	3.13	I(0)
	1996:06 - 2000:10	4.88	5.23	I(0)
	2000:12 - 2003:02	1.59	3.34	I(0)
	2003:03 - 2007:01	4.86	3.31	I(0)
Brazil	1980:01 - 1983:04	71.07	10.53	I(0)
	1983:05 - 1996:02	182.89	135.90	I(1)
	1996:03 - 2008:06	6.52	4.73	I(0)
Chile	1963:06 - 1972:06	26.02	27.46	I(0)
	1972:07 - 1981:01	92.53	93.68	I(1)
	1981:02 - 1998:06	14.62	17.58	I(0)
	1998:08 - 2003:05	3.22	1.59	I(0)
	2004:06 - 2006:07	3.23	1.27	I(0)
Colombia	1963:12 - 2000:03	17.66	11.29	I(0)
	2000:05 - 2008:04	5.88	3.20	I(0)
Ecuador	1962:08 - 1980:02	8.57	12.91	I(0)
	1982:11 - 1999:10	33.30	17.97	I(0)
	1999:11 - 2003:09	28.33	33.34	I(1)
	2003:10 - 2007:06	2.61	2.53	I(0)
El Salvador	1960:02 - 1973:03	0.88	10.52	I(0)
	1973:10 - 1994:11	15.09	12.17	I(0)
	1994:12 - 1998:12	6.03	8.44	I(0)
	1999:07 - 2008:01	3.70	5.81	I(0)
Honduras	1961:03 - 1989:12	5.56	11.27	I(0)
	1990:01 - 1993:03	18.00	14.89	I(1)
	1993:04 - 1997:08	20.88	9.70	I(0)
	1999:02 - 2007:10	10.83	29.82	I(0)
Mexico	1961:04 - 1972:12	3.23	6.82	I(0)
	1973:04 - 1981:11	19.79	9.68	I(0)
	1981:12 - 2002:08	31.21	28.75	I(1)
	2002:09 - 2008:04	4.06	2.00	I(0)

Table 8
Summary Statistics for Latin American Inflation (Cont.)

Country	*Sample*	*Mean*	*Std. Dev.*	*Order of Integration*
Paraguay	1961:09 - 1971:03	2.51	7.14	I(0)
	1971:06 - 2003:05	14.65	16.76	I(0)
	2005:02 - 2008:06	9.33	6.46	I(0)
Peru	1960:10 - 1977:05	12.03	16.28	I(0)
	1978:02 - 1982:09	51.28	20.69	I(0)
	1982:10 - 1996:12	116.08	190.14	I(1)
	1997:01 - 2008:05	3.06	3.80	I(0)
Uruguay	1960:04 - 1972:02	35.71	36.94	I(0)
	1972:05 - 1990:01	47.91	30.93	I(0)
	1991:02 - 1994:01	48.16	14.45	I(0)
	1996:12 - 1998:11	11.79	5.13	I(1)
	1998:12 - 2002:01	4.28	4.13	I(0)
	2002:02 - 2003:07	18.91	15.69	I(1)
	2003:08 - 2008:04	6.97	4.33	I(0)
Venezuela	1960:02 - 1962:07	-0.48	22.70	I(0)
	1962:08 - 1973:08	2.04	3.47	I(0)
	1975:04 - 1978:12	7.11	3.53	I(0)
	1979:01 - 1981:01	18.45	7.06	I(1)
	1981:02 - 1986:12	9.79	6.41	I(0)
	1987:01 - 1989:01	31.73	19.14	I(1)
	1989:02 - 1996:02	41.69	29.84	I(0)
	1996:03 - 1998:05	44.75	26.41	I(1)
	1998:06 - 2007:09	17.53	9.46	I(0)

Table 9
Summary Statistics for OECD Inflation

Country	*Sample*	*Mean*	*Std. Dev.*	*Order of Integration*
Australia	1960:01 - 1976:02	5.26	4.87	I(1)
	1976:03 - 1983:04	9.62	3.07	I(0)
	1984:01 - 1991:03	6.31	2.95	I(1)
	1991:04 - 2007:03	2.47	2.07	I(0)
Belgium	1961:08 - 1985:04	5.61	4.49	I(0)
	1985:05 - 2007:09	2.00	2.64	I(0)
Canada	1962:05 - 1972:07	3.21	2.26	I(0)
	1973:01 - 1975:11	9.89	2.77	I(0)
	1977:01 - 1982:07	9.71	2.83	I(0)
	1982:12 - 1987:11	4.15	2.23	I(0)
	1988:01 - 2008:03	2.38	3.24	I(0)

Table 9
Summary Statistics for OECD Inflation (Cont.)

