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DISCUSSION PAPER SERIES

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ABSTRACT

The Impact of Inflation Targeting on Inflation and Growth: How Robust Is the Evidence?

This paper evaluates the success of Inflation Targeting on inflation and growth on a large panel data set of both developing and developed countries. Earlier studies have found contradictory results depending on the methodology used, different authors have used different estimation methods on different samples of data. Some of the differences in results may also be due to the different time periods (or different frequencies of data) used in the estimation. In this paper, we provide evidence to show that the support for a successful Inflation Targeting policy is very weak or non-existent. We use various estimation methods on panel data on a large sample of countries. We note that the results depend critically on the sample selected, the method of estimation employed, and the procedure used to control for outliers. Section 2 of the paper outlines the process by which inflation targeting is hypothesised to influence inflation and growth, Section 3 surveys this literature, and Section 4 describes the data and provides descriptive statistics comparing the performance of Inflation Targeting countries and non-Inflation Targeting countries, Section 5 uses panel estimation methods including GMM techniques on different samples of data and demonstrates the fragile nature of the results. Section 6 provides the conclusions that suggest that IT policy does not necessarily help to reduce inflation and certainly does not stimulate economic growth.

JEL Classification: E31, J68, J08
Keywords: Inflation Targeting, inflation, growth

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Inflation Targeting: How Robust is the Evidence?[1]

1. Introduction

There have been several studies that attempt to show that Inflation Targeting (IT) has led to lower rates of inflation (and a lower rate of volatility) and helped to stimulate economic growth. However, some of these studies provide contradictory evidence depending on the methodology used in the testing for the impact of Inflation Targeting. Different authors have used different estimation methods on different samples of data. In particular, some studies have limited their study to a set of OECD developed countries (e.g. (Ball and Sheridan, 2004)), whilst others have used a sample of developing countries (emerging economies) or a combination of developing and developed economies. Again, the choice of the control groups is critical but not always justified. Some of the differences in results may also be due to the different time periods used in the estimation, for example (Brito and Bystedt, 2010) using three-year averaged time series data end the estimation period in 2006 (well before the Global Financial Crisis, although the paper was published after the GFC in 2010), while some use annual data and others use quarterly data. Some authors simply estimate models on countries that have introduced IT (comparing *before and after* using a difference-in-differences (DID) method) while others use a control group of non-IT countries. A significant issue that is usually not discussed is the problem of outliers: some countries have inflation rates in the thousands[2] and some have negative inflation rates[3]. This issue is sometimes dealt with by introducing a zero-one dummy for high inflation rates, others delete the high inflation or negative inflation observations (or countries), while others use a logarithmic transform (adding an arbitrary constant before taking logs).

In this paper, we use a large data set and provide evidence to show that the support for a successful Inflation Targeting policy is very weak or non-existent. We use various estimation methods on panel data on a large sample of countries. We note that the results depend critically on the sample selected, the method of estimation employed, and the procedure used to control

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[1] This paper follows up on a project on "Monetary Policy, Growth and Employment in Developing Economies: A Review of the Literature", that the first named author had conducted for the IMF and is published as an IZA paper Junankar (2019). He is grateful to the IMF for supporting the research for that paper.

[2] The Democratic Republic of Congo in 1994 had an inflation rate of 23,773%!

[3] In 2004 Bhutan had a negative inflation rate of -18%!

for outliers. An issue that is not given enough importance is the question of finding an appropriate "control group" to compare with the "treatment group". Section 2 of the paper outlines the process by which inflation targeting is hypothesised to influence inflation and growth, Section 3 surveys this literature, and Section 4 describes the data and provides descriptive statistics comparing the performance of Inflation Targeting countries and non-Inflation Targeting countries, Section 5 uses panel estimation methods including GMM techniques on different samples of data and demonstrates the fragile nature of the results. Section 6 provides the conclusions that suggest that IT policy does not necessarily help to reduce inflation and certainly does not stimulate economic growth.

2. How does Inflation Targeting work?

Inflation targeting has become an important focus of many central banks to control inflation. The Central Bank has two instruments to attempt to control inflation: it can attempt to control the money supply and/or it can control the interest rate. Most Central Banks have now given up trying to control the money supply as it was found to be an endogenous variable. The aim of controlling the interest rate is to influence investment behaviour of the private sector and to influence consumer expenditure. It is argued that the Central Bank is more powerful in affecting the macroeconomy when it is independent of political influences. An independent central bank is given authority to carry out its actions independently of political influence, regardless of any short-term issues of increased unemployment. Much of the literature argues that controlling inflation levels and volatility would lead to a more stable and growing economy. A low and stable inflation rate provides the private sector with an appropriate environment to encourage private sector investment and hence technological change. And a tight monetary policy helps to control inflation and hence is necessary for economic growth.

However, for monetary policy to be successful in affecting consumer and investment expenditures, it needs a fully functioning monetary system with an integrated banking system with most people having bank accounts, and with consumers and producers accessing the banking system to obtain loans. Further, it requires an independent Central Bank with sufficient control of the instruments of monetary policy. In addition, most transactions should be in the formal economy with money as the main means of intermediation of all transactions. However, in the developing world a large proportion of the economy consists of an informal sector where money may play a minor role and a large proportion of the population do not have bank accounts. In this paper we argue that as much of inflation in developing countries is imported

via commodity (or food) prices and that money plays a very limited role, monetary policy via Inflation Targeting has a very limited impact on inflation and growth in developing countries[4]. Even in developed economies, monetary policies do not necessarily lead to lower rates of inflation.

3. Recent studies on IT and Inflation[5]

One of the earliest studies by Ball and Sheridan (Ball and Sheridan, 2004) considers whether Inflation Targeting matters in twenty OECD countries, in which seven that adopted Inflation Targets (IT) and thirteen that did not. They excluded countries with inflation rates in excess of 20% since 1984, (Greece, Iceland and Turkey). They also exclude some countries (Luxembourg, Switzerland, and Norway) for differing reasons (Luxembourg as it did not have an independent currency before the Euro, and Switzerland[6] and Norway as they had just introduced IT in 1999 and 2000). They used quarterly panel data for the period from 1960 to 2001. The non-IT countries (the "control group") included such diverse countries as the USA, Japan, and the Euro countries. The paper then estimates the coefficient of the IT dummy by applying the DID method for IT and non-IT countries, allowing for an initial value of inflation to correct for regression to the mean. They find that there are no significant differences between the IT and non-IT groups for the means or standard deviations of inflation rates. Similarly, they find no evidence that IT leads to a higher growth rate or a decrease in the standard deviation of growth rates. Note, for the control group, i.e., the non-IT countries, the post-targeting period was defined as starting at the mean of the start dates of the IT countries[7]. Again, the choice of the period for the non-IT countries is important: what is the appropriate cut-off date to be used to compare the non-IT countries with the IT countries? As mentioned above we should expect a "control group" of countries should be similar to the "treatment group" at least in some

[4]IMF 2015b. Evolving monetary policy frameworks in low-income and other developing countries-background paper: country experience. Washington D.C.: International Monetary Fund. Country Experiences "Food inflation has often been singled out as a key driver of India's high and persistent inflation in the past few years…food inflation presents a challenge for monetary policy management." (p. 19). IMF (2015a) states "Headline inflation is much more volatile in LLMICs given the high CPI food shares and more volatile food prices, due in large part to shocks to agricultural production." (p. 20)

[5] This section is partly based on work that Ahmed Taneem Muzaffar had done on this project. We are thankful for his help in this literature review.

