

# **Inflation Targeting and Inflation Convergence: International Evidence**

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## **Abstract**

We examine whether the inflation rates of the countries that pursue inflation targeting policies have converged as opposed to the experience of the OECD non-inflation targeters. Using a methodology introduced by Pesaran (2007a), we examine the stationarity properties of the inflation differentials. This approach has the advantage of avoiding setting arbitrarily a specific country as the benchmark economy. Our results indicate that the inflation rates converge irrespective of the monetary policy framework.

**Keywords:** Inflation Targeting, Inflation Convergence, Pair-wise approach, Unit Roots.

**JEL Classification:** E31, C22

## **1. Introduction**

Since the late 1980s an increasing number of countries have adopted explicit inflation targets as a means for anchoring expectations and securing price stability. In addition to the theoretical research that establishes analytically the rationale for inflation targeting (e.g. Svensson, 2011), substantial evidence has been produced on the effects of inflation targeting on the inflation rate, its volatility, and output growth, focusing on both the time series and the cross sectional dimension. The results are far from conclusive, however, with the evidence upon the effects of targets on inflation being mixed. Extensive evidence has been produced emphasising the importance of targets in the reduction of both the inflation level and its persistence (e.g. Hyvonen, 2004; Johnson 2002, Levin *et al.*, 2006; Lin and Ye, 2007, Goncalves and Salles, 2008). Nevertheless, other analyses suggest that the declining tendency of inflation in several inflation targeting countries cannot be attributed to the inflation targeting (e.g. Ball and Sheridan, 2005; Ball, 2010; Genc *et. al*, 2007; Angeriz and Arestis, 2007b, 2008).

Another line of research considers the process of inflation convergence across countries in a time series context among countries that may share the same policy regime (e.g. Busetti *et al.*, 2007 consider European countries), or not (e.g. Crowder and Phengpis, 2007). The focus of this literature, however, is on inflation convergence and does not account for the implications of inflation targeting.

In this contribution we consider whether the inflation rates in the inflation targeting and non-inflation targeting OECD economies converge using the pair-wise stationarity testing procedure of Pesaran (2007a) on

bilateral inflation differentials. We also employ some recently developed panel unit-root tests for robustness purposes that allow us to consider whether the inflation convergence process differs for inflation targeters and non-targeters. The results indicate that convergence is evident regardless of whether central banks announce explicit inflation targets or not. This evidence is in line with findings from earlier literature that employs different methodologies and indicates that the inflation targeting regimes by themselves cannot explain the improved inflation performance observed during the periods of inflation targeting (e.g. Ball and Sheridan, 2005; Angeriz and Arestis, 2008). Overall, this study contributes towards answering one of the key enduring questions about inflation targeting, namely whether the “improvements in performance observed in countries that have adopted inflation targeting [are] the direct result of the change in policy regime” (Bernanke and Woodford, 2005, p. 2).

The remainder of the paper is structured as follows. The following section reviews the relevant literature on inflation targeting and on inflation convergence; it also provides the reasons behind investigating inflation convergence among the countries selected for the purposes of this contribution. Section 3 describes the econometric methodology. Section 4 discusses the findings, and, finally, Section 5 summarises and concludes.

## **2. Background literature: Empirical Analyses of Inflation Targeting and Macroeconomic Performance**

A large number of studies have examined the effects of inflation targeting on macroeconomic performance. Early studies such as those of Neumann and Hagen (2002), Hu (2003), and Levin *et al.* (2004) find that

adopting inflation targets reduces both the average level and the variance of inflation. The contribution of inflation targeting in reducing inflation rates is corroborated by evidence suggesting that it has also been instrumental in reducing inflation expectations (e.g. Johnson, 2002; Johnson, 2003; Levin *et al.*, 2004; Gurkaynak *et al.*, 2008).

Interestingly enough those positive results on inflation targeting performance do not seem to account for any potential cost of output. Furthermore, evidence exists showing an overall improvement in the growth performance of inflation targeters (e.g., Mollick *et al.*, 2011). Moreover, the adoption of inflation targets appears to be associated with a reduction in output growth volatility (e.g. Goncalves and Salles; 2008).

More recent research outcomes, nonetheless, produce mixed results in terms of the impact of inflation targeting. A spate of papers suggests that inflation targeting has made a difference only in developing and emerging economies but not in advanced economies. Lin and Ye (2007) focusing on seven industrialised inflation targeters find that adopting inflation targets does not lead to the reduction of inflation and its variability. On the contrary, repeating the same analysis for thirteen developing inflation targeters (Lin and Ye, 2009), shows that the effect of inflation targeting in lowering inflation and its volatility is large and significant. The analyses of Mishkin and Schmidt-Hebbel (2007) and Walsh (2009) support further the proposition that inflation targeting seems to play a role in emerging markets but it does not matter in advanced countries. Angeriz and Arestis (2007a) consider the implementation of 'inflation targeting lite', i.e. the pursuit of inflation targeting by certain small emerging countries as a means of defining their monetary policy framework. The authors conclude that priority to inflation

targeting in relation to other objectives cannot be assigned in the case of ‘lite’ countries.