Country	*Sample*	*Mean*	*Std. Dev.*	*Order of Integration*
Denmark	1967:02 - 1985:04	8.44	8.22	I(0)
	1985:05 - 2008:05	2.47	2.77	I(0)
Finland	1961:10 - 1968:12	6.00	5.92	I(0)
	1969:04 - 1972:10	5.31	5.20	I(0)
	1972:11 - 1982:06	11.59	7.43	I(0)
	1983:08 - 1991:12	4.93	2.90	I(0)
	1992:01 - 2008:04	1.59	2.66	I(0)
France	1962:05 - 1972:04	4.22	3.15	I(0)
	1972:05 - 1985:07	9.74	3.24	I(1)
	1985:08 - 2008:04	2.05	1.97	I(0)
Germany	1960:05 - 1972:06	2.93	3.07	I(0)
	1972:10 - 1981:12	4.95	2.87	I(0)
	1983:12 - 1985:12	1.79	1.80	I(0)
	1987:01 - 1993:04	3.19	3.36	I(0)
	1993:05 - 2008:05	1.66	2.30	I(0)
Greece	1960:04 - 1979:06	5.78	18.18	I(0)
	1981:04 - 1991:04	17.12	6.65	I(0)
	1993:05 - 1996:06	8.99	3.03	I(0)
	1997:03 - 2008:06	3.44	2.58	I(0)
Hungary	1976:02 - 1988:12	7.20	9.26	I(0)
	1989:04 - 1998:05	21.01	13.36	I(0)
	1998:06 - 2008:06	6.48	4.16	I(0)
Iceland	1976:02 - 1990:09	30.88	25.65	I(1)
	1990:10 - 2007:07	3.67	3.04	I(0)
Ireland	1975:12 - 1990:01	9.61	9.75	I(1)
	1990:02 - 2006:05	2.85	2.27	I(0)
	2006:06 - 2008:06	4.70	0.47	I(1)
Italy	1960:01 - 1972:06	3.74	4.40	I(0)
	1972:07 - 1991:07	11.57	6.61	I(1)
	1991:08 - 1996:06	4.51	1.97	I(0)
	1996:08 - 2006:09	2.21	1.15	I(0)
Luxembourg	1960:06 - 1973:10	3.18	4.27	I(0)
	1973:11 - 1990:11	5.40	4.46	I(1)
	1990:12 - 2007:09	2.17	2.76	I(0)
Netherlands	1961:10 - 1980:10	5.92	7.17	I(0)
	1980:11 - 1986:04	7.22	31.40	I(0)
	1986:12 - 1999:08	0.40	20.14	I(0)
	2001:06 - 2008:04	1.83	1.51	I(0)

Table 9
Summary Statistics for OECD Inflation (Cont.)

Country	*Sample*	*Mean*	*Std. Dev.*	*Order of Integration*
New Zealand	1960:04 - 1969:04	3.41	2.62	I(0)
	1970:01 - 1990:02	10.92	5.22	I(0)
	1991:01 - 2008:01	2.07	1.67	I(0)
Norway	1964:02 - 1978:12	6.67	6.17	I(0)
	1979:10 - 1983:01	11.46	4.34	I(0)
	1983:02 - 1986:05	5.76	1.70	I(0)
	1988:07 - 2007:10	2.24	3.51	I(0)
Portugal	1960:01 - 1966:08	2.67	7.06	I(0)
	1966:09 - 1992:08	14.17	13.69	I(0)
	1993:12 - 2008:05	2.99	2.56	I(0)
Spain	1960:09 - 1972:06	6.31	7.16	I(0)
	1972:07 - 1985:04	14.33	7.18	I(0)
	1986:03 - 2008:05	4.02	2.59	I(0)
Sweden	1960:02 - 1964:06	3.01	3.40	I(0)
	1964:07 - 1993:04	7.09	6.45	I(0)
	1993:07 - 2007:09	1.28	2.46	I(0)
Switzerland	1961:05 - 1971:10	3.81	2.55	I(0)
	1971:11 - 1975:06	7.96	5.69	I(0)
	1976:12 - 1992:10	3.35	3.48	I(0)
	1992:12 - 2007:09	0.96	2.15	I(0)
Turkey	1969:12 - 1973:11	13.10	14.12	I(0)
	1974:03 - 2003:03	43.50	27.58	I(0)
	2003:09 - 2008:03	9.21	4.54	I(0)
UK	1960:07 - 1970:08	4.00	4.12	I(0)
	1970:09 - 1977:06	13.27	7.76	I(0)
	1977:07 - 1991:04	7.61	6.06	I(0)
	1991:05 - 2008:03	2.80	2.13	I(0)
USA	1960:08 - 1965:11	1.32	1.61	I(0)
	1967:05 - 1973:01	4.44	1.72	I(0)
	1973:02 - 1981:09	8.99	3.70	I(1)
	1981:10 - 2007:12	3.12	2.67	I(0)

