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What to Target? Inflation or Exchange Rate

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This study empirically compares, for the first time, the popular exchange-rate–targeting regime with the recently emerged inflation-targeting framework in developing countries. Applying a variety of propensity score matching methods and dynamic panel generalized method of moments (GMM) regressions to a sample of 50 developing countries for the years 1990–2006, we find strong and robust evidence that, compared to exchange-rate targeting, inflation targeting leads to a significantly lower inflation rate, and the lower inflation rate does not come at a cost of slower growth.

JEL Classification: E5, F3

1. Introduction

One of the most important recent innovations in the conduct of monetary policy is inflation targeting, in which a monetary authority makes public an estimated inflation rate (or range) and attempts to steer the actual inflation toward the target using monetary tools. Since its emergence in the early 1990s, inflation targeting has certainly been gaining popularity over the last two decades. By the end of 2006, 27 countries, among which 17 are developing countries, had explicitly adopted this new monetary policy regime.

The emergence of inflation targeting has attracted substantial attention from both researchers and policymakers. Numerous studies have empirically evaluated the effects of adopting an explicit inflation-targeting regime on a country's economic performance, especially on inflation and growth. While studies focusing on advanced industrial countries so far have yielded mixed results, the evidence in developing countries seems to be more robust.[1] Batini, Kuttner, and Laxton (2005), Gonçalves and Salles (2008), and Lin and Ye (2009) all find that inflation targeting significantly lowers inflation in developing countries where the credibility of the central bank has not yet been well established (thus, the credibility gain of adopting an explicit inflation-targeting regime is substantial). In addition, Capistrán and Ramos-Francia (2010) show that inflation targeting significantly lowers the dispersion of inflation expectations in developing countries. Two recent survey articles, Walsh (2009) and Ball (2010), also concluded that inflation targeting has larger beneficial effects in developing countries than those in advanced industrial countries.

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[1] See, among others, Ammer and Freeman (1995), Mishkin and Posen (1997), Groenveld (1998), Bernanke et al. (1999), Kuttner and Posen (1999), Mishkin (1999), Johnson (2002), Ball and Sheridan (2005), Lin and Ye (2007), and Gonçalves and Carvalho (2009) for evidence in advanced countries.

Despite the success of inflation targeting in developing countries, the more traditional exchange-rate–targeting framework still remains the dominant monetary policy regime in developing countries. It is so popular that an influential study by Calvo and Reinhart (2002) finds an epidemic case of "fear of floating" in the developing world.[2] Furthermore, similar to inflation targeting, an exchange-rate–targeting regime (especially a credibly enforced one) is also viewed as an effective means to achieve price stability in developing countries because it serves as a nominal anchor by allowing a developing central bank to borrow credibility from a foreign monetary authority. In a strict exchange-rate–targeting framework, the targeting country's inflation rate should be equal to that of the country (usually a low-inflation, rich country) to which its exchange rate is pegged.

Does an inflation-targeting framework outperform an exchange-rate–targeting regime in achieving price stability in developing countries? If so, does this benefit come at a cost of slower growth? These two important and policy-related questions have not yet been examined in the literature. A common feature of previous studies is that they all compare an inflation-targeting regime with a very broad alternative, namely, a non-inflation-targeting regime, while ignoring the substantial heterogeneity in the monetary policy regimes adopted by non-inflation-targeting countries. A disadvantage of comparing inflation targeting with such a broad alternative is that the results may not be of direct use for policy choices.

The objective of this study, therefore, is to make the first attempt in the literature to conduct a direct empirical comparison of the emerging inflation-targeting framework with the popular exchange-rate–targeting regime in developing countries. In particular, we compare the effects of these two monetary policy regimes on two key outcome variables, inflation and economic growth. Our study is built upon three recent empirical works on the effects of inflation targeting in developing countries, including Batini, Kuttner, and Laxton (2005), Gonçalves and Salles (2008), and Lin and Ye (2009), but we focus on directly comparing inflation targeting with exchange-rate targeting. This article is also related to Gonçalves and Carvalho (2009), which links inflation with growth by exploring the effect of inflation targeting on sacrifice ratios.

To control for the self-selection problem of nonrandom policy adoption, we make use of a variety of propensity score matching methods recently developed in the treatment effect literature. In addition, we also utilize dynamic panel generalized method of moments (GMM) regressions, which allow us to compare inflation-targeting with other non-inflation-targeting regimes as well. Employing a panel data set that consists of 50 developing countries for the years 1990–2006, we find that the answers to the two empirical questions are yes and no, respectively. First, we show that inflation targeting leads to a significantly lower inflation rate than an exchange-rate–targeting regime. Second, we also find that the lower inflation rate does not come at the cost of slower growth, because the effects of inflation targeting and exchange-rate targeting on real gross domestic product (GDP) per capita growth are not significantly different. Our results are robust to different samples, model specifications, and empirical methodologies. Another contribution of our study is that we make specific efforts to identify a de facto inflation-targeting regime following the seminal work of Miao (2009) and Aizenman, Hutchinson, and Noy (2011).