[6] Switzerland is an interesting case: it did introduce IT in the year 2000, but it does not use the inflation target as an overriding condition for monetary policy. As such it is probably better to include it in the non-IT countries.

[7] Since Switzerland and Norway introduced IT late, they excluded these countries, as mentioned above.

important characteristics (e.g. per capita income, some institutional characteristics, etc.) in order to secure the parallel trend assumption of applying the DID estimation.

In a follow-up paper (Goncalves and Carvalho, 2009) Goncalves and Carvalho (2009) treat the decision to introduce IT by OECD countries as endogenous using a Probit model. Allowing for sample selection they find that the introduction of IT leads to a smaller sacrifice ratio of output. In a critique, (Brito, 2010) Brito (2010) argues that the result was based on considering only some disinflation periods. They argue that the impact of the Maastricht treaty on the macroeconomies was ignored. Making allowance for these factors they find that "IT does not matter for lowering disinflation costs" (p. 1686).

Goncalves and Salles (2008) (Goncalves and Salles, 2008) study the role of IT for 36 emerging economies from 1980 to 2005. Like Ball and Sheridan (2005), they use a DID estimation strategy to compare IT with non-IT countries. Curiously, they do not treat the introduction of IT as endogenous in this study although they had argued strongly in their previous paper that it should be treated as an endogenous variable. They find that for emerging economies countries that introduced IT had significant reductions in inflation and growth volatility. In their study they have 13 inflation targeters and 23 non-targeters. However, there is no justification provided for the choice of the control group (non-IT countries), see footnote on page 313 for the list of countries. Some of the IT countries that they include are ex-Communist countries like the Czech Republic, Hungary, and Poland which would have had a very different history prior to the end of Communism. Although they mention in concluding that IT has helped growth, their econometric analysis does not study the impact on *growth* but on *volatility of growth*. A recent paper by Thornton (Thornton, 2016) shows that in an enlarged sample of developing countries and controlling for different exchange rate regimes, inflation targeting does not improve inflation behaviour nor does it improve growth volatility.

Brito and Bystedt (2010) (Brito and Bystedt, 2010) provide empirical evidence that inflation targeting regime (IT) does not improve economic performance both in terms of inflation and output growth in *developing countries*. Based on a panel sample of 46 developing countries, between 1980 and 2006, the paper employs System GMM estimation and attempts to isolate the improvement in performance exclusively due to the adoption of IT from other sources, such as common time-varying effects, country fixed effects and endogeneity. It is worth noting that they use a logarithmic transform (of one plus the inflation rate) which eliminates the problem of negative inflation rates and completely changes the variance of the dependent variable. In

addition, they use a high inflation dummy for inflation rates above 40 percent. Controlling for common time effects, the authors argue that the impact of IT on inflation, inflation volatility and output growth is less negative and less significant compared to what is claimed in the previous literature. As mentioned above the samples used in different studies vary depending on which countries are included as IT countries and which countries are non-IT countries. The sample of non-IT countries includes a diverse group: for example, Lebanon and Pakistan, where military conflicts would have affected inflation and growth in these economies. Some of the earlier studies such as (Angeriz and Arestis, 2006) Angeriz and Arestis (2006), also provide weak or no evidence of impact of IT on the behaviour of inflation. The latter study simply compares the behaviour of 10 IT countries with a control group of only the USA and the European Union.

Contrary to the pessimistic claims made by the above panel studies, an optimistic view, that is, IT lowers the level and volatility of inflation (growth) in developing countries, is expressed by studies such as Batini and Laxton (2007) (Batini and Laxton, 2007), (De Mendoca and e Souza, 2012) De Mendoça and e Souza (2012), (Goncalves and Salles, 2008) Gonçalves and Salles (2008), International Monetary Fund (IMF) (2006), (Lin and Ye, 2009) Lin and Ye (2009), (Mishkin and Schmidt-Hebbel, 2007) Mishkin and Schmidt-Hebbel (2007), (Samarina and De Haan, 2014) Samarina and De Haan (2014), and (Vega and Winkelried, 2005) Vega and Winkelried (2005). In a smaller sample of eight Asian countries, (Valera et al., 2017) Valera et al. (2017) investigate inflation behaviour through a three-way approach by defining inflation target as perfect, imperfect and zero credibility over the period of 1987:M1 – 2013:M11. Using quantile unit root estimation techniques, the study shows that the credibility of inflation targeting and the alternative monetary policy frameworks in Asia are imperfect, except for Malaysia and South Korea under a fully-fledged adoption of inflation targeting. The authors conclude that Asian inflation targeting countries have managed to create greater monetary policy credibility than the non-inflation targeting countries in terms of a faster rate of decline in inflation rate changes.

In summarising previous studies of the impact of IT on Inflation and GDP, (Ayres et al., 2014) Ayres et al. (2014) provide the following findings:

Table 1: Summary of Some Previous Studies on IT

Author	Methodology	Time span	Frequency	Size of sample	Impact on inflation	Impact on GDP	R2 of GDP regressions
Angeriz and Arestis (2006)	SURE	1980–2004	Quarterly	10 IT	No impact	N/A	N/A
Ball and Sheridan (2005)	Diff-in-diff	1960–2000	Quarterly	7 IT, 13 non-IT	Small decline	Weak increase	.02–.23 depending on sample
Batini and Laxton (2007)	Diff-in-diff	1985–2004	Quarterly	31 countries, 21 IT, 10 non-IT	Strong decline	N/A	N/A
Brito and Bystedt (2006)	Diff-in-diff	1994–2005	Quarterly	5 IT, 8 non-IT	Strong decline	Strong increase	.12 and .28
Brito and Bystedt (2010)	OLS, fixed effects	1980–2006	3 year periods	13 IT, 33 non-IT	Weak decline	Weak increase	.15, .18, .20
Goncalves and Salles (2008)	Diff-in-diff	1980–2005	Annual	13 IT, 23, non-IT	Strong decline	N/A	N/A
Lin and Ye (2009)	Probit propensity scores	1985–2005	Annual	52 countries, 13 IT	Strong decline	N/A	N/A
Mishkin and Schmidt-Hebbel (2007)	OLS, IV	1989–2004	Quarterly	13 non-IT, 21 IT	Decline	N/A	N/A
Levin et al. (2004)	Impulse responses	1994–2003	Quarterly	5 IT, 7 non-IT	Reduces inflation persistence	N/A	N/A
Neumann and von Hagen (2002)	VARs, impulse responses	1978–2001	Monthly, quarterly	7 IT, 3 non-IT	Decline	N/A	N/A