The analysis of Ball and Sheridan (2005), who examine the effect of the IT adoption on the average level of inflation, poses a more fundamental challenge. Applying the ‘differences-in-differences’ methodology, Ball and Sheridan (2005) estimate the following equation

$$\pi_i^{post} - \pi_i^{pre} = a + bI_i + c\pi_i^{pre} + u_i \quad (1)$$

where  $\pi_i^{post}$  and  $\pi_i^{pre}$  are the inflation rates after and before the adoption of inflation targets, respectively,  $I_i$  is a dummy that takes the value of one in the case of a country that is an inflation targeter and zero otherwise, and  $u_i$  is the error term. Examining 7 inflation targeters and 13 non-targeters, they find that the IT dummy is statistically insignificant; that is, the reduction in the inflation rate takes place irrespective of the IT adoption. While the sample of Ball and Sheridan (2005) includes only advanced economies, Goncalvez and Salles (2008) extend the analysis to include emerging inflation targeter and non-targeter countries. Their evidence suggests that IT matters as the inflation targeters have experienced a greater drop in inflation rates than the non-targeters.

Another set of evidence suggests that although inflation targeting has gone hand-in-hand with low inflation, the inflation targeting approach was introduced well after inflation had begun its downward trend. Angeriz and Arestis (2008) make this point and go further to apply intervention analysis to multivariate structural time series models to produce evidence for the OECD

countries, which suggests that after the adoption of the inflation targeting framework inflation is 'locked in' at low rates. However, the non-inflation targeting central banks appear to have also been as successful on this score.

These findings are intrinsically related to the literature, which emphasises the issue of endogeneity of the monetary policy regime; that is, the dependence of the monetary policy regime on the whole nexus of economic policy decisions. Mishkin and Schmidt-Hebbel (2002) and Gertler (2005) point out that the adoption of inflation targeting is only one part of an overall process of economic and political reform. Thus, the improvement of the macroeconomic performance prior to the August 2007 crisis, which is found to be related to inflation targeting, may not necessarily be due to the new monetary framework. Indeed, Angeriz and Arestis (2008) conclude that 'globalisation' may be a better explanation of the improvement of macroeconomic performance referred to above.

Evidence on how the implementation of inflation targeting may have affected the process of inflation convergence is scarce. Ball and Sheridan (2005) interpret the statistically significant  $\pi_i^{pre}$  on the right-hand side of equation (1) as evidence of convergence. This resembles to the notion of  $\beta$ -convergence; greater reduction in inflation rates is achieved by countries that initially faced higher such rates. As argued above the fact that the IT dummy is found to be insignificant is actually an indication that inflation targeting does not account for the inflation convergence. Ball and Sheridan's analysis is extended by Hyvonen (2004) who uses a larger number of countries and separates the time span into three sub-periods. The empirical evidence thereby produced suggests that inflation convergence still holds for the

extended grouping. Hyvonen (op. cit.) concludes that the observed inflation convergence is mainly due to the anti-inflation policies of the 1990s, which include inflation targeting as one of the alternative monetary policy frameworks adopted to achieve inflation reduction.

Apart from these papers the literature on inflation convergence does not address the effects of inflation targeting adoption. Earlier studies examined whether the coordination of policies under the European Monetary System (EMS), aiming at common inflation goals, helped inflation rates to converge. Caporale and Pittis (1993) consider inflation convergence among EMS economies finding that the coordination of the exchange rate policies helped the convergence process. Westbrook (1998) results corroborate these findings for selected EMS countries. After the creation of the Euro in 1999, the same question is rephrased. Busetti *et al.* (2007) also consider inflation convergence using two subsamples, 1980-1997 and 1998-2004. They find evidence of convergence only for the former period, while in the second period two subgroups emerge; one of low inflation countries and of relatively high inflation countries. The importance of non-linearities in accounting for convergence is highlighted by Gregoriou *et al.* (2011). Apart from the importance attached to inflation convergence in the context of coordinated EMS policies or a single monetary policy, some authors raise the question of inflation convergence among countries with different monetary policies. Becker and Hall (2009) address inflation convergence for a group of non-EMU Central and Eastern European (CEE) countries. Kocenda (2001) also provides evidence of convergence of various macroeconomic variables, (including inflation) fundamentals among CEEs, while Kutan and Yigit (2004) challenge these results. Other studies consider advanced economies, as in Siklos and

Wohar (1997) who find that inflation rates converge across the EMU countries, US, Canada and Japan, but interest rates do not. Crowder and Phengpis (2007) produce similar results focusing on the G7 economies.

