HAS INFLATION TARGETING BEEN SUCCESSFUL? EVIDENCE FROM UNIT ROOT TESTS[1]

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ABSTRACT

The popularity of inflation targeting has risen in the last decade and the number of countries that adopted inflation targeting as their monetary policy framework surpassed 40 by the end of 2016. This study analyzes whether inflation targeting around the world has been successful in terms of achieving the announced target and keeping inflation rate around it. We argue that a successful inflation targeting necessitates the deviation of inflation from the target be stationary. We employ both time series and panel unit root tests in order to analyze the stationarity properties of deviation of inflation from the target. Results of unit root tests provide evidence in favor of the success of inflation targeting framework around the world.

Key words: Inflation targeting, central banks, inflation, unit root tests, stationarity, price stability.
JEL Classification: C23, E52, E58.

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¿HAN SIDO EXITOSAS LAS METAS DE INFLACIÓN?
RESULTADOS DE LAS PRUEBAS DE RAÍZ UNITARIA

RESUMEN

La popularidad de las metas de inflación ha aumentado en la última década y el número de países que adoptaron metas de inflación como su marco de política monetaria sobrepasó los 40 a finales de 2016. Este estudio analiza si las metas de inflación alrededor del mundo han tenido éxito en términos de alcanzar el objetivo anunciado y mantener la tasa de inflación cerca de su meta. Argumentamos que una meta exitosa de inflación requiere que la desviación de la inflación respecto a la meta sea estacionaria. Empleamos tanto series de tiempo como pruebas de raíz unitaria en panel con el fin de analizar las propiedades estacionarias de la desviación de la inflación respecto al objetivo. Los resultados de las pruebas de raíz unitaria proporcionan evidencia a favor del éxito del marco de metas de inflación en todo el mundo.

Palabras claves: metas de inflación, bancos centrales, inflación, pruebas de raíz unitaria, estacionariedad, estabilidad de precios.
Clasificación JEL: C23, E52, E58.

1. INTRODUCTION

The inflation targeting regime was first adopted by New Zealand in 1990, and has become an important phenomenon in central banking since then. Its popularity has risen in the last decade and the number of countries that adopted inflation targeting as their monetary policy framework surpassed 40 by the end of 2016. In parallel with its increasing popularity, inflation targeting attracted attention of both academics and policy makers.

Inflation targeting central banks announce an explicit inflation target and implement monetary policy with an aim of maintaining price stability. Though they have several tools, the main instrument of inflation targeting is policy rates. Central banks raise (lower) policy rates according to inflation being above (below) the target level. Deviations of inflation from the announced target are expected to be small and temporary. Large and permanent deviations can be interpreted as a sign of unsuccessful inflation targeting implementation.

In this study, we investigate whether central banks that implement inflation targeting around the world have been successful in reaching the inflation target and keeping inflation around it. We posit that successful inflation targeting requires that deviation of inflation rate from the target to follow a stationary process. Within this scope, we employ various unit root tests to analyze the stationarity of deviations. This empirical research has three motivations and contributions. First, although there are several studies concerning the macroeconomic effects of inflation targeting, whether inflation targeting has been successful in terms of achieving the announced inflation target and keeping inflation rate around the target is missing in the literature. As far as we know, no studies analyzed this topic except Gregoriou and Kontonikas (2006 and 2009). Second, contrary to many studies, we use a large data set of both advanced and emerging market countries, which allows us to capture potential distinction between these groups. Third, we use both time series and panel unit root tests to investigate the success of the inflation targeting regime. We also check the robustness of our findings by employing time series tests that are robust to structural breaks and panel unit root tests that are robust to cross section dependence and slope heterogeneity.

The rest of the paper is organized as follows. Section 2 discusses the theoretical aspects of inflation targeting. Section 3 provides a brief literature review. Section 4 explains the empirical methodology and data set. Section 5 reports and discusses the model results. Section 6 concludes.