Table 10
Summary Statistics for Asian Inflation

Country	*Sample*	*Mean*	*Std. Dev.*	*Order of Integration*
Hong Kong	1981:04 - 1987:03	6.97	7.23	I(0)
	1987:04 - 1995:09	9.00	4.27	I(0)
	1998:06 - 2003:05	-3.15	5.77	I(0)
	2003:08 - 2007:09	1.45	4.95	I(0)
Indonesia	1968:02 - 1970:05	18.29	63.88	I(1)
	1970:06 - 2008:06	11.47	15.07	I(0)
Japan	1960:12 - 1981:06	7.10	8.01	I(0)
	1981:07 - 2008:05	0.85	3.36	I(0)
Korea	1960:05 - 2008:06	8.70	13.75	I(0)
Malaysia	1960:02 - 1972:11	1.16	6.60	I(0)
	1972:12 - 1976:02	9.31	10.94	I(1)
	1976:03 - 2008:05	3.22	4.30	I(0)
Singapore	1961:02 - 1972:07	1.24	7.98	I(0)
	1972:08 - 1974:05	20.74	21.32	I(1)
	1974:06 - 1981:03	3.71	6.78	I(0)
	1981:09 - 1987:05	0.79	4.84	I(0)
	1987:06 - 2007:06	1.49	3.14	I(0)
Thailand	1965:03 - 1972:07	2.35	5.33	I(0)
	1972:08 - 1974:05	20.28	11.56	I(1)
	1974:06 - 1979:06	6.03	7.61	I(0)
	1981:05 - 2007:09	3.56	4.84	I(0)

6 Conclusions

Using time series techniques, we have analyzed the dynamics of persistence in inflation rates for 45 countries, using (mostly) monthly seasonally adjusted data from 1960 to 2008. Our results indicate that for half of the countries analyzed, inflation is stationary throughout the sample. For this group of countries, the level around which (nonpersistent) inflation has fluctuated does not seem to be constant. For many countries in this group, particularly those belonging to the OECD, the lowest levels of inflation correspond to the most recent periods, i.e. from the 1980s to the end of the sample for some countries, or from the 1990s to the end of the sample for others. This phenomenon could be related to the 'Great Moderation', and the introduction of inflation targeting as a framework for monetary policy.

On the other hand, the presence of persistence change seems to be pervasive: for half of countries mixtures of low and high persistence episodes were detected along the sample period, most prominently among Latin American economies. For the great majority of countries in this second group, the high persistence periods are also those with the highest inflation mean and standard deviation within the sample.