Finally, a branch of literature shifts focus from cross-country comparisons on regions of one or more economies Busetti *et al.* (2006) consider inflation in 19 Italian regional capitals, while Beck *et al.* (2009) examine regional inflation rates from 5 European countries. Finally, Yilmazkuday (2013) examines the disaggregated inflation rates for the Turkish economy before and after the adoption of inflation targeting in 2001.

In this paper, we consider countries that have adopted inflation targeting and examine whether inflation convergence among them is more pronounced as compare to non-inflation targeters. Ball and Sheridan (2005) suggest that the disinflation achieved by inflation-targeting countries was due to their higher rate of initial inflation relative to other industrialised countries. In other words, they attribute the inflation performance of inflation targeters to the ‘regression to the mean’ or as Hyvonen (2004) puts it inflation convergence. More precisely, if there is no difference in disinflation between inflation targeters and non-inflation targeters one can dispute the role of inflation targeting in reducing inflation along the lines suggested by Ball and Sheridan (2005). The policy implication of such a finding could be that inflation convergence cannot be attributed to inflation targeting but should be viewed as a manifestation of the goals of monetary policy becoming more similar across countries (e.g. Hyvonen, 2004).

We attempt to answer this question by focusing on a group of targeters and considering the performance of non-targeters as a control group. Our analysis is based on the examination of stationarity properties of the inflation



differential using the pairwise testing procedure (Pesaran, 2007a). To briefly illustrate our results we find that inflation convergence is true for both targeters and non-targeters, which suggests that the improved inflation performance over the period considered may not be an attribute of inflation targeting only.

### 3. Empirical Methodology

Stochastic convergence suggests that any difference between series that are temporary in nature will fade away in the long run with shocks dissipating over time (e.g., Bernard and Durlauf, 1995; 1996). More specifically, considering the inflation rate ( $\pi_i$ ) for countries  $i$  and  $j$  convergence implies that:

$$\lim_{h \rightarrow \infty} E(\pi_{i,t+h} - \pi_{j,t+h} | I_t) = 0, \quad (2)$$

where  $I_t$  denotes the information set at time  $t$ . A less strict definition allows for a nonzero constant as a limit and implies an equilibrium differential that remains constant through time. A direct implication is that stochastic convergence can be tested by examining the stationarity properties of the differential between the two variables, i.e.  $d_{i,j,t} = \pi_{i,t} - \pi_{j,t}$ . A commonly used approach focuses on the stationarity properties of this differential. Typically, the differentials considered emerge from setting one country as the benchmark and focusing upon it. This approach, however, can be considered as arbitrary. If one wishes to analyze inflation convergence among developed

economies, there is no obvious reason for setting one specific country as the benchmark. In addition, the results can be sensitive to the choice of the reference country and the focus on only one possible dimension may lead to the loss of substantial information from the other combinations.

Such issues, however, can be circumvented by using a pair-wise testing procedure developed by Pesaran (2007a), which takes into account all pair-wise differential combinations. Let  $\pi_{i,t}$  be the inflation rate for country  $i$  at time  $t$ , where  $i=1\dots N$ ,  $t=1\dots T$  and  $d_{i,j,t} = \pi_{i,t} - \pi_{j,t}$  be the inflation differential of countries  $i$  and  $j$  at time  $t$ . The Pesaran (2007a) pair-wise approach is based on the examination of stationarity properties of all differentials of  $N$  countries without taking into account any benchmark. Instead, it considers the stationarity properties of all possible differentials between all countries under study. Specifically, the number of all differentials is  $N(N-1)/2$ .<sup>1</sup> The fact that this methodology is based on the computation of all possible differentials, and not only on the differentials based on one benchmark, reveals its main advantage; that is, it provides additional information concerning the process of convergence.

Suppose  $Z_{i,j,t}$  is an indicator function that takes the value of one if the null of unit root is rejected at significance level  $\alpha$  and zero otherwise. Specifically,  $Z_{i,j,t}=1$  when  $ADF(k) < C_{\alpha,k,T}$  or  $Z_{i,j,t}=0$  when  $ADF(k) > C_{\alpha,k,T}$ , where  $C_{\alpha,k,T}$  is the critical value for size  $\alpha$ , lag order  $k$  and  $T$  observations. Pesaran (2007a) shows that under the null of unit root (non-stationarity) the fraction

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<sup>1</sup> The number  $N(N-1)/2$  is equal to the number of combinations of  $N$  per 2; in other words, 
$$\binom{N}{2} = \frac{N!}{(N-2)!2!} = \frac{N(N-1)}{2}$$

of differentials for which the null is rejected is equal to the significance level.