2. THEORETICAL ASPECTS OF INFLATION TARGETING

Scholars have developed many theories to explain the phenomenon of inflation. According to Keynes (1930) inflation occurs if the aggregate demand grows faster than the aggregate supply under full employment. Keynes also thought that inflation and unemployment have an inverse relationship. Thus, central banks could fight against inflation by employing interest rates as their main policy tool. Keynesian theory remained as the leading theory for a long time, but it was heavily criticized when it failed to account for the phenomenon of stagflation. One of the critics was the Nobel Laureate Milton Friedman, through his well known Modern Quantity Theory of Money (Friedman and Schwartz, 1963).

Friedman argued that there might be a trade-off between inflation and unemployment in the short run, but this trade-off does not exist in the long-run. He asserted that inflation is created when the money supply grows faster than production. Therefore, inflation is always and everywhere a monetary phenomenon.

Friedman suggested targeting the growth of money supply with the purpose of controlling inflation. This approach works if the central bank can control the money supply reasonably well and if money growth is stably related to inflation over time (Friedman and Schwartz, 1963). However, the Monetarist approach also failed since the demand for money became unstable mainly due to innovations in the financial markets. This urged scholars to find another anchor for price stability. In this respect, some central banks employed a currency peg that links the value of the domestic currency to the value of the currency of a low-inflation country. The major problem with this approach is that it leaves little independence to the central bank and constraints the central banks' ability to respond to changes in their own economic circumstances. As a result, many countries began to adopt flexible exchange rates, which forced them to find a new anchor. Therefore, countries with flexible exchange rates started to target inflation more directly and that gave rise to an inflation targeting framework. Some argue that wide acceptance of inflation targeting is a pragmatic response to the failure of other monetary policy regimes (Jahan, 2012).

Whether inflation targeting has so far been successful is a hot debate and there are numerous studies in this field. Although proponents of inflation targeting outweigh the opponents, there are several critics. Among them, Vredin (2015) argues that pure inflation targeting is not compatible with financial stability. It does not take into account the financial cycle and produces excessively expansionary and asymmetric monetary policy. In addition, the main argument in favor of inflation targeting maintaining that it lowered inflation is questionable. Disinflation started before inflation targeting was invented and starting from 1990s, globalization has been the major force behind falling global inflation. Another argument is that inflation targeting disregards the source of inflation and applies single treatment to all types of inflation. In case of a commodity price shock, an increasing interest rate causes economic slowdown and high unemployment (Bernanke *et al.*, 2001).

Other strong argument against inflation targeting is its lack of response to asset-price bubbles[2].

3. LITERATURE REVIEW

The literature on the effects and performance of inflation targeting is rich and growing rapidly. Most of the studies in this field analyze the impact of inflation targeting on macroeconomic variables such as inflation, inflation volatility and economic growth. Despite vast amount of studies, empirical evidence provides mixed results about the performance of inflation targeting.

Most of the early studies provide supportive evidence regarding inflation targeting in advanced economies. Among them, Johnson (2002) analyzes advanced economies in a panel setting and finds that inflation targeting lowers expected inflation. Neumann and von Hagen (2002) show that inflation targeting has been successful in reducing inflation and its volatility using several different methods such as vector autoregression (VAR) and event studies. Levin, Natalucci, and Piger (2004) argue that inflation targeting helps reduce both the level and variance of inflation. Gregoriou and Kontonikas (2006 and 2009) employ both linear and non-linear unit root tests to analyze whether inflation targeting in advanced economies has been successful. They find that deviation of inflation from the target is stationary and this implies successful inflation targeting implementation. By employing Ordinary Least Squares (OLS) and instrumental variable approach, Mishkin and Schmidt-Hebbel (2007) find that inflation targeting decreases inflation levels both in the short and in the long run. Gonçalves and Carvalho (2009) show that the sacrifice ratio and the cost of reducing the inflation rate are lower in inflation targeting Organisation for Economic Co-operation and Development (OECD) countries.