7 Appendix

Figure 1
Results of the LKT Tests for Latin American Inflation

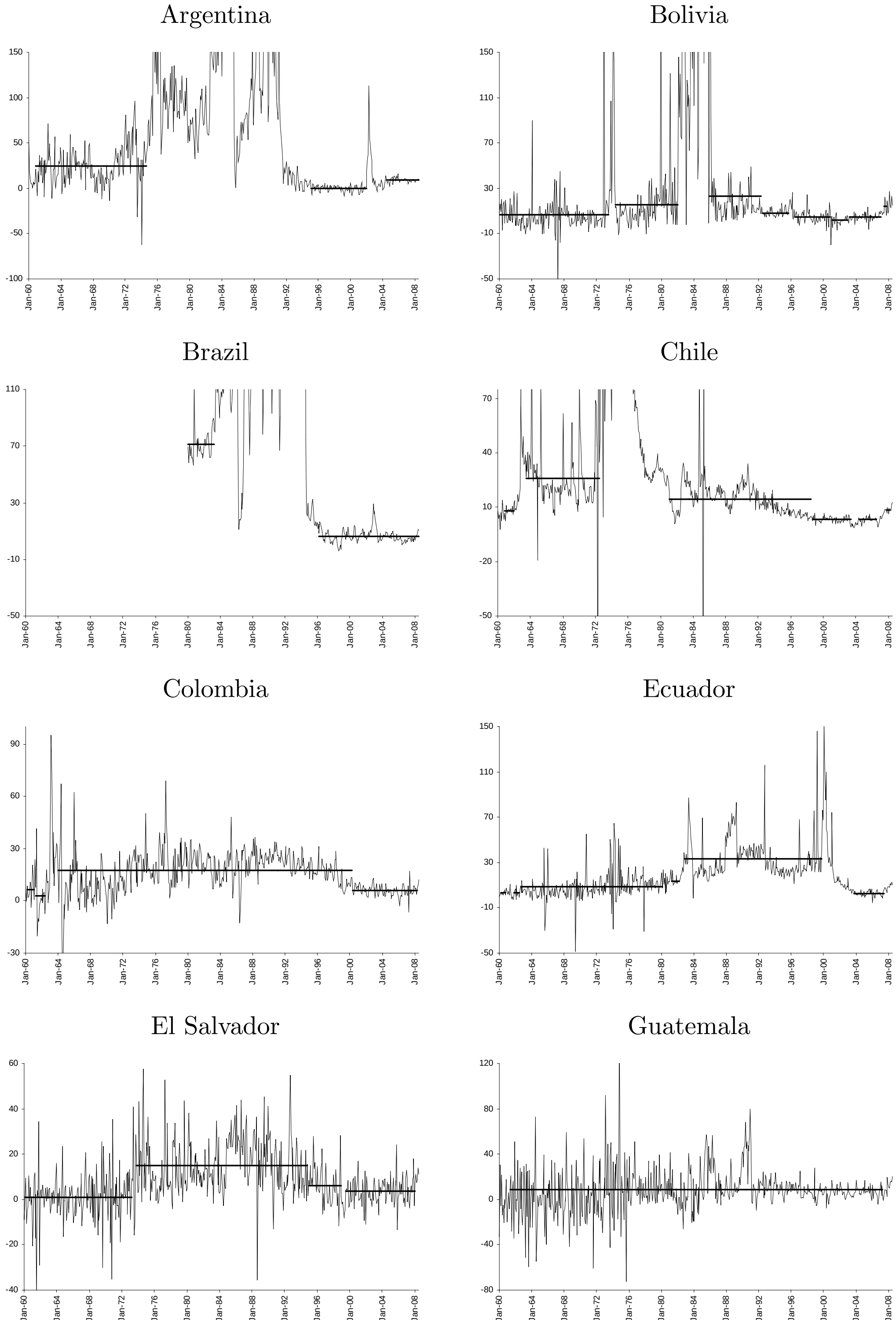


Figure 1
Results of the LKT Tests for Latin American Inflation (Cont.)