Formally, this fraction is equal to:

$$\bar{Z} = \frac{2}{N(N-1)} \sum_{i=1}^{N-1} \sum_{j=i+1}^N Z_{i,j,t} \quad (3)$$

and under the assumption that the null of unit root holds, we have:

$$\lim_{T \rightarrow \infty} E(\bar{Z}|H_0) = \alpha \quad (4)$$

In the case where convergence (i.e. stationarity) holds, the percentage of rejections tends towards 100% as the number of observations tends to infinity, i.e.  $T \rightarrow \infty$ . Consequently, the higher the proportion of rejections is, the stronger the evidence in favour of convergence.

We consider the stationarity of each differential through the use of unit root tests, including the Augmented Dickey-Fuller (ADF) tests and the cross-sectional ADF tests (CADF, hereafter), as developed by Pesaran (2007b). The ADF equation is written as:

$$\Delta d_{i,l,t} = a + \beta d_{i,l,t-1} + \sum_{l=0}^k \gamma_l \Delta d_{i,l,t-l} + \varepsilon_t \quad (5)$$

where  $d_{i,l,t}$  is the inflation differential of country  $i$  relative to country  $l$  at time  $t$ ,  $\Delta$  is the difference operator and  $k$  is the lag order. The inference is based on the  $t$ -statistic of the  $\beta$  coefficient. If  $\beta$  is not found to be statistically different from zero, then the series contains one unit root.

Given the fact that we consider all possible differentials, a potential problem that may be raised is that of cross-sectional dependence. The obvious

dependence between  $d_{i,l,t}$  and  $d_{i,f,t}$  with  $l \neq f$  may induce problems in inference concerning the existence of convergence. So, the existence of dependence among the variables under study, i.e. among all the examined differentials, has to be detected. This is done by performing the cross-section dependence (CD) test proposed by Pesaran (2004). The first step is to estimate the ADF equation of the form (5) for each cross-section separately and compute the pair-wise cross-section correlation coefficients of the residuals from equation (5), i.e.  $\hat{\rho}_{i,j}$ . The simple average of these coefficients across all the  $N(N-1)/2$  pairs,  $\bar{\hat{\rho}}$ , is equal to:

$$\bar{\hat{\rho}} = \left( \frac{2}{N(N-1)} \right) \sum_{i=1}^{N-1} \sum_{j=i+1}^N \hat{\rho}_{i,j} \quad (6)$$

Using these calculations, Pesaran (2004) shows that the test:

$$CD = \left( \frac{TN(N-1)}{2} \right)^{1/2} \bar{\hat{\rho}} \quad (7)$$

is normally distributed (see also Pesaran, 2007b, p. 297).

Given the existence of cross-section dependence, the ADF test has to be modified. Pesaran (2007b) proposes such a modification according to which equation (5) is now rewritten as:

$$\Delta d_{i,t} = a_i + \beta_i d_{i,t-1} + c_i \bar{d}_{t-1} + \sum_{l=0}^k d_l \Delta \bar{d}_{t-l} + \varepsilon_{i,t} \quad (8)$$

where  $\bar{d}_t = M^{-1} \sum_{l=1}^M d_{l,t}$  is the cross-sectional average of all  $M$  differentials at time  $t$ . The inclusion of the average term, and its differences, takes into account the existence of dependence among variables. As in the standard ADF test, the

inference about the unit root is based on the  $t$ -statistic of  $\beta$  coefficient. This statistic, however, does not follow either the  $t$ -student or the Dickey-Fuller ones. For this reason, specific and relevant critical values are provided by Pesaran (2007b).

The above pair-wise testing procedure draws on unit root tests applied on a single series of inflation differentials sequentially and the inference is based on the aggregate behaviour of these individual tests. As a robustness check to the pair-wise approach, we perform panel unit root tests for the examined differentials. That is, instead of looking into the time series properties of each differential, we now draw our attention to the whole panel of the series, which have the advantage of increased power.