On the other hand, other studies find no significant evidence in favor of inflation targeting. Among them, Ball and Sheridan (2005) employ

[2] For a comprehensive theoretical discussion on inflation targeting through the Marxist, Keynesian, Monetarist and post-Keynesian perspective, see Itoh and Lapavitsas (1998), Kriesler and Lavoie (2007), Trigg (2013).

difference-in-differences approach to advanced OECD economies and find that inflation targeting does not improve economic performance in terms of output, inflation and interest rate. Using intervention analysis, Angeriz and Arestis (2006 and 2008) show that inflation targeting central banks have not been successful in reducing inflation rates. According to the study, countries adopted inflation targeting after inflation is already under control. Genc *et al.* (2007) use autoregressive moving average model (ARMA) and generalized autoregressive conditional heteroskedasticity model (GARCH) methods to analyze the impact of inflation targeting and find that adoption of inflation targeting does not cause a structural break in inflation rate. Lin and Ye (2007) use propensity score matching methods to analyze the effects of inflation targeting in advanced economies. Their analysis shows that the inflation targeting regime has no significant impact on inflation and inflation volatility. De Mendonça and Souza (2012) find that adoption of inflation targeting regime lowers inflation and its volatility in developing economies, but has no effect in advanced economies.

Studies related to emerging market economies provide relatively more favorable evidence on the macroeconomic effects of inflation targeting. Among these studies, Gonçalves and Salles (2008) apply difference-in-differences methodology to the data of emerging countries and find that inflation targeting countries experience larger drops in inflation and growth volatility compared to others. Lin and Ye (2009) investigate 13 inflation targeting developing economies using probit propensity scores and show that inflation targeting has a strong and significant impact in reducing inflation and its volatility. The authors assert that the performance of inflation targeting differs across countries and depends on country-specific characteristics. Brito and Bystedt (2010) use fixed effects dynamic panel estimator to analyze the effect of inflation targeting in emerging economies. Their study finds no significant relationship between inflation targeting regime, inflation and economic growth. By using static panel data methods covering both advanced and developing countries, Mollick, Cabral, and Carneiro (2011) find that the inflation targeting regime improves growth performance and leads to higher income per capita. Abo-Zaid and Tuzemen (2012) find that both advanced and developing countries benefit from the inflation targeting regime and conclude that inflation targeters experience lower infla-

tion and higher growth. Moreover, they stress that both inflation and growth tend to become more stable under the inflation targeting regime. Ayres, Belasen and Kutan (2014) examine whether the inflation targeting regime improves economic performance of developing economies by utilizing OLS and fixed effect regression. Results show that inflation targeting was successful in reducing inflation, but the impact on growth is small and the effect varies across regions. Minea and Tapsoba (2014) find that adoption of inflation targeting in developing economies improves fiscal discipline. Finally, Balima, Combes, and Minea (2017) show that the inflation targeting framework in emerging market economies reduces sovereign debt risk and improves access to international financial markets.

Some scholars have argued that one can use other macroeconomic variables instead of interest rates as an anchor for price stability. Among them, Perrotini Hernández and Vázquez Muñoz (2017) assert that, in addition to nominal interest rates, most inflation-targeting central banks adopt an implicit exchange rate policy based on market interventions to reach their inflation targets. However, they criticized the effectiveness of the well-known Taylor Rule and look for alternative anchors for inflation. In this respect, the authors employ the autoregressive distributed lag model for seven countries to calculate long-run elasticities of consumer prices with respect to unit labor costs and exchange rates. The authors stress that suitable anchors of inflation are the wage rate and the unit labor costs, rather than conventionally used nominal interest rates and exchange rates. In fact, the elasticity of the exchange rate is found to be statistically insignificant in some specifications, raising questions about the suitability of using exchange or interest rates as an anchor.

4. DATA AND METHODOLOGY

Our data set consists of twenty-four advanced and developing countries that use inflation targeting as the monetary policy framework[3]. Countries included are Armenia, Australia, Brazil, Canada, Chile, Colombia,

[3] According to the International Monetary Fund's classification, 10 out of 24 countries are advanced economies and the remaining 14 are emerging economies.