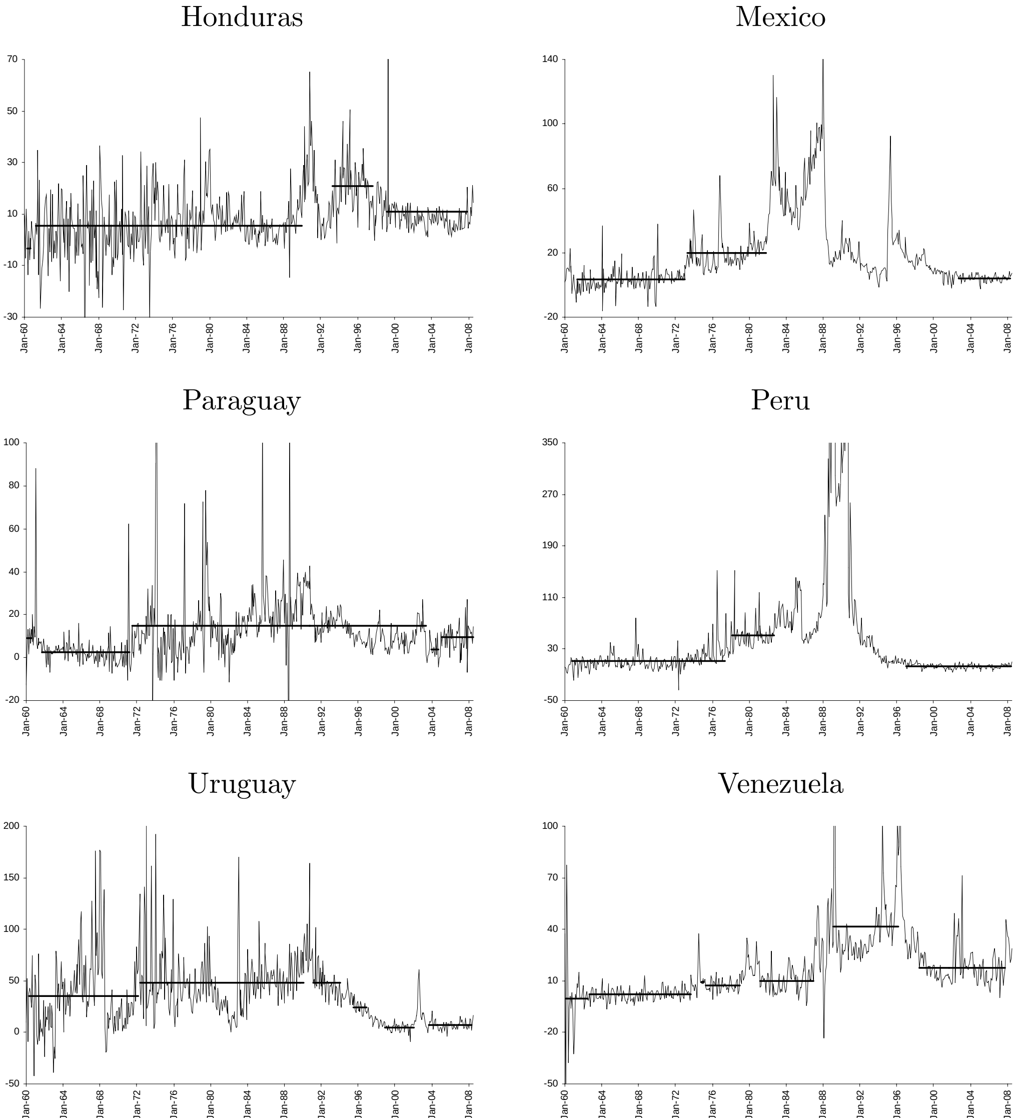


Figure 2
Results of the LKT Tests for OECD Inflation