We employ panel versions of ADF and CADF tests. In particular, we use the panel version of ADF proposed by Im *et al.* (2003) (henceforth, IPS), which constitutes a simple average of individual ADF unit root tests and has the following form:

$$t_{IPS} = \frac{\sqrt{M}(\bar{t} - E(t_i))}{Var(t_i)} \quad (9)$$

where  $M$  is the number of cross-sectional units (here, differentials) and  $\bar{t}$  is the corresponding average, i.e.  $\bar{t} = M^{-1} \sum_{i=1}^M t_i$ , with  $t_i$  being the individual ADF  $t$ -statistic. The values of  $E(t_i)$  and  $Var(t_i)$  are computed through simulations by Im *et al.*

The IPS test, however, does not take into account cross-sectional dependence. To overcome this shortcoming, Pesaran (2007b) incorporates cross-sectional means, as in the CADF test. In fact, performing for each single differential the CADF test, and taking the average values of the CADF  $t$ -statistics, give rise to the following test statistic:

$$(10) \quad t_{\text{CIPS}} = M^{-1} \sum_{i=1}^M t_i^{\text{CADF}}$$

where  $t_i^{\text{CADF}}$  is the  $t$ -statistic of the individual CADF tests and the subscript ‘CIPS’ refers to ‘cross-sectional IPS’. Pesaran (2007b) provides critical values for this panel test. In fact the two panel unit tests are the average versions of individual ADF and CADF tests.

#### **4. Data and Empirical Results**

Our dataset consists of quarterly series of CPI from 1990:1 to 2011:4. All data come from the International Financial Statistics (IFS) of the IMF. From these series we calculate the quarterly annualised inflation as  $\pi_t = \ln P_t - \ln P_{t-4}$ . According to Hammond’s (2012) classification, twenty-six economies have adopted inflation targeting with the New Zealand being the first economy to do so in December 1989. In the present study we focus on those economies that established the inflation targeting framework during the whole decade of the 1990s. In this way we exclude the economies, which officially adopted targets during the 2000s. Moreover, we exclude countries, such as the Czech Republic and Poland, due to lack of data despite the fact that they employed IT during the 1990s. The included economies in our sample are shown in the upper panel of Table 1. The left column shows these countries and the corresponding dates of the adoption. According to the pair-wise analysis presented in the previous section, we analyse  $N=11$  economies and we compute  $N(N-1)/2=55$  pair-wise differentials.

The analysis is repeated for a group of 11 OECD non-targeters (right column of Table 1). By testing the time series properties of differentials in each group, we are able to examine whether there is inflation convergence within each of the two groups, which differ according to the monetary policy regime.

Apart from convergence within each group, it is of interest to explore any pattern of convergence considering both inflation targeters and non-targeters as a single group; i.e. when the countries are grouped together irrespective of their monetary policy framework ( $N=22$ ). In this way we can investigate the existence of inflation convergence among countries irrespective of the monetary policy pursued.

**Table 1 here**

Since the group of 11 inflation targeters includes Brazil, Chile, Colombia and South Korea, which introduced inflation targeting in the late 1990s, we also consider a narrower group that excludes these countries and consists of 7 countries that adopted targeting in the early 1990s. The pair-wise convergence analysis is repeated separately for the narrower groups of 7 early 1990s inflation targeters and 7 non-targeters (lower panel of Table 1), as well as for the joint set, which includes the 14 inflation targeter and non-targeter countries.

Table 2 presents the results of pairwise ADF(k) tests for  $k=0,1,2,3,4$ . The first panel shows the percentage of rejections for the wide groups. As far as the inflation targeters are concerned, under the null of unit root (i.e. of no convergence), we expect the percentage of rejection to be close to the level of significance. At the 5% significance level the proportion of rejections ranges

from 56.36% to 87.27%. The range of rejection percentages is roughly the same when 10% is used as the level of significance. These results provide clear evidence of inflation rates convergence among inflation targeters.

For the non-inflation targeters group, the findings are even stronger in terms of their support of the convergence hypothesis. When we use one, two and three lags in the ADF test, the percentage of rejections reaches 100%, as all the pair-wise differentials are found to be stationary at the 5% significance level. Consequently, within both groups inflation seems to converge. Unsurprisingly, inflation convergence is also supported for the joint set consisting of both inflation targeters and non-targeters. At the 5% level of significance, the lowest percentage of rejections is 72.73%, while at the 10% level it is 83.12%.

### **Table 2 here**

The same analysis is performed for the smaller group of economies that adopted inflation targets in the early 1990s. For the smaller groups the results are similar in nature and provide even stronger support for inflation convergence, irrespective of whether or not the countries are classified according to the monetary policy regime. As shown in the second panel of Table 2, for the majority of the chosen lags the percentage of rejections is 100% in all the three groups.