Source: Table 1 Survey analysis in Ayres et al. (2014)

To summarise, there is a range of different results obtained about the success or otherwise of the impact of inflation targeting on inflation and growth. However, the differences are due to different estimation methods, different samples of countries in the IT and non-IT countries, different definitions of the dependent variables, different sets of independent variables included, different time periods – some excluding the Global Financial Crisis - (and different frequencies of data), and different ways of treating *outliers* (very high or negative inflation observations for some countries). To reiterate, the choice of the "control group" is critical in studying the impact of inflation targeting. In our econometric analysis, we shall specify clearly the procedures we follow to allow for the above-mentioned issues.

4. Some Descriptive Statistics

In this paper we study the behaviour of a large sample of countries (both developing and developed) using time series data from 1980 to 2015. For our econometric analyses we use three-year averages so that we can use SGMM estimation methods, (Arellano and Bond, 1991,

Blundell and Bond, 2000); (Arellano and Bover, 1995). Before we provide some econometric results, we present some descriptive statistics that illustrate the differences between IT and non-IT countries. The data for inflation and growth were collected from the World Development Indicators from the World Bank data set.

As mentioned earlier, econometric results differ for various reasons: the countries included in the sample selected, the time period chosen and the frequency of data used (annual, three year averages, or quarterly), the countries that are included in the treatment group and the control group, and the econometric methods employed for estimation purposes. It is important that the authors allow for the endogeneity of the introduction of IT. Ideally, authors should provide robustness checks using different samples and different estimation methods.

In our descriptive statistics we compare the behaviour of three-year averages of inflation (growth rates) before IT was introduced with three-year averages immediately after IT was introduced, and also with the subsequent three-year period. We have used three-year averages to allow for a comparison that is not affected by unusual activity in any one year and allow for the impact of IT to take place (not immediately) but over the following three-year period. For our control group, the non-IT countries, we have tried to match the non-IT country with an IT country from the *same* region and in the *same* income group (as defined by the World Bank, i.e., Low Income, Lower Middle Income, Upper Middle Income and Upper Income). For this group of non-IT countries, we use the cut-off date for each non-IT country as the average year in which a similar country introduced IT.

In Table 2 we compare the inflation rates in the three-year average before IT was introduced in period t (inflation rate average for period t, $t-1$, and $t-2$) and in the next three-year average after IT was introduced (inflation average for the period $t+1$, $t+2$, and $t+3$). In order to see any long term effect, we also compare the inflation rate of the average three-year period in the succeeding period ($t+4$, $t+5$, and $t+6$).

Table 2: Summary of Inflation Rates before and after IT Introduction in 42 Countries[1]

	Difference (1-3 years after-before)	**Difference (4-6 years after-before)**
No. of countries w/ decrease in inflation rate	29 (69.0%)	31 (73.8%)
No. of countries w/ increase in inflation rate	13 (31.0%)	11 (26.2%)
No. of countries w/ significant decrease in inflation rate[2]	9 (21.4%)	14 (33.3%)
No. of countries w/ significant increase in inflation rate[2]	0 (0.0%)	0 (0.0%)

Note: (1) Detail results are available upon request. (2) Includes countries with the change in inflation rate that are statistically significant at 5% level.

In only 9 out of 42 (21% cases) IT countries, inflation went down significantly in the next three-year period after the introduction of IT. In 14 out of these 42 (33% cases) IT countries, inflation had gone down significantly in the subsequent three-year period. Although inflation **increased** in 13 IT countries, the increase was not significant.

In Table 3 we list the inflation rates before and after the introduction of IT in comparable non-IT countries (where we match these countries with an IT country from the same region and the same income group). In 12 of this group of 117 (10.3% cases) non-IT countries, inflation also went down significantly in the period after IT was introduced in matched countries. In 14 of this group of countries (12% cases), inflation went down significantly in the subsequent period after the introduction of IT in matched countries.

Thus, a simple comparison of inflation rates before and after the introduction of IT suggests that inflation went down for only a small group of IT countries. In fact, for many non-IT countries, inflation also decreased over the same period. *This suggests that IT was not very successful in lowering the inflation rate.*

Table 3: Summary of Inflation Rates before and after IT for 117 Non-Inflation Targeting Countries[1]

	Difference (1-3 years after-before)	**Difference (4-6 years after-before)**
No. of countries w/ decrease in inflation rate	75 (64.1%)	67 (57.3%)
No. of countries w/ increase in inflation rate	42 (35.9%)	50 (42.7%)
No. of countries w/ significant decrease in inflation rate[2]	12 (10.3%)	14 (12.0%)
No. of countries w/ significant increase in inflation rate[2]	5 (4.3%)	8 (6.8%)

Note: (1) Detailed results are available upon request. (2) Includes countries with the change in inflation rate that are statistically significant at 5% level.

Table 4: Summary of GDP Growth Rates before and after IT Introduction in 42 Countries[1]

	Difference (1-3 years after-before)	**Difference (4-6 years after-before)**
No. of countries w/ decrease in GDP growth	21 (50.0%)	18 (42.9%)
No. of countries w/ increase in GDP growth	21 (50.0%)	24 (57.1%)
No. of countries w/ significant decrease in GDP growth[2]	4 (9.5%)	3 (7.1%)
No. of countries w/ significant increase GDP growth[2]	2 (4.8%)	4 (9.5%)

Note: (1) Detailed results are available upon request. (2) Includes countries with the change in growth rate that are statistically significant at 5% level.

In Table 4 and 5 we carry out a similar analysis for comparing the GDP growth rates before and after the introduction of IT for the two sets of countries. In *only* two of the IT countries did the growth rate increase significantly in the period after the introduction of IT. In only four of

these countries did the growth rate increase significantly in the subsequent three-year period. This simple analysis suggests that IT did not help to promote growth. For the non-IT countries, growth rates increased in 18 countries after IT was introduced in matched countries. For this group of non-IT countries, in 11 countries the growth rate was higher in the subsequent period after the introduction of IT in matched countries. Again, a simple comparison of before and after the introduction of IT we find little evidence to support the hypothesis that IT helps to foster growth rates.