Czech Republic, Hungary, Indonesia, Iceland, Israel, Korea, Mexico, New Zealand, Norway, Peru, Philippines, Poland, Romania, Sweden, Thailand, Turkey, South Africa and the United Kingdom. Our sample starts from the establishment of inflation targeting regimes in each country until the end of 2016. Monthly inflation is measured as year-on-year change in consumer price index. Data on inflation rates are obtained from the World Bank Global Economic Monitor database[4]. Quantitative inflation targets of each country are gathered from the websites of central banks. After gathering inflation rates and targets, we calculate the difference of annual inflation from the target level. Figure 1 plots the deviations of inflation from the target level for our sample countries.

Following Svensson (1997), we posit that deviations from target inflation should be stationary under an inflation targeting regime. Accordingly, if deviations follow a mean reverting process and do not persist above or below the target, we conclude that the central bank is successful. However, if the deviations from the target have a unit root, we indicate central banks as unsuccessful. Since there is a risk of employing inadequate stationary tests or tests that are not suitable to the data set, we employ various unit root tests and compare the results to make proper inference.

We define the mismatch between inflation target and inflation as follows:

$$y_t = \pi_t - \pi_t^* \qquad [1]$$

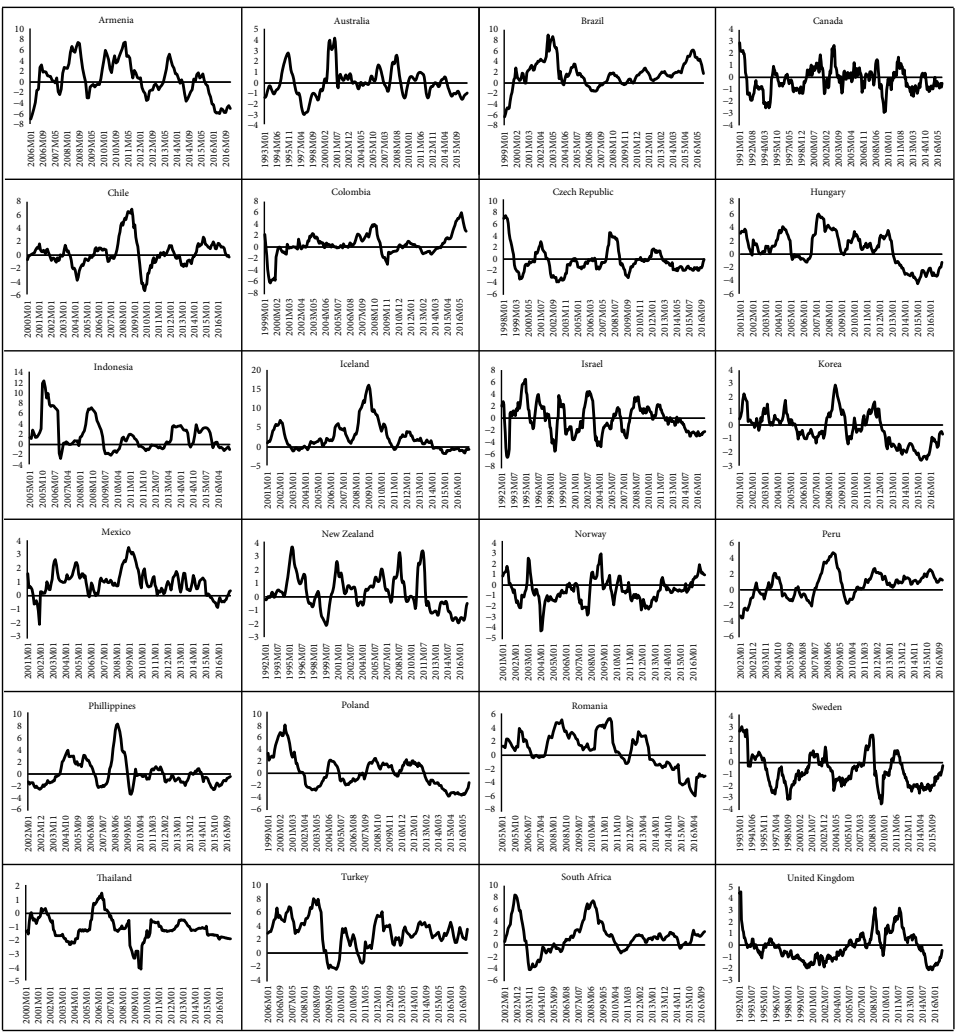
where π_t is the *ex post* annual inflation rate and π_t^* is the inflation target of the central bank. According to this specification, there is undershooting if y_t is positive and overshooting if y_t is negative. Figure 1 denotes the deviations of inflation from the target. As can be seen from the figure, the mismatch follows a mean-reverting process in general. However, there are large deviations in some countries especially during the latest global crisis. These deviations indicate long-lasting cycles and most of them sharply revert to the mean in response to a possible reaction