The validity of the results in Table 2, however, could be questioned. As illustrated in the previous section, cross-sectional dependence is likely to bias the outcomes. The first step is to test the existence of such dependence. Table 3 shows the results from the CD-test statistic. In all cases, the null of cross



section independence is strongly rejected. Note that the dependence is higher for the non-targeters. This may be due to the fact that the non-inflation targeters group is more homogeneous than the group of inflation targeters.

**Table 3 here**

In view of the evidence of high dependence among economies, due to globalisation in particular, we also investigate the stationarity properties using the Pesaran (2007b) testing procedure, which takes into account cross-sectional dependence. As shown in Table 4, for all the groupings under investigation the results suggest that the convergence hypothesis seems to hold when cross-sectional dependence is taken on board. However, the percentage of rejections of the null of non-convergence still exceeds the chosen levels of significance, although lower than those of Table 2. The only case where the proportion of rejections is slightly lower than the 5% level occurs when the lag order is set at 4 in the non-targeters group of 7 countries.

**Table 4 here**

The application of cross-sectional ADF testing procedure leads to the same conclusions as before. The inflation rates seem to have converged both among the inflation targeters and non-targeters. Moreover, pairwise convergence does not seem to be a phenomenon specific to the countries that adopt a common monetary policy regime. The panel unit-root-test results as shown in Table 5 confirm this conclusion. The null of unit root (non-convergence) is rejected by both the IPS and the CIPS tests for all the groups

under consideration. In all cases both tests give results, which are significant at the 1% level.

**Table 5 here**

Overall, the evidence produced by employing a pairwise testing procedure for unit roots Pesaran' (2007a) and the "cross-sectional IPS" test (Pesaran, 2007b) point to the same conclusions. Specifically, the empirical results strongly support the existence of inflation convergence. But this result applies equally to inflation-targeting countries and non-inflation targeting ones. Indeed, utilising three different groupings of countries according to whether a country has adopted the inflation targeting policy prescription or not, we conclude that the usage of inflation targets does not play a significant role in explaining the pre-2007 inflation convergence. This finding is in line with the literature stressing that it may be difficult to disentangle the effect of inflation targeting on inflation rates from other factors. Such factors can be a more general process of reforms (e.g. Gertler, 2005) such as central bank independence (e.g. Kohn, 2005), the central bank's communication policy (e.g. Mankiw, 2005) globalisation (Angeriz and Arestis, 2007b), and so on.

**5. Summary and Conclusions**

This paper examines the behaviour of the inflation rates across inflation-targeting and non-inflation-targeting countries. In particular, we focus on inflation convergence. We draw our attention to potential differences in inflation (convergence) performance of countries with different monetary policy frameworks. Putting it differently, we investigate whether the inflation

rates of the countries that have adopted inflation targeting have converged; and, most importantly, whether non-inflation targeting countries have had the same experience or not. This is undertaken by examining the stationarity properties of the inflation differentials of the inflation targeting and the non-targeting economies, using Pesaran's (2007a) pairwise testing procedure. Moreover, we conduct the same analysis for all the examined economies regardless of the introduction or otherwise of inflation targets. Our findings indicate that the inflation rates converge within the inflation-targeters group as well as within the non-targeters group. In addition, the inflation rates converge across the two groups, suggesting that inflation targeting does not seem to be associated with different patterns of inflation rate behaviour. This finding is in line with the literature stressing the fact that the reduction of the inflation rates may not be attributed solely to the adoption of inflation targeters. Instead, the reduction of inflation rates and inflation convergence could be the outcome of the coordination implicit in the economic policies pursued in a globalized environment rather than that of inflation targeting per se.

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## **TABLES**

### **Table 1**

#### **Selected Countries**

<b>Wide Group</b>	
<b><i>Inflation Targeters as from the 1990s (month/year of adoption)</i></b>	<b><i>Non-targeters</i></b>



Australia--(6/1993)	Denmark
Brazil--(6/1999)	Finland
Canada--(2/1991)	France
Chile--(9-1999)	Germany
Colombia--(10/1999)	Ireland
Guatemala--(1/1991)	Italy
Israel--(6/1992)	Japan
New Zealand--(12/1989)	Netherlands
South Korea--(4/1998)	Portugal
Sweden--(1/1993)	Spain
United Kingdom--(10/1992)	United States
<b>Narrow Group</b>	
<b><i>Inflation Targeters as from the early 1990s</i></b>	<b><i>Non-targeters</i></b>
Australia--(6/1993)	Denmark
Canada--(2/1991)	France
Guatemala--(1/1991)	Germany
Israel--(6/1992)	Italy
New Zealand--(12/1989)	Japan
Sweden--(1/1993)	Spain
United Kingdom--(10/1992)	United States

Source: Hammond (2012).