Table 5 Summary of GDP Growth Rates before and after IT for 138 Non-Inflation Targeting Countries[1]

	Difference (1-3 years after-before)	**Difference (4-6 years after-before)**
No. of countries w/ decrease in GDP growth	62 (45.3%)	74 (54%)
No. of countries w/ increase in GDP growth	75 (54.7%)	63 (45.0%)
No. of countries w/ significant decrease in GDP growth[2]	4 (2.9%)	13 (9.5%)
No. of countries w/ significant increase in GDP growth[2]	18 (13.1%)	11 (8.0%)

Note: (1) Detailed results are available upon request. (2) Includes countries with the change in growth rate that are statistically significant at 5% level.

In a similar analysis we compared the *volatility* of inflation (measured by the coefficient of variation) before and after IT was introduced (again using the three-year average before (including the year IT was introduced), and a three-year average after IT was introduced (see Tables 6 and 7)[8]. We see that volatility fell for 17 IT countries (40.5%) and fell for 14 countries (33.3%) in the subsequent period. Comparing the volatility of the non-IT countries (matched as mentioned earlier) we find that volatility decreased for 54 countries (43.9%) and for the subsequent period decreased for 56 countries (45.5%). Hence a simple count suggests that IT did not lead to a fall in the volatility of inflation. This rejects the official argument that IT is good not only for lowering the rate of inflation but also for lowering volatility of inflation.

Table 6: Summary of Volatility of Inflation Rates before and after IT for IT Countries[1]

	1-3 years after	**4-6 years after**
No. of countries went down[2]	17	14
Percentage went down[2]	40.48%	33.33%

Note: (1) Detailed results are available upon request. (2) The comparison is performed in terms of the absolute values of CVs.

[8]The coefficient of variation (CV) is estimated by using the ratio of the sample standard deviation to the sample mean within a particular period $\widehat{cv_y} = \frac{s_y}{\bar{y}}$. Since CV takes negative values if the sample mean is less than zero, when we compared the CVs between two time periods, we compared the absolute values instead of the nominal values of the CVs.

Table 7: Summary of Volatility of Inflation Rates before and after IT for non-IT Countries[1]

	1-3 years after	4-6 years after
No. of countries went down[2]	54	56
Percentage went down[2]	43.90%	45.53%

Note: (1) Detailed results are available upon request. (2) The comparison is performed in terms of the absolute values of CVs.

In other words, these simple descriptive statistics suggest that there is little evidence to support that IT helped to lower the ***rate*** or ***volatility*** of inflation. The performance of IT countries in reducing inflation (and lowering its volatility) is not significantly different from non-IT countries. Obviously, a formal comparison requires an econometric study.

We then compared the volatility of growth rates before and after IT was introduced in IT and non-IT countries. In Table 8 we see that the volatility of growth rates went down for 38% of IT countries in the immediate period after IT was introduced but for only 29% in the subsequent period.

Table 8: Volatility of Growth Rates before and after IT, IT countries[1]

	1-3 years after	4-6 years after
No. of countries went down[2]	16	12
Percentage went down[2]	38.10%	28.57%

Note: (1) Detailed results are available upon request. (2) The comparison is performed in terms of the absolute values of CVs.

In Table 9 we do a similar comparison for non-IT countries.

Table 9: Summary of Volatility of Growth Rates before and after IT, for non-IT countries[1]

	1-3 years after	4-6 years after
No. of countries went down[2]	47	43
Percentage went down[2]	32.64%	29.86%

Note: (1) Detailed results are available upon request. (2) The comparison is performed in terms of the absolute values of CVs.

This analysis of the volatility of growth rates shows that for non-IT countries the fall was for 33%. Hence this simple descriptive analysis shows that there was no benefit to countries in adopting IT to control inflation or stimulate growth rates or to control the volatility of inflation or growth rates.

5. Some Robustness Tests using a simple model to study the impact of IT

In this section we employ a simple model that was used by Brito and Bystedt (2010) and show the sensitivity of the results to the definitions used, the sample selected and to the choice of a control group. We estimate the model with simple OLS, fixed effects panel estimation, Arellano and Bond GMM and SGMM techniques. The latter method controls for the endogeneity of the IT variable and also for omitted variable bias, see Arellano and Bond (Arellano and Bond, 1991). The GMM and SGMM estimations are carried out using the xtabond and xtdpdsys packages in Stata 16 respectively.

We estimate the model on the available panel data set of countries and use the list of countries that have introduced Inflation Targeting (see (Jahpan, 2018)), a list of these countries and the date when IT was introduced is provided in the Appendix. The time series data are from the World Development Indicators for the period 1980-2015. We have used three-year averaged data for this analysis.

The model we have estimated is adapted from Brito and Bystedt (Brito and Bystedt, 2010):

$$y_{it} = \alpha y_{i,t-1} + \beta IT_{i,t} + \boldsymbol{X}_{i,t}\boldsymbol{\gamma} + \delta_t + \mu_i + \epsilon_{it},$$

where the y's are the dependent variables (inflation rate or growth rate) for country i at time t. IT is a dummy variable for Inflation Targeting which equals one for the period IT was introduced and continues during the period of inflation targeting. $\boldsymbol{X}$ is a set of control variables that we will discuss later. A lagged dependent variable allows for persistence in the trajectories of the dependent variables. The equation allows for country μ_i, and period (time) δ_t effects, and a disturbance term ϵ_{it}.

Initially we tried to replicate the results in B & B (2010). We estimated the same model with a data set from the World Development Indicators for the *same set of developing countries* (excluding Taiwan) for the same period (1980-2006). It is important to note that B & B use a curious transformation of the inflation data (ostensibly to prevent the results being affected by outliers):

$$y_i = 100*\ln(1+ y_{it}/100).$$

In effect this transformation allows the negative inflation rates to be transformed into logarithms, as well as compressing the distribution of the variable. Although they use this transformation, they still allow for a High Inflation dummy (inflation greater than 40 percent) in their estimations.

When we replicated their study, we find that Inflation Targeting was successful in decreasing the rate of inflation (but significant only at the 10 percent level) when we used SGMM estimation techniques, see Table 10 below. It is interesting to note that B & B had a similar result, but it was contradicted when they used a balanced panel data set. However, the growth rate was unaffected by Inflation Targeting. In all these estimates we have a significant coefficient for the high inflation dummy (even though the dependent variable had been transformed apparently to control for outliers). Apparently, the estimates satisfy the instrument validity test and no serial correlation, AR(2).

One difficulty in replicating the results from B & B is that they did not mention the number of lags of dependent variable to be used as instrumental variables (IVs). It is well-known that the Arellano-Bond estimator may exhibit significant downward bias if the dependent variable follows a random walk and hence the estimator suffers from a weak instrument problem. In our replication, we deployed no more than two lags of the dependent variable as instruments in the B & B replication. We noticed that when we changed the number of lags of the dependent variable as the IVs, it substantially changed the coefficient estimates as the number of instruments multiplied. Also, the number of IVs applied in the Arellano-Bond estimation has a significant impact on the results from the AR tests and the Sargan test of overidentifying restrictions. In other words, the estimates were very sensitive to the number of lags in the dependent variable used as instruments.