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[2] As a matter of fact, 75 out of the 100 developing countries included in our sample adopted a fixed exchange-rate regime in 2006, among which 31 countries had a hard peg according to the de facto exchange-rate classification of Reinhart and Rogoff (2004).

The rest of our study is organized as follows. Section 2 describes the data, and section 3 discusses our empirical strategy. Sections 4 and 5 report the empirical results obtained from propensity score matching and the dynamic panel GMM regressions, respectively. Section 6 offers our conclusions.

2. Data

Sample Coverage and Data Sources

The annual data set we construct for this study is an unbalanced panel (due to missing data) of 50 developing countries for the years 1990 to 2006. Among the 50 countries, 13 adopted an explicit inflation-targeting regime, and they are listed in Panel A of Appendix 1.[3] Since the 13 inflation-targeting countries are all relatively large and rich developing countries, we only include non-target regime countries that have a real GDP per capita at least as large as that of the poorest inflation-targeting country and population size at least as large as that of the smallest inflation-targeting country in our control group to ensure comparability. Panel B of Appendix 1 demonstrates these 37 non-inflation-targeting countries. A few countries in our data set have experienced high inflation (defined as an annual inflation rate of 30% or higher). To avoid our results being affected by those high inflation episodes, we exclude them from our sample in our main empirical analysis.[4]

Most of the data are drawn from the World Bank's World Development Indicators (WDI). We also use the de facto exchange-rate regime classifications from Reinhart and Rogoff (2004), central bank governor turnover rate from Dreher, de Haan, and Sturm (2008), the financial openness index from Chinn and Ito (2007), and inflation targeting starting years from Gonçalves and Salles (2008).[5] Detailed variable definitions and sources are reported in Appendix 2, and summary statistics of the variables are presented in Table 1.

Identifying Inflation-Targeting and Exchange-Rate–Targeting Regimes

Our task is to empirically compare an exchange-rate–targeting regime with an inflation-targeting regime. Theoretically, as a domestically oriented policy framework, inflation targeting should be associated with a floating exchange-rate regime (Taylor 2001). In practice, however, inflation targeting and exchange-rate targeting are not absolutely mutually exclusive, as a small number of countries has adopted a hybrid monetary policy framework that targets both inflation and exchange rate (Roger, Restrepo, and Garcia 2009). In our data, there are a total of 31 such country-year episodes.[6] These observations are discarded in our benchmark empirical analysis. Nonetheless, in a robustness check, we do try to treat those observations as

[3] Four countries, Indonesia, Romania, the Slovak Republic, and Turkey, adopted inflation targeting after 2005. We still treat them as non-inflation-targeting countries since a two-year experience or less is too short to tell any meaningful treatment effects.

[4] Inclusion of these observations in our sample, however, does not affect our results.

[5] Reinhart and Rogoff's original classification is only applicable until 2001. It was subsequently updated by Ilzetzki, Reinhart, and Rogoff (2009).

[6] Those observations include Chile 1991 and 1999, Czech Republic 2002–2006, Hungary 2001–2006, Peru 1994–2006, and the Philippines 2002–2006.

Table 1. Descriptive Statistics

Variable	No. of Obs.	Mean	Std. Dev.	Min.	Max.
(Transformed) Inflation	650	0.075	0.059	−0.040	0.261
Real GDP per capita growth	650	3.602	3.675	−11.481	14.041
Exchange rate–targeting dummy	633	0.649	0.479	0	1
Other regime dummy	633	0.216	0.412	0	1
Hybrid regime dummy	633	0.049	0.216	0	1
Hard-peg dummy	633	0.177	0.382	0	1
Soft-peg dummy	633	0.472	0.500	0	1
Broad money growth	634	0.172	0.131	−0.455	0.896
Turnover rate	623	0.207	0.198	0	1.6
Trade openness	637	87.972	57.932	14.731	473.510
Real GDP per capita in thousand $	650	4.633	5.388	0.392	32.250
Country size	650	0.013	0.023	0.00004	0.185
Reserves	644	0.181	0.160	0.007	1.045
Current account	571	−1.629	5.796	−18.184	28.444
Fiscal balance	464	−0.007	0.034	−0.088	0.161
Financial openness	626	0.421	1.533	−1.812	2.532
Debt	468	6.645	4.111	1	29
Coup	650	0.025	0.182	0	2
Population growth	650	1.174	1.213	−3.931	11.181
Primary school	564	104.684	10.346	64.459	150.510
Secondary school	537	75.709	19.663	20.253	109.496
Quality of institution	570	0.565	0.146	0.130	0.944
Financial development	650	47.363	34.735	3.907	170.279
U.S. inflation	650	2.805	0.796	1.6	5.4

an additional category of monetary policy regime. We also exclude from our sample episodes classified by Reinhart and Rogoff (2004) as freely falling or having a dual market because those episodes are often characterized by hyperinflation and currency crises.