**Table 2**

Proportion of differentials for which ADF unit-root is rejected

<b>1-Wide Group</b>					
<i>Inflation Targeters</i>					
<b>Lag order</b>	<b><i>k=0</i></b>	<b><i>k=1</i></b>	<b><i>k=2</i></b>	<b><i>k=3</i></b>	<b><i>k=4</i></b>
$\alpha=5\%$	56.36%	87.27%	87.27%	87.27%	74.55%

$\alpha=10\%$	63.64%	90.91%	89.09%	89.09%	87.27%
<i>Non-Targeters</i>					
<b>Lag order</b>	<b>k=0</b>	<b>k=1</b>	<b>k=2</b>	<b>k=3</b>	<b>k=4</b>
$\alpha=5\%$	87.27%	100%	100%	100%	96.36%
$\alpha=10\%$	98.18%	100%	100%	100%	100%
<i>All</i>					
<b>Lag order</b>	<b>k=0</b>	<b>k=1</b>	<b>k=2</b>	<b>k=3</b>	<b>k=4</b>
$\alpha=5\%$	72.73%	93.94%	92.64%	91.77%	83.12%
$\alpha=10\%$	83.12%	96.54%	95.24%	94.81%	92.21%
<b>2-Narrow Group</b>					
<i>Inflation Targeters</i>					
<b>Lag order</b>	<b>k=0</b>	<b>k=1</b>	<b>k=2</b>	<b>k=3</b>	<b>k=4</b>
$\alpha=5\%$	71.43%	100%	100%	100%	76.19%
$\alpha=10\%$	85.71%	100%	100%	100%	100%
<i>Non-Targeters</i>					
<b>Lag order</b>	<b>k=0</b>	<b>k=1</b>	<b>k=2</b>	<b>k=3</b>	<b>k=4</b>
$\alpha=5\%$	80.95%	100%	100%	100%	95.24%
$\alpha=10\%$	100%	100%	100%	100%	100%
<i>All</i>					
<b>Lag order</b>	<b>k=0</b>	<b>k=1</b>	<b>k=2</b>	<b>k=3</b>	<b>k=4</b>
$\alpha=5\%$	80.22%	100%	100%	100%	85.71%
$\alpha=10\%$	92.31%	100%	100%	100%	100%

Note: Each entry shows the percentage rates of rejections of the null hypothesis  $H_0 : \beta = 0$  at  $\alpha=5\%$  and  $\alpha=10\%$  level of statistical significance. The test equation has the form:

$$\Delta d_{i,t} = a + \beta d_{i,t-1} + \sum_{l=0}^k \gamma_l \Delta d_{i,t-l} + \varepsilon_t.$$

**Table 3**

CD Test for Cross-Sectional Dependence

<i>Inflation Targeters</i>					
<b>Lag order</b>	<b>k=0</b>	<b>k=1</b>	<b>k=2</b>	<b>k=3</b>	<b>k=4</b>
Wide Group	10.30***	11.92***	12.33***	12.25***	11.15***

Narrow Group	6.33***	5.62***	5.82***	6.31***	7.06***
	<i>Non-Targeters</i>				
<b>Lag order</b>	<b>k=0</b>	<b>k=1</b>	<b>k=2</b>	<b>k=3</b>	<b>k=4</b>
Wide Group	18.46***	22.52***	22.60***	22.38***	18.20***
Narrow Group	13.10***	12.97***	12.80***	13.53***	13.30***
	<i>All</i>				
<b>Lag order</b>	<b>k=0</b>	<b>k=1</b>	<b>k=2</b>	<b>k=3</b>	<b>k=4</b>
Wide Group	30.39***	34.83***	36.15***	34.85***	34.63***
Narrow Group	11.41***	13.89***	15.13***	14.41***	15.19***

Note: Each entry shows  $p$ -values of CD statistic for cross-sectional dependence. Inference is based on normal distribution. \*\*\* shows rejection of null of independence at 1% level of significance.

**Table 4**

Proportion of differentials for which CADF unit-root is rejected

<b>1-Wide Group</b>					
	<i>Inflation Targeters</i>				
<b>Lag order</b>	<b>k=0</b>	<b>k=1</b>	<b>k=2</b>	<b>k=3</b>	<b>k=4</b>
$\alpha=5\%$	23.64%	52.73%	54.55%	61.82%	23.64%