We then extended the sample period (1980-2015) for the same set of countries and again found that IT was significant at the five percent level and negative in the inflation equation but not significant for the growth. However, although the estimates passed the no autocorrelation tests, the p-value of the instrument validity test was so close to unity that this test suggests that there is a problem with the instruments. Having more instruments seems to worsen the case and hence we deployed only one lag of dependent variable as the instrument, see Roodman (2009) (Roodman, 2009). These results are provided in Table 11 below. Thus, we find that IT is apparently significant in lowering inflation but does not have a significant impact on growth rates. In these estimates we have used an unbalanced sample. However, given the problem with the instrument validity test (a very high p-value for the Sargan test which Roodman (2009) argues is a sign of mis-specification as well as questions the validity of the test) we should be cautious in accepting these results.

Table 10: Exactly Following B&B Paper, 45 countries, 9 periods (1980-2006)

	Inflation						GDP growth					
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
IT	-3.702***	-0.939	-12.106*	-7.968	-8.000**	-4.711*	0.308	-0.376	-1.777**	-0.46	-0.829	-0.258
	(1.114)	(0.941)	(6.469)	(6.049)	(4.021)	(2.749)	(0.351)	(0.387)	(0.769)	(0.727)	(1.187)	(1.047)
Lagged inflation	0.264***	0.278***	0.179***	0.122*	0.207**	0.206**	0.355***	0.369***	0.136**	0.281***	0.331***	0.314**
/GDP growth	(0.078)	(0.078)	(0.064)	(0.065)	(0.101)	(0.102)	(0.070)	(0.070)	(0.052)	(0.070)	(0.089)	(0.153)
High inflation	72.883***	69.287***	71.066***	89.764***	82.973***	83.569***	-2.075***	-1.816***	-3.287**	-2.942**	-2.643*	-2.978*
	(16.702)	(15.935)	(17.778)	(23.047)	(15.403)	(15.809)	(0.683)	(0.668)	(1.375)	(1.168)	(1.487)	(1.600)
Constant	6.339***	8.316***	-0.601	4.678	6.984	5.555	1.872***	2.258***	7.061***	2.441***	2.376***	2.087
	(1.534)	(2.565)	(9.068)	(4.534)	(6.003)	(4.997)	(0.221)	(0.564)	(1.448)	(0.599)	(0.696)	(1.367)
N	312	312	312	270	312	312	329	329	329	284	329	329
R-sq	0.62	0.641	0.703				0.23	0.324	0.488			
Period FE	No	Yes	Yes				No	Yes	Yes			
Country FE	No	No	Yes				No	No	Yes			
Groups				42	42	42				45	45	45
IV's				23	30	36				23	30	36
AR(1): Z				-1.783	-1.683	-1.663				-4.120	-4.133	-4.160
p-value				0.075	0.092	0.096				0.000	0.000	0.000
AR(2): Z				-1.158	-0.8768	-0.869				0.276	0.414	0.472
p-value				0.247	0.381	0.385				0.782	0.679	0.637
Sargan: Chisq				16.900	29.431	30.901				7.843	27.130	29.762
p-value				0.153	0.060	0.192				0.797	0.102	0.233

Notes: Standard errors are in parentheses. Specifications: (1) pooled OLS; (2) time fixed effects; and (3) time and country fixed effects, with robust standard errors clustered by country. (4) Arellano-Bond estimator using two-step GMM; (5) Arellano-Bover estimator using two-step S-GMM; and (6) Arellano-Bover estimator using two-step S-GMM, assuming that the IT dummy is endogenous. In specifications (4) – (6), maximum two lags of dependent variable are used as the instruments. AR(1), AR(2), and Sargan tests with the respective p-values are reported.

Table 11: B&B paper variables, 45 countries,12 periods (1980-2015)

	Inflation						GDP growth					
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
IT	-2.912***	-0.914	-9.358*	-7.569*	-6.208	-4.193**	0.097	-0.038	-1.172	-1.093*	-0.601	-0.218
	(0.965)	(0.678)	(5.038)	(4.043)	(4.274)	(1.890)	(0.307)	(0.272)	(0.705)	(0.609)	(0.895)	(2.119)
Lagged inflation /GDP growth	0.274***	0.283***	0.209***	0.145*	0.212**	0.212**	0.314***	0.356***	0.142***	0.266***	0.294***	0.283
	(0.076)	(0.077)	(0.070)	(0.085)	(0.101)	(0.102)	(0.068)	(0.070)	(0.036)	(0.053)	(0.074)	(0.244)
High inflation	71.839***	68.117***	69.442***	76.535***	82.366***	81.692***	-2.037***	-1.832***	-2.737**	-2.675**	-2.218*	-2.911*
	(16.034)	(15.250)	(16.636)	(22.312)	(25.305)	(18.278)	(0.632)	(0.619)	(1.032)	(1.073)	(1.136)	(1.682)
Constant	5.630***	8.347***	-1.154	6.902	5.494	5.386	1.789***	2.270***	3.515***	2.619***	2.516***	2.376
	(1.266)	(2.515)	(5.985)	(4.361)	(8.695)	(12.811)	(0.198)	(0.568)	(0.978)	(0.612)	(0.549)	(3.454)
N	442	442	442	398	442	442	464	464	464	419	464	464
R-sq	0.632	0.654	0.695				0.197	0.294	0.439			
Period FE	No	Yes	Yes				No	Yes	Yes			
Country FE	No	No	Yes				No	No	Yes			
Groups				44	44	44				45	45	45
IV's				32	42	60				32	42	60
AR(1): Z				-1.684	-1.679	-1.661				-4.534	-4.630	-4.611
p-value				0.092	0.093	0.097				0.000	0.000	0.0000
AR(2): Z				-1.061	-0.839	-0.828				1.304	1.424	1.340
p-value				0.289	0.401	0.408				0.192	0.155	0.180
Sargan: Chisq				27.057	34.634	33.057				12.196	28.271	35.419
p-value				0.078	0.181	0.924				0.837	0.450	0.871

Notes: Standard errors are in parentheses. Specifications: (1) pooled OLS; (2) time fixed effects; and (3) time and country fixed effects, with robust standard errors clustered by country. (4) Arellano-Bond estimator using two-step GMM; (5) Arellano-Bover estimator using two-step S-GMM; and (6) Arellano-Bover estimator using two-step S-GMM, assuming that the IT dummy is endogenous. In specifications (4) – (6), maximum two lags of dependent variable are used as the instruments. AR(1), AR(2), and Sargan tests with the respective p-values are reported.