[4] Quarterly inflation data of Australia and New Zealand are converted to monthly data employing the Chow-Lin procedure.

from central banks. Furthermore, there is persistent undershooting in some countries (Iceland and Turkey) and overshooting in some others (Sweden and Thailand). Therefore, it is not possible to make inference by just looking at the figures.

To investigate the stationarity of the mismatch between inflation target and *ex post* inflation we employ several unit root tests. First, we use conventional time series unit root tests —Augmented Dickey-Fuller

Figure 1. Deviations of inflation from the target level



(ADF) and Phillips-Perron (PP)— that are well documented in the literature. Then, considering our sample covers a large period with serious economic fluctuations, we use unit root test that takes structural breaks into consideration. Finally, we employ both the first (Maddala-Wu) and second generation (cross-sectionally augmented Im, Pesaran and Shin, CIPS) panel unit root tests.

4.1. Augmented Dickey-Fuller unit root test

The Augmented Dickey-Fuller (ADF) unit root test is one of the most favored unit root tests in the literature. The initial version of the test was proposed by Dickey and Fuller (1979) and could only be used if the series followed an AR(1) process. In the following years, the test was strengthened to analyze series that follow an AR(p) process by adding p lagged difference terms of the dependent variable. Accordingly, the ADF test uses the specification denoted below:

$$\Delta y_t = \alpha y_{t-1} + \sum_{i=1}^{p} \alpha_i \Delta y_{t-i} + \varepsilon_t \qquad [2]$$

where y_t is the deviation from the target inflation $\pi_t - \pi_t^*$, α is a constant and ε_t is a random noise. The null hypothesis indicates non-stationarity. Therefore, if the null hypothesis is rejected, then we conclude that deviations from inflation target are stationary.

4.2. Phillips-Perron unit root test

The Phillips-Perron (PP) test was introduced by Phillips and Perron (1988) and has become a strong alternative to the ADF test. The PP test estimates the non-augmented version of the ADF test as shown below:

$$\Delta y_t = \alpha y_{t-1} + \varepsilon_t \qquad [3]$$

The innovation of the PP test is to make a non-parametric correction to the t-test statistic, which makes the test robust to heteroskedasticity and autocorrelation. The PP test is based on the statistic denoted in equation x:

$$\varphi_{\alpha} = t_{\alpha}\left(\frac{\frac{(T-k)s^2}{T}}{f_0}\right)^{\frac{1}{2}} - \frac{(Tf_0 - (T-k)s^2)(se(\hat{\alpha}))}{2f_0^{\frac{1}{2}}s} \quad [4]$$

where t_{α} is the t-statistic of α, f_0 is the estimator of the residual spectrum at frequency zero, T is the sample size, k is the number of regressors, s is the standard error of the test regression, $se(\hat{\alpha})$ is the coefficient standard error. The null hypothesis is unit root, so rejecting the null indicates stationarity.

4.3. Lee-Strazicich unit root test with two structural breaks

The third unit root test we employ is the Lagrange Multiplier Test proposed by Lee and Strazicich (2003). The Lagrange Multiplier (LM) test allows for 2 structural breaks and has superior properties to the previous endogeneous break unit root tests such as Zivot and Andrews (1992) and Lumsdaine and Papell (1997). The Zivot-Andrews and Lumsdaine-Papell tests assume no breaks under the null hypothesis of unit root and assert that there are structural breaks under the alternative. Therefore, it is possible to have unit root with a single break or multiple breaks under these tests. In that case, rejection of the null hypothesis does not necessarily imply rejection of a unit root *per se*, but would imply rejection of a unit root without breaks. In this respect, rejection of the null indicates evidence of a trend stationary time series with breaks, when in fact the series is difference-stationary with breaks (Lee and Strazicich, 2003). Lee-Strazicich (LS) test ensures that the rejection of the null hypothesis unambiguously implies trend-stationarity and prevents us from making incorrect inference regarding stationarity.