$\alpha=10\%$	34.55%	70.91%	72.73%	74.55%	30.91%
	<i>Non-Targeters</i>				
<b>Lag order</b>	<b>k=0</b>	<b>k=1</b>	<b>k=2</b>	<b>k=3</b>	<b>k=4</b>
$\alpha=5\%$	16.36%	45.45%	43.64%	43.64%	12.73%
$\alpha=10\%$	32.73%	63.64%	65.45%	60.0%	25.45%
	<i>All</i>				
<b>Lag order</b>	<b>k=0</b>	<b>k=1</b>	<b>k=2</b>	<b>k=3</b>	<b>k=4</b>
$\alpha=5\%$	29.44%	60.61%	59.74%	61.90%	27.27%
$\alpha=10\%$	43.72%	70.13%	73.16%	71.00%	37.66%
	<b>2-Narrow Group</b>				
	<i>Inflation Targeters</i>				
<b>Lag order</b>	<b>k=0</b>	<b>k=1</b>	<b>k=2</b>	<b>k=3</b>	<b>k=4</b>
$\alpha=5\%$	76.19%	71.43%	85.71%	80.95%	33.33%
$\alpha=10\%$	90.48%	90.48%	90.48%	90.48%	38.10%
	<i>Non-Targeters</i>				
<b>Lag order</b>	<b>k=0</b>	<b>k=1</b>	<b>k=2</b>	<b>k=3</b>	<b>k=4</b>
$\alpha=5\%$	23.81%	33.33%	33.33%	52.38%	4.76%
$\alpha=10\%$	38.10%	52.38%	52.38%	66.67%	28.57%
	<i>All</i>				
<b>Lag order</b>	<b>k=0</b>	<b>k=1</b>	<b>k=2</b>	<b>k=3</b>	<b>k=4</b>
$\alpha=5\%$	42.86%	50.55%	57.14%	57.14%	28.57%
$\alpha=10\%$	48.35%	62.64%	68.13%	70.33%	36.26%

Note: Each entry shows the percentage rates of rejections of the null hypothesis  $H_0 : \beta = 0$  at  $\alpha=5\%$  and  $\alpha=10\%$  level of statistical significance. The test equation has the form:

$$\Delta d_{i,t} = a_i + \beta_i d_{i,t-1} + c_i \bar{d}_{t-1} + \sum_{l=0}^k d_l \Delta \bar{d}_{t-l} + \varepsilon_{i,t}.$$

**Table 5**

Values of IPS and CIPS panel unit root tests

<b>1-Wide Group</b>					
<i>Inflation Targeters</i>					
<b>Lag order</b>	<b>k=0</b>	<b>k=1</b>	<b>k=2</b>	<b>k=3</b>	<b>k=4</b>
IPS	-5.660***	-14.390***	-12.912***	-13.293***	-7.457***

CIPS	-3.330***	-3.824***	-3.863***	-3.855***	-2.942***
<i>Non-Targeters</i>					
<b>Lag order</b>	<b>k=0</b>	<b>k=1</b>	<b>k=2</b>	<b>k=3</b>	<b>k=4</b>
IPS	-8.679***	-13.491***	-14.121***	-15.876***	-8.871***
CIPS	-2.589***	-3.094***	-3.116***	-3.152***	-2.496***
<i>All</i>					
<b>Lag order</b>	<b>k=0</b>	<b>k=1</b>	<b>k=2</b>	<b>k=3</b>	<b>k=4</b>
IPS	-13.921***	-29.456***	-29.132***	-32.051***	-20.082***
CIPS	-3.300***	-3.794***	-3.861***	-3.783***	-2.945***
<b>2-Narrow Wide</b>					
<i>Inflation Targeters</i>					
<b>Lag order</b>	<b>k=0</b>	<b>k=1</b>	<b>k=2</b>	<b>k=3</b>	<b>k=4</b>
IPS	-3.883***	-10.123***	-11.779***	-11.688***	-9.303***
CIPS	-4.138***	-4.712***	-4.207***	-4.000***	-2.938***
<i>Non-Targeters</i>					
<b>Lag order</b>	<b>k=0</b>	<b>k=1</b>	<b>k=2</b>	<b>k=3</b>	<b>k=4</b>
IPS	-5.675***	-7.372***	-7.764***	-9.430***	-4.482***
CIPS	-2.757***	-2.987***	-3.043***	-3.258***	-2.444***
<i>All</i>					
<b>Lag order</b>	<b>k=0</b>	<b>k=1</b>	<b>k=2</b>	<b>k=3</b>	<b>k=4</b>
IPS	-9.658***	-19.987***	-21.847***	-23.340***	-17.068***
CIPS	-3.678***	-3.982***	-4.127***	-3.982***	-2.877***

Note: Each entry shows the values of the IPS and CIPS test. For the former test inference is based on normal distribution while for the latter Table 2 of Pesaran (2007b) is used.

\*\*\* shows rejection at 1% level of significance.