We then estimated the same B & B equations but extended the sample to all the countries for which we had data (217 countries) and the results for the period 1980-2006 are presented in Table 12. As before, the inflation targeting dummy is significant (now at the one percent level) in the inflation equation but not in the growth equation. However, for the inflation equation, again the instrument validity test provides a p-value close to 0.25 which Roodman (2009) warns that there is a problem with it. In Table 13 we extend the data period to 2015 for this enlarged sample of countries. Though the Sargan tests of instrument validity give very high p-values and the statistics are insignificant at the commonly used significance levels, the test result does not secure that the instruments are exogenous.

Table 12: B&B paper variables, 217 countries, 9 periods (1980-2006)

	Inflation						GDP growth					
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
IT	-3.085***	-1.732***	-8.162*	-2.182	-2.943	-2.473***	0.129	-0.334	-1.160**	-0.196	-0.277	0.119
	(0.519)	(0.626)	(4.716)	(2.438)	(2.602)	(0.788)	(0.241)	(0.225)	(0.457)	(0.525)	(0.573)	(0.305)
Lagged inflation	0.184***	0.195***	0.089	0.203**	0.235***	0.244***	0.263***	0.264***	0.117**	0.250***	0.274***	0.265***
/GDP growth	(0.056)	(0.057)	(0.055)	(0.086)	(0.084)	(0.075)	(0.052)	(0.053)	(0.051)	(0.053)	(0.077)	(0.066)
High inflation	75.973***	73.979***	68.858***	58.499***	66.392***	62.940***	-1.970***	-1.678***	-3.178***	-2.452***	-2.109***	-2.579***
	(10.154)	(9.992)	(11.480)	(15.631)	(11.756)	(10.286)	(0.339)	(0.313)	(0.767)	(0.678)	(0.734)	(0.755)
Constant	5.510***	5.389***	1.028	5.287***	4.351***	4.787***	1.898***	2.052***	0.970***	2.374***	2.303***	2.459***
	(0.683)	(1.332)	(0.744)	(1.147)	(1.098)	(1.500)	(0.158)	(0.307)	(0.171)	(0.393)	(0.417)	(0.382)
N	1138	1138	1138	966	1138	1138	1395	1395	1395	1188	1395	1395
R-sq	0.581	0.59	0.668				0.123	0.18	0.351			
Period FE	No	Yes	Yes				No	Yes	Yes			
Country FE	No	No	Yes				No	No	Yes			
Groups				163	171	171				196	205	204
IV's				23	30	45				23	30	45
AR(1): Z				-2.212	-2.329	-2.331				-3.774	-3.729	-3.723
p-value				0.027	0.020	0.020				0.000	0.000	0.000
AR(2): Z				-1.610	-1.568	-1.474				-0.082	-0.024	-0.051
p-value				0.107	0.117	0.140				0.935	0.981	0.959
Sargan: Chisq				21.528	25.336	38.847				13.342	25.253	32.243
p-value				0.043	0.150	0.260				0.345	0.152	0.554

Notes: Standard errors are in parentheses. Specifications: (1) pooled OLS; (2) time fixed effects; and (3) time and country fixed effects, with robust standard errors clustered by country. (4) Arellano-Bond estimator using two-step GMM; (5) Arellano-Bover estimator using two-step S-GMM; and (6) Arellano-Bover estimator using two-step S-GMM, assuming that the IT dummy is endogenous. In specifications (4) – (6), maximum two lags of dependent variable are used as the instruments. AR(1), AR(2), and Sargan tests with the respective p-values are reported.

Table 13: B&B paper variables, 217 countries, 12 periods (1980-2015)

	Inflation						GDP growth					
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
IT	-2.535***	-1.576***	-6.474*	-1.77	-2.011	-2.847***	0.054	-0.094	-0.769*	-0.292	-0.459	-0.047
	(0.449)	(0.463)	(3.901)	(1.981)	(1.892)	(0.927)	(0.207)	(0.203)	(0.446)	(0.516)	(0.562)	(0.329)
Lagged inflation	0.193***	0.201***	0.123**	0.192***	0.224***	0.236***	0.228***	0.239***	0.149***	0.265***	0.285***	0.282***
/GDP growth	(0.055)	(0.056)	(0.056)	(0.057)	(0.074)	(0.072)	(0.053)	(0.057)	(0.048)	(0.062)	(0.063)	(0.070)
High inflation	75.105***	72.980***	71.059***	60.876***	66.909***	62.553***	-1.603***	-1.426***	-3.041***	-2.253***	-2.127***	-2.438***
	(9.964)	(9.784)	(10.686)	(10.965)	(10.612)	(9.286)	(0.326)	(0.306)	(0.597)	(0.665)	(0.696)	(0.737)
Constant	4.983***	6.800***	-0.232	5.491***	4.748***	5.103***	1.690***	1.989***	-2.662***	1.440***	1.342***	1.438*
	(0.566)	(2.366)	(0.493)	(0.927)	(1.067)	(1.610)	(0.154)	(0.309)	(0.303)	(0.465)	(0.457)	(0.741)
N	1691	1691	1691	1501	1691	1691	1993	1993	1993	1784	1993	1993
R-sq	0.586	0.596	0.652				0.101	0.158	0.286			
Period FE	No	Yes	Yes				No	Yes	Yes			
Country FE	No	No	Yes				No	No	Yes			
Groups				186	189	189				206	207	207
IV's				32	42	76				32	42	76
AR(1): Z				-2.412	-2.381	-2.389				-4.020	-4.012	-4.014
p-value				0.016	0.017	0.017				0.000	0.000	0.000
AR(2): Z				-1.678	-1.639	-1.509				0.243	0.285	0.276
p-value				0.093	0.101	0.131				0.808	0.776	0.783
Sargan: Chisq				22.868	30.043	57.736				24.688	34.745	48.865
p-value				0.196	0.361	0.630				0.134	0.177	0.888

Notes: Standard errors are in parentheses. Specifications: (1) pooled OLS; (2) time fixed effects; and (3) time and country fixed effects, with robust standard errors clustered by country. (4) Arellano-Bond estimator using two-step GMM; (5) Arellano-Bover estimator using two-step S-GMM; and (6) Arellano-Bover estimator using two-step S-GMM, assuming that the IT dummy is endogenous. In specifications (4) – (6), maximum two lags of dependent variable are used as the instruments. AR(1), AR(2), and Sargan tests with the respective p-values are reported.