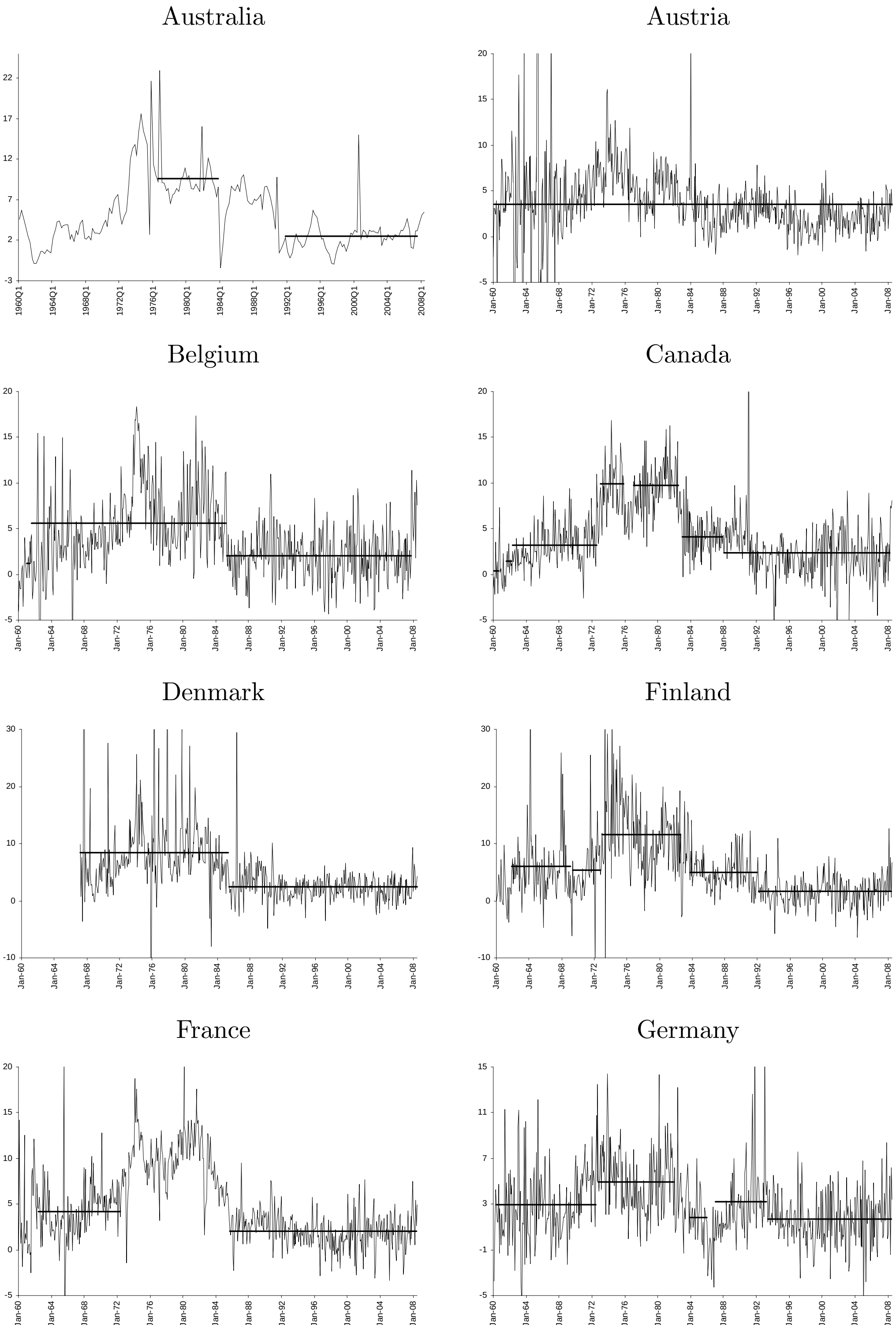
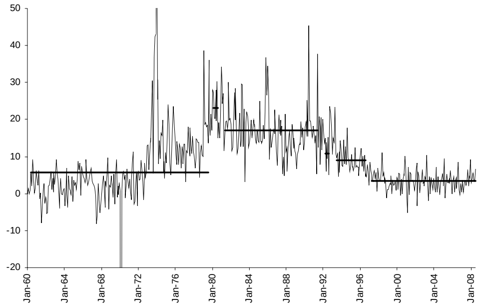
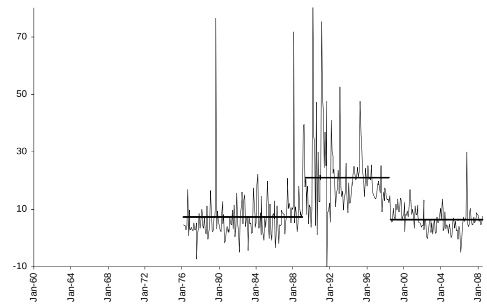