The LS unit root test uses the equations below:

$$\Delta y_t = \delta' \Delta \mathbf{Z}_t + \Phi y_{t-1}^d + \sum_{i=1}^{k} \gamma_i \Delta y_{t-i}^d + u_t \quad [5]$$

$$y_t^d = y_t - \tilde{\varphi}_x - \mathbf{Z}_t \tilde{\delta}, \; t = 2,\ldots,T \quad [6]$$

$$\tilde{\varphi}_x = y_1 - \mathbf{Z}_1 \tilde{\delta} \quad [7]$$

where $\mathbf{Z}_t$ is the vector of exogeneous variables; $\mu \sim iid\ N(0,\sigma^2)$, y_1 and $\mathbf{Z}_1$ are the first observations of y_t and $\mathbf{Z}_t$, respectively. The LS unit root test uses two specifications. The first one allows for two shifts in level and is denoted by $\mathbf{Z}_t = [1, t, D_{1t}, D_{2t}]'$ where $D_{jt} = 1$ for $t \geq T_{Bj} + 1$, $j = 1,2$, and zero otherwise. T_{Bj} shows the point where the break emerges and D_{1t} and D_{2t} denote intercept changes emerging at time points T_{B1} and T_{B2}, respectively. The second specification allows for two shifts in level and trend and is represented by $\mathbf{Z}_t = [1, t, D_{1t}, D_{2t}, DT_{1t}, DT_{2t}]'$ where $DT_{jt} = t$ for $t \geq T_{Bj} + 1$, $j = 1,2$, and zero otherwise. DT_{1t} and DT_{2t} indicate slope changes emerging at time points T_{B1} and T_{B2}, respectively. The null hypothesis of unit root ($\phi = 0$) is tested by comparing the t-statistic with critical values provided in Lee and Strazicich (2003).

4.4. Maddala-Wu and CIPS panel unit root tests

Maddala and Wu (1999) propose a Fisher-type test:

$$P = -2\left(\sum_{i=1}^{N} \ln p_i\right) \rightarrow \chi^2(2n) \qquad [8]$$

which combines the p-vales of each cross-sectional unit. The null and alternative hypotheses can be defined as:

$$H_0 = p_i = 1,\ i = 1,2,\ldots,N \qquad [9]$$

against the alternatives:

$$\begin{aligned} H_A &= p_i < 1,\ i = 1,2,\ldots,N_1; \\ p_i &= 1,\ i = N_1 + 1, N_1 + 2,\ldots,N \end{aligned} \qquad [10]$$

Unit root tests are implemented separately for every cross-section unit. The ADF regression is:

$$y_{i,t} = \alpha_i + p_i y_{i,t-1} + \sum_{j=1}^{p_i} \theta_{ij} \Delta y_{i,t-j} + \in_{i,t},\ t = 1,2,\ldots,T \qquad [11]$$

This equation is applied separately for cross-section units and ADF t-statistic is calculated for individual series. After that, calculated *p*-values are compared with the critical values (Baltagi, 2013).