To test the robustness of these B & B results that used a peculiar definition of inflation (converting negative inflation rates into positive rates, as well as changing the distribution by taking a log transform), we re-estimated those equations with the measure of inflation and GDP growth as provided by the World Bank, i.e. as a percentage change in the price level and the GDP per capita growth (annual %) respectively. Following the same logic, the high inflation indicator takes the value of one if the (raw) inflation rate is over 40% and zero otherwise. We also extended the sample to all countries.

Once we used the definition of inflation (to one that is standard in the literature) we find that IT is no longer significant in either the inflation or the growth equation, but the Sargan test of the validity of instruments is rejected for the SGMM estimates. In other words, these results are suspect. Note, however, the only case where IT is significant is for the simple OLS estimates that does not control for period or country fixed effects. These results are presented in Tables 14, 15, and 16.

Again, for the same period, we tested for robustness by excluding outliers, countries that had exceptionally high rates of inflation (inflation > 1000 percent) and/or high rates of growth (growth rate > 50%). These results are similar to those listed above (IT is not significant for inflation or for growth, although the Sargan test is not rejected), so are not reported here.

Similarly, when we add dummies for the Asian Financial Crisis and for negative inflation rates, the estimates do not satisfy the instrument validity test, and IT is not significant.

When the same equation was estimated for shorter time period (1989-2015), since the SGMM method requires a shorter time period, we find that the results are similar with IT not being significant, although the Sargan test is satisfied. Only the Negative Inflation dummy is significant (as is the High Inflation dummy), but the Asian Financial Crisis dummy is not significant.

Table 14: Raw inflation and GDP growth rates, all countries, 12 periods (1980-2015)

	Inflation						GDP growth					
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
IT	-2.023***	2.497	1.153	0.964	-5.92	-3.256	0.129	0.073	-0.476	-0.143	-0.173	0.307
	(0.448)	(2.044)	(31.223)	(8.476)	(16.547)	(3.809)	(0.210)	(0.209)	(0.410)	(0.352)	(0.366)	(0.268)
Lagged inflation	0.058**	0.061**	-0.024	0.039	0.074**	0.074**	0.220***	0.236***	0.094	0.147**	0.188***	0.196**
/GDP growth	(0.026)	(0.025)	(0.024)	(0.045)	(0.031)	(0.031)	(0.061)	(0.064)	(0.065)	(0.060)	(0.071)	(0.081)
High inflation	266.316***	258.555***	236.733***	70.065*	140.966**	146.005**	-1.238**	-1.104**	-2.412***	-0.924	-0.831	-0.679
	(94.229)	(90.790)	(83.441)	(40.238)	(55.130)	(58.652)	(0.553)	(0.529)	(0.719)	(0.671)	(0.588)	(0.677)
Constant	5.757***	20.564	-6.601	12.747	-5.342	-9.288	1.809***	1.872***	-2.671***	1.975***	1.877***	1.620***
	(0.410)	(34.679)	(7.837)	(12.429)	(13.837)	(12.316)	(0.158)	(0.351)	(0.335)	(0.474)	(0.515)	(0.479)
N	1691	1691	1691	1501	1691	1691	1670	1670	1670	1485	1670	1670
R-sq	0.069	0.075	0.165				0.076	0.136	0.297			
Period FE	No	Yes	Yes				No	Yes	Yes			
Country FE	No	No	Yes				No	No	Yes			
Groups				186	189	189				183	184	184
IV's				23	33	69				23	33	69
AR(1): Z				-1.194	-1.213	-1.215				-3.629	-3.490	-3.496
p-value				0.233	0.225	0.225				0.000	0.001	0.001
AR(2): Z				-1.288	-0.383	-0.372				1.794	1.826	1.838
p-value				0.198	0.702	0.710				0.073	0.068	0.066
Sargan: Chisq				12.554	88.716	103.622				17.621	20.741	44.708
p-value				0.184	0.000	0.000				0.040	0.351	0.838

Notes: Standard errors are in parentheses. Specifications: (1) pooled OLS; (2) time fixed effects; and (3) time and country fixed effects, with robust standard errors clustered by country. (4) Arellano-Bond estimator using two-step GMM; (5) Arellano-Bover estimator using two-step S-GMM; and (6) Arellano-Bover estimator using two-step S-GMM, assuming that the IT dummy is endogenous. In specifications (4) – (6), one lag of dependent variable is used as the instruments. AR(1), AR(2), and Sargan tests with the respective p-values are reported.

Table 15: Raw inflation and GDP growth rates, all countries, 9 periods (1980-2006)

	Inflation						GDP growth					
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
IT	-2.738***	3.633	-19.49	0.333	-22.179	-5.876	0.122	-0.39	-0.972**	-0.369	-0.327	0.143
	(0.517)	(3.664)	(36.853)	(8.084)	(49.145)	(27.151)	(0.259)	(0.258)	(0.452)	(0.413)	(0.435)	(0.371)
Lagged inflation	0.055**	0.058**	-0.067***	0.036	0.073**	0.072**	0.282***	0.283***	0.094*	0.139*	0.224**	0.214***
/GDP growth	(0.027)	(0.026)	(0.023)	(0.041)	(0.032)	(0.032)	(0.062)	(0.064)	(0.055)	(0.071)	(0.097)	(0.082)
High inflation	279.118***	272.803***	214.630**	51.173***	148.162**	161.018**	-1.475***	-1.191**	-2.369***	-1.021	-0.834	-1.035
	(98.836)	(95.865)	(86.260)	(18.569)	(69.790)	(71.239)	(0.530)	(0.502)	(0.879)	(0.690)	(0.688)	(0.696)
Constant	6.188***	-23.93	-11.697	13.148**	16.413	15.382	1.989***	1.846***	1.230***	0.777*	0.637	0.583
	(0.500)	(15.931)	(13.796)	(5.885)	(66.351)	(79.234)	(0.170)	(0.348)	(0.198)	(0.457)	(0.433)	(0.403)
N	1138	1138	1138	966	1138	1138	1125	1125	1125	948	1125	1125
R-sq	0.069	0.075	0.204				0.108	0.164	0.416			
Period FE	No	Yes	Yes				No	Yes	Yes			
Country FE	No	No	Yes				No	No	Yes			
Groups				163	171	171				165	176	176
IV's				17	24	39				17	24	39
AR(1): Z				-1.191	-1.215	-1.214				-3.023	-2.971	-2.903
p-value				0.234	0.224	0.225				0.003	0.003	0.004
AR(2): Z				-1.311	-0.402	-0.440				1.969	2.086	2.036
p-value				0.190	0.688	0.660				0.049	0.037	0.042
Sargan: Chisq				6.333	78.717	89.175				14.118	17.857	28.728
p-value				0.387	0.000	0.000				0.028	0.163	0.426

Notes: Standard errors are in parentheses. Specifications: (1) pooled OLS; (2) time fixed effects; and (3) time and country fixed effects, with robust standard errors clustered by country. (4) Arellano-Bond estimator using two-step GMM; (5) Arellano-Bover estimator using two-step S-GMM; and (6) Arellano-Bover estimator using two-step S-GMM, assuming that the IT dummy is endogenous. In specifications (4) – (6), one lag of dependent variable is used as the instruments. AR(1), AR(2), and Sargan tests with the respective p-values are reported.