Figure 2
Results of the LKT Tests for OECD Inflation (Cont.)

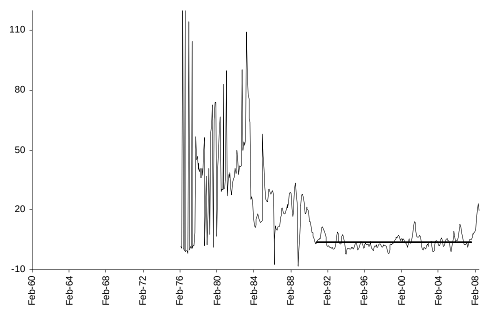
Greece



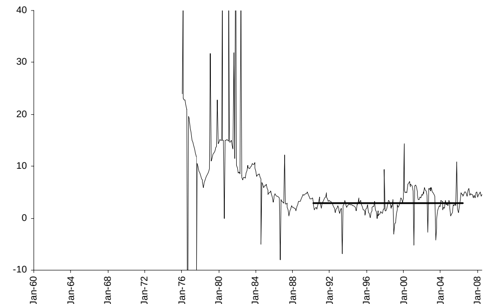
Hungary



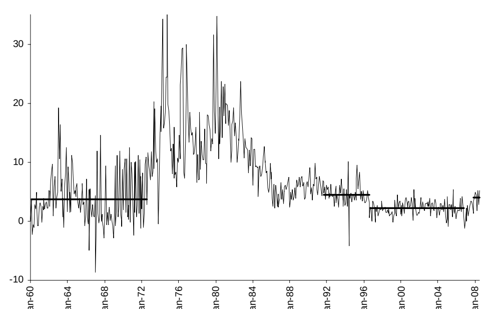
Iceland



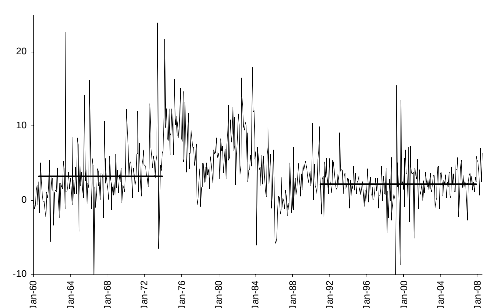
Ireland



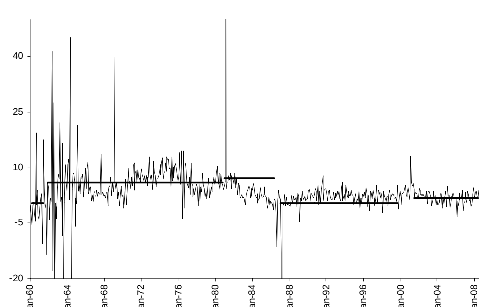
Italy



Luxembourg



Netherlands



New Zealand

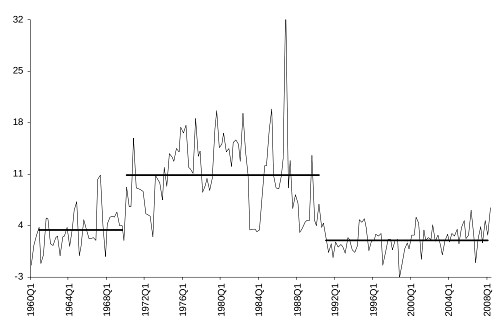


Figure 2
Results of the LKT Tests for OECD Inflation (Cont.)