We also use the second generation CIPS panel unit root test (Pesaran, 2007) that takes into consideration cross section dependence. Pesaran (2007) augments the standard ADF regression with the cross section averages of lagged levels and first-differences of each series. The test is based on the AR(*p*) equation below augmented with the lagged and current values of y_t.

$$y_{i,t} = \alpha_i + \gamma_i y_{i,t-1} + \cdots + \delta_{i0}\overline{y}_t + \delta_{i1}\overline{y}_{t-1} + \cdots + \delta_{ip}\overline{y}_{t-p} + \in_{i,t} \quad [12]$$

In order to get the CIPS statistic, we transform the equation above into first difference and calculate individual ADF statistics ($CADF_i$) for every cross section. The simple average of the $CADF_i$ statistics yields the CIPS statistics:

$$CIPS = \frac{\sum_{i=1}^{N} CADF_i}{N} \quad [13]$$

5. EMPIRICAL RESULTS

Conventional univariate unit root test results are presented in Table 1. Accordingly, both the ADF and PP tests indicate stationarity for the majority of the countries in our analysis. According to the PP unit root test with intercept, deviation of inflation from the target is stationary in 18 out of 24 countries[5]. The countries that present evidence of unit root are Iceland, Korea, Hungary, Poland, Romania and Thailand. The results from ADF test are more or less similar.

However, the ADF and PP tests do not take structural breaks into consideration. Since shocks such as economic crises and oil price swings cause breaks in the data set and these shocks lead to temporary deviations

[5] Since the variable under investigation is the deviation of inflation from the target level, it is more reasonable to focus on unit root test results with only intercept.

Table 1. Unit root test results for the deviation of inflation from the target

Countries	ADF		PP	
	Intercept	Trend + Intercept	Intercept	Trend + Intercept
Armenia	–2.9768**	–3.7219**	–2.905**	–3.4728**
Australia	–3.2569**	–3.2707*	–3.1934**	–3.1786*
Brazil	–3.4766***	–3.3224**	–3.5752***	–3.3935*
Canada	–3.2201**	–3.2528*	–4.8077***	–4.7904***
Chile	–2.7676*	–2.8218	–3.0177**	–3.0075
Colombia	–2.754*	–3.138	–3.0275**	–3.6096**
Czech Republic	–4.6553***	–4.5068***	–3.9429***	–3.7821**
Hungary	–2.127	–2.4197	–2.1304	–2.5128
Iceland	–2.2968	–2.438	–2.0787	–2.2317
Indonesia	–2.7025*	–2.7491	–2.858*	–3.1724*
Israel	–4.3972***	–4.4604***	–3.9921***	–4.0626***
Mexico	–3.1659**	–3.264*	–3.0196**	–3.0533
New Zealand	–2.6408*	–3.0434	–3.0783**	–3.3266*
Norway	–3.0277**	–3.1849*	–3.5105***	–3.5966**
Peru	–2.6173*	–3.1461*	–3.0831**	–3.1185
Philippines	–3.3634**	–3.4633**	–2.9934**	–3.0615
Poland	–1.7264	–2.0721	–1.9706	–2.2083
Republic of Korea	–2.3274	–3.0117	–2.4376	–3.0115
Romania	–1.647	–2.5701	–1.6295	–2.5347
South Africa	–2.1475	–2.2431	–2.6174*	–2.6187
Sweden	–2.4546	–2.4933	–3.4309**	–3.3296**
Thailand	–2.2049	–2.3812	–2.5154	–2.6932
Turkey	–3.0609**	–3.0914	–2.6731*	–2.7123
United Kingdom	–4.077***	–4.2312***	–4.0551***	–4.1415***

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

Table 2. LS unit root test results

Country	Lag order	Break dates	LM test statistic
Armenia	9	2007M6, 2011M8	–4.7374***
Australia	8	1996M9, 2000M2	–6.1669***
Brazil	5	2002M12, 2007M1	–5.3888***
Canada	12	1994M9, 2004M4	–4.6628***
Chile	12	2007M5, 2010M1	–5.3367***
Colombia	5	2007M9, 2009M8	–5.13***
Czech Republic	12	2000M8, 2003M12	–3.7308*
Hungary	11	2006M7, 2014M4	–5.6161***
Iceland	12	2007M12, 2010M1	–6.2633***
Indonesia	12	2009M4, 2013M5	–3.9117**
Israel	9	1997M3, 2008M3	–6.4267***
Mexico	10	2008M3, 2009M12	–6.42***
New Zealand	10	1996M11, 2011M8	–5.6382***
Norway	12	2004M12, 2010M5	–4.7437***
Peru	12	2004M6, 2007M12	–3.4106
Philippines	12	2003M11, 2009M11	–4.4130**
Poland	12	2007M9, 2013M8	–4.1225**
Republic of Korea	12	2007M8, 2012M12	–4.7892***
Romania	12	2008M11, 2014M9	–5.0594***
South Africa	12	2007M8, 2009M10	–5.7039***
Sweden	12	1998M9, 2003M1	–4.5318***
Thailand	12	2008M6, 2010M6	–4.0224**
Turkey	12	2008M11, 2012M4	–5.4414***
United Kingdom	12	1994M9, 2013M6	–2.5369