Table 16: Raw inflation and GDP growth rates, all countries, 9 periods (1989-2015)

	Inflation						GDP growth					
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
IT	-1.753***	3.347	-15.097	2.177	0.499	-1.194	0.082	0.084	-0.191	-0.128	-0.162	0.333
	(0.439)	(2.414)	(43.428)	(3.938)	(78.378)	(9.747)	(0.219)	(0.212)	(0.452)	(0.413)	(0.419)	(0.275)
Lagged inflation	0.065**	0.069***	-0.041	0.078***	0.068	0.067***	0.203***	0.225***	0.067	0.154**	0.208**	0.214**
/GDP growth	(0.025)	(0.025)	(0.029)	(0.017)	(0.042)	(0.016)	(0.068)	(0.070)	(0.068)	(0.073)	(0.087)	(0.095)
High inflation	286.013**	275.244**	257.822**	37.477	50.04	51.334**	-1.098	-0.92	-2.594***	-0.158	-0.013	0.066
	(121.058)	(115.156)	(104.248)	(34.523)	(81.216)	(25.243)	(0.690)	(0.659)	(0.875)	(0.803)	(0.649)	(0.755)
Constant	5.448***	36.382	28.614	8.779	4.595	11.535	1.902***	1.262***	-2.184***	2.677***	2.527***	2.584***
	(0.387)	(26.285)	(22.838)	(14.007)	(10.617)	(187.631)	(0.177)	(0.381)	(0.446)	(0.332)	(0.348)	(0.351)
N	1457	1457	1457	1141	1330	1330	1447	1447	1447	1142	1326	1326
R-sq	0.073	0.079	0.192				0.064	0.127	0.31			
Period FE	No	Yes	Yes				No	Yes	Yes			
Country FE	No	No	Yes				No	No	Yes			
Groups				186	189	189				183	184	184
IV's				17	24	59				17	24	59
AR(1): Z				-1.365	-1.446	-1.463				-2.671	-2.628	-2.633
p-value				0.172	0.148	0.144				0.008	0.009	0.009
AR(2): Z				1.176	1.158	1.166				1.785	1.774	1.781
p-value				0.240	0.247	0.244				0.074	0.076	0.075
Sargan: Chisq				2.565	13.371	67.177				16.392	18.239	42.846
p-value				0.861	0.420	0.035				0.012	0.149	0.684

Notes: Standard errors are in parentheses. Specifications: (1) pooled OLS; (2) time fixed effects; and (3) time and country fixed effects, with robust standard errors clustered by country. (4) Arellano-Bond estimator using two-step GMM; (5) Arellano-Bover estimator using two-step S-GMM; and (6) Arellano-Bover estimator using two-step S-GMM, assuming that the IT dummy is endogenous. In specifications (4) – (6), one lag of dependent variable is used as the instruments. AR(1), AR(2), and Sargan tests with the respective p-values are reported.

To summarise our results: when we tested for the impact of inflation targeting on inflation in developing and emerging economies (using the B&B sample of countries) we found either an insignificant impact of IT from the GMM and SGMM estimation but significant impact from the SGMM estimation that treats IT as endogenous variable. Interestingly, the inflation targeting dummy was never significant to explain growth rates. When we extended the sample to encompass all the countries (developed and developing), we found that although the inflation targeting dummy was significant, the diagnostics on the instrument validity test suggested significant problems. We noted that B&B had used a peculiar log transformation of the inflation data to include negative values and compress extremely high values of the inflation rate.

We then estimated the models with the inflation rate measured as the log difference of the price level/GDP (i.e. the usual definition used in the literature) and found that the inflation targeting dummy was not significant in either the inflation equation or in the growth rate equation.

These results suggest that the results claim that inflation targeting has led to lower inflation rates and higher growth rates are not robust. Further research is necessary to provide light on this issue.

6. Summary and Conclusions

In this paper we discussed several studies that attempt to show that Inflation Targeting has led to lower rates of inflation (and a lower rate of volatility) and helped to stimulate economic growth. We argued that a range of econometric studies had found contradictory results depending on the sample of countries selected, the data period used, and the methods of estimation employed. However, for monetary policy to be successful in affecting consumer and investment expenditures we need a fully functioning monetary system with an independent Central Bank. In addition, inflation is often affected by international factors like oil price hikes, food prices being affected by weather etc. We then reviewed the literature and found that the results were very sensitive to the sample of data used, construction of variables and the methods of estimation. In a preliminary analysis we used descriptive statistics to show that inflation rates decreased not only in Inflation Targeting countries (21%) but also at similar times in non-Inflation Targeting countries (10%), for a small proportion of the countries. Again, we found that growth rates increased for both IT (5%) and non-IT (18%) countries at about the same time as IT was introduced in IT countries, but again in a trivial number of countries. A similar study of the volatility of inflation and growth rates found that for both sets of countries volatility rates went down. In other words, there was no difference between either the volatility of inflation

(growth) between IT and non-IT countries. Finally, we used panel estimation methods to study whether an IT dummy was significant in lowering (increasing) the inflation (growth) rates. In general, we found that either the IT dummy was not significant and/or the diagnostic statistics vitiated the results.

To sum up: we found the results of Inflation Targeting were not robust to different samples of data or to different estimation methods. Further research is necessary to explain differences in inflation (growth) rates of different groups of countries.

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Appendix

Table A1: Inflation Targeting Countries

	Inflation Targeting Country	Date Introduced
Advanced economies	Australia	Mar-93
	Canada	Feb-91
	Czech Republic	Dec-97
	Japan	Feb-13
	New Zealand	Mar-90
	Norway	Mar-01
	Spain	Jan 95 (ended in 99)
	South Korea	Apr-98
	Sweden	Jan-93
	Switzerland	Jan-00
	United Kingdom	Oct-92
	United States	Jan-12
Developing countries	Brazil	Jul-99
	Chile	Sep-99
	Colombia	Sep-99
	Hungary	Jun-01
	India	Feb-15
	Indonesia	Jul-05
	Mexico	Feb-01
	Peru	Jan-02
	Philippines	Jan-02
	Poland	Sep-98
	Romania	Aug-05
	Russia	Jan-15
	Thailand	Jan-00
	Turkey	Jan-06

Source: Steve Brito, Yan Carrriere-Swallow, and Bertrand Gruss (2018) Disagreement about Future Inflation: Understanding the Benefits of Inflation Targeting and Transparency, IMF Working Paper/18/24.