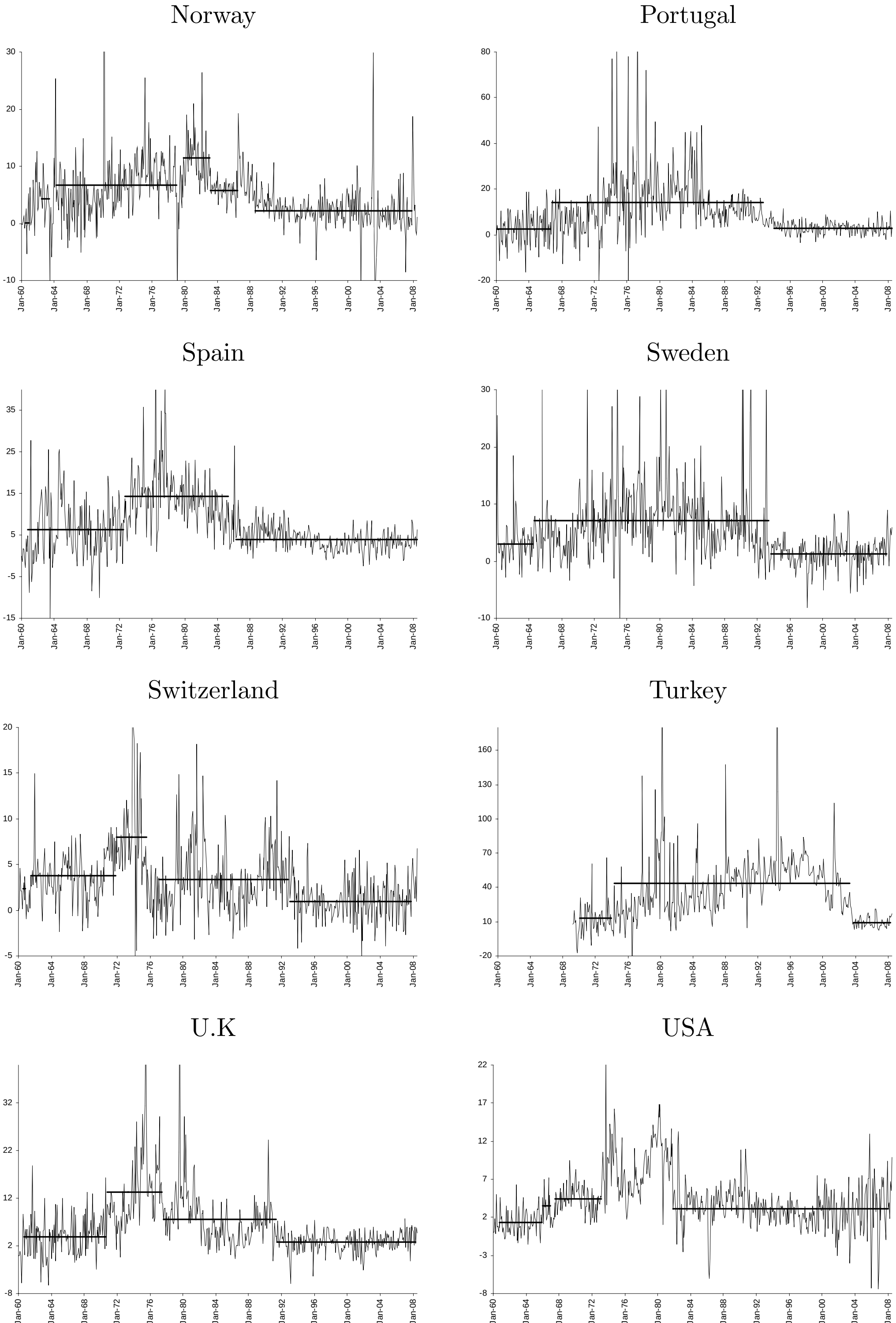
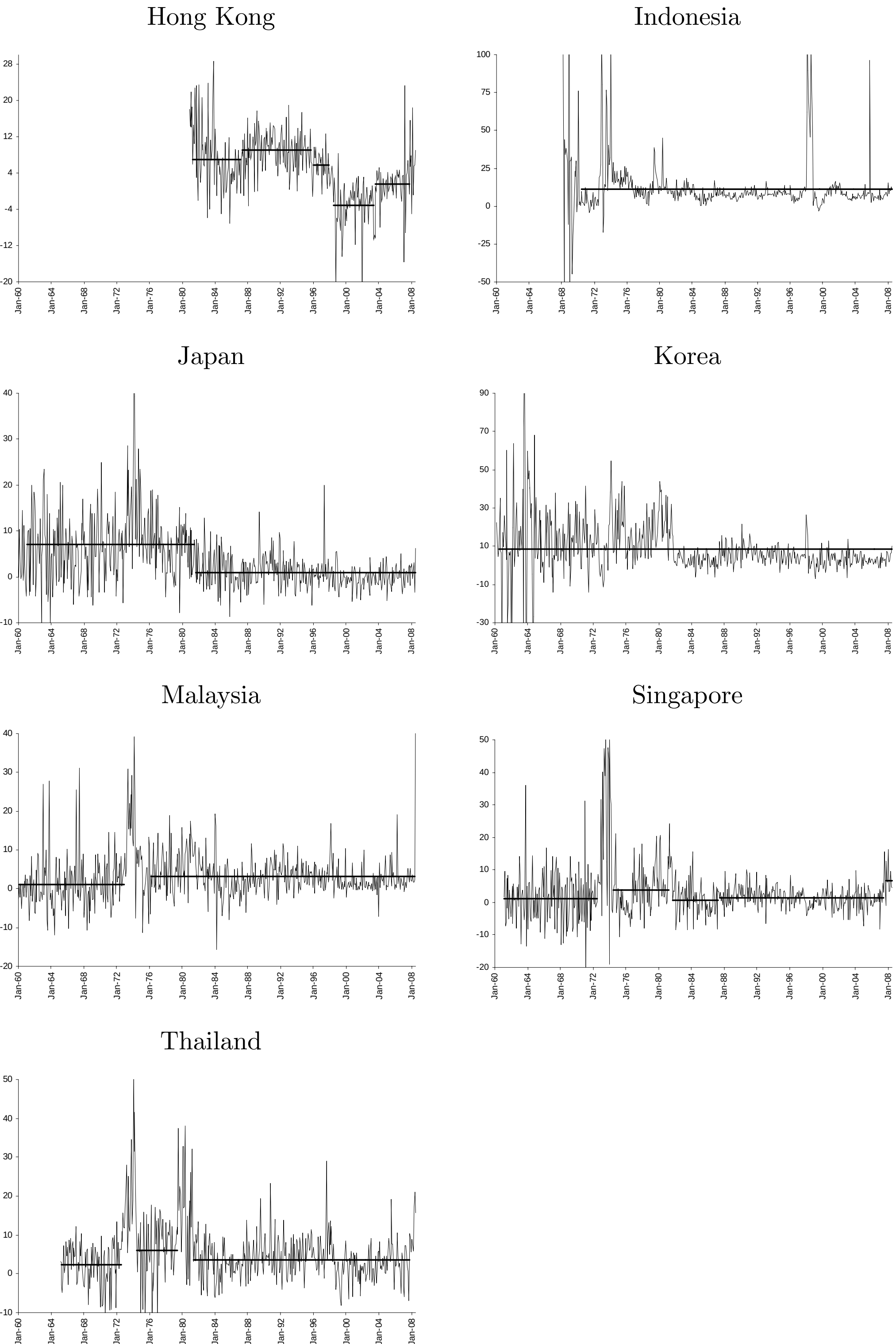


Figure 3
Results of the LKT Tests for Asian Inflation



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