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

of inflation from the target level, it may be misleading to omit potential breaks in the data when testing for unit root. Therefore, we also use the unit root test proposed by Lee and Strazicich (2003) that allows for two structural breaks. The test results are presented in Table 2. Accordingly, deviation of inflation from the target is stationary in all countries except for Peru and the United Kingdom. The test results also indicate that the series has significant breaks in most countries during the latest global crisis. This stresses the importance of employing unit root tests that are robust to structural breaks as the results are quite different from what we obtained in the ADF and PP tests.

In addition to time series unit root tests, we also employ the first (Maddala-Wu) and second generation (CIPS) panel unit root tests (see Table 3). Accordingly, the deviation of inflation from the target is found to be stationary for both advanced and developing economies. Considering most series are found stationary by employing time series unit root tests, the results of the panel unit root tests support the evidence of stationarity.

On average, time series and panel unit root test results display evidence in favor of the success of inflation targeting framework around the world. Inflation targeters have been more or less successful in achievingthe announced targets and keeping the headline inflation around the target level. The deviations of inflation from the target have been only temporary.

Table 3. First and second generation panel unit root test results

	Maddala-Wu		CIPS	
	Intercept	Intercept + Trend	Intercept	Intercept + Trend
Advanced	126.1***	98.5***	–6.50***	–5.54***
Emerging	135.3***	107.5***	–4.11***	–2.75***
All countries	261.3***	206.0***	–7.86***	–6.18***

Note: *, **, *** indicate that statistics are significant at the 10%, 5% and 1% level of significance, respectively. For the Maddala-Wu and CIPS tests the null hypothesis is non-stationarity.

6. CONCLUSION

Many countries adopted inflation targeting as their monetary policy framework in recent decades. Even though the success of inflation targeting regime has been investigated by many studies, the evidence so far is mixed. This study contributes to the existing literature by analyzing whether the inflation targeting framework has been successful in advanced and emerging market economies in terms of reaching the target level and keeping the inflation level around the target. We argue that for a successful inflation targeting, deviations of inflation from the target should be temporary and inflation should revert back to the target level. This indicates deviations of inflation from the target to be stationary.

We use various time series and panel unit tests to investigate whether the deviations of inflation from the target level is stationary. With few exceptions, we find that deviations are stationary implying successful inflation targeting implementation. Considering the number of countries that adopted inflation targeting increased in recent decades, our findings provide evidence in favor of inflation targeting and confirm the choice of central banks.

Even though our findings are notable, they should be interpreted with caution. First, stationarity of the deviation from the target is not a sufficient condition for the success of the inflation targeting framework. The deviation of inflation from the target may be persistently positive or negative, but stationary at the same time. Therefore, in addition to stationarity, further research could also focus on the persistence of deviations. Second, the success of inflation targeting could be affected by many cyclical factors such as fiscal stance, recessions, and commodity prices as well as structural factors such as institutions.

Since every country has different dynamics and exposure levels to various risks, it would be unfair to assess the performance of central banks under the same roof. It may be a good idea to take into consideration heterogeneity across countries when analyzing the determinants of successful inflation targeting. Finally, even though central banks are assumed to be operationally independent, they often get affected by political decisions. As governments directly or indirectly interfere with the election of board members, central banks could be torn between rule-based monetary policy and populism. This is especially the case in

emerging economies with weak institutions. Therefore, the number of countries that successfully implement inflation targeting may differ from our results after controlling for the degree of central bank independence. ◄

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