We then divide the remaining observations into three regime categories: exchange-rate–targeting, inflation-targeting, and other (neither exchange-rate targeting nor inflation targeting) monetary policy regimes. Inflation-targeting regimes are identified by using Gonçalves and Salles' (2008) starting years. We define an exchange-rate–targeting regime as either a hard peg or a soft peg according to the de facto exchange-rate regime classification of Reinhart and Rogoff (2004).

3. Empirical Methodology

We empirically compare the effects of inflation targeting on inflation and growth with those of exchange-rate targeting mainly by making use of a variety of propensity score matching methods. In addition, we also utilize dynamic panel GMM regression methods to obtain additional evidence.

Propensity Score Matching Methods

An important econometric issue in comparing the effects of inflation targeting with those of exchange-rate targeting is the nonrandom selection of policy adoption, which arises when a country's monetary policy regime choice is systematically correlated with a set of observable variables that also affect the outcomes. Following Lin and Ye (2007, 2009), here we apply a variety of propensity score matching methods recently developed in the treatment effect literature to address the self-selection problem.

To carry out the propensity score matching, we restrict our sample to only include observations that are identified as either inflation targeting or exchange-rate targeting.[7] The matching method is a two-step procedure. We first use the following probit model to estimate the propensity scores, which are the probabilities of adopting an exchange-rate–targeting regime conditional on a group of control variables.

$$P(Y_{it}=1|X_{it})=\Phi(X'_{it}\beta)+\eta_{it}, \tag{1}$$

where Y_{it} is a dummy variable for the adoption of an exchange-rate–targeting regime (inflation targeting is the omitted category), X_{it} is a set of control variables, Φ is the cumulative function of the standard normal distribution, and η_{it} is the error term. We then utilize the estimated propensity scores to conduct matching to obtain the treatment effects of exchange-rate targeting (compared to those of inflation targeting) on the outcome variables. We consider a variety of commonly used propensity score matching methods, including two types of nearest-neighbor matching estimators with $n = 1$ and $n = 3$, three radius matching estimators with a wide radius ($r = 0.2$), a medium radius ($r = 0.1$), and a tight radius ($r = 0.05$), a kernel matching estimator, and a regression-adjusted local linear matching estimator.[8]

Dynamic Panel GMM

In addition to propensity score matching, we also consider dynamic panel GMM methods. While the propensity score matching method is more effective in dealing with the self-selection problem of policy adoption, the regression method has its own advantage because it allows us to include more than two monetary policy regimes in the sample. Therefore, the results from the dynamic panel GMM can provide us with useful additional evidence to check if our results are robust to inclusion of the third (classified as other) monetary policy regime in the sample and use of an alternative estimation method.

In particular, we employ the following regression to compare the effects of inflation targeting on inflation and growth with those of exchange-rate targeting and other monetary policy regimes:

$$y_{it}=\alpha y_{it-1}+\beta_1 ERT_{it}+\beta_2 OTHER_{it}+\gamma' Z_{it}+\mu_i+\varepsilon_{it}, \tag{2}$$

where y_{it} represents either inflation or real GDP per capita growth, μ_i is country fixed effects, and ε_{it} is the error term. Z_{it} is a set of control variables, and we use different controls for the

[7] To be precise, if an inflation-targeting country had a fixed exchange rate before it adopted inflation targeting, those fixed exchange-rate episodes are also included in the sample. Simply dropping them does not affect our results.

[8] See Lin and Ye (2007) for detailed discussions of the propensity score matching method.

inflation and the growth regressions. A lagged dependent variable is also included in our empirical model to capture potential serial correlation in the outcome variables. In the above statistical model, our primary variable of interest is the exchange-rate–targeting regime dummy, ERT_{it}. Since inflation targeting is the omitted regime category, the coefficient β_1 catches the differences in the effects of the two regimes on the outcome variables. In addition to inflation-targeting and exchange-rate–targeting regimes, we now can also include the third monetary policy regime, $OTHER_{it}$, in our analysis, and the differences between this third regime and inflation targeting are reflected in the coefficient β_2. Given the potential self-selection bias in countries' monetary policy regime adoption and the presence of both a lagged dependent variable and fixed effects in the right-hand side of Equation 2, we use the dynamic panel GMM method developed by Arellano and Bond (1991) to estimate the statistical model, treating the regime dummies and all control variables as endogenous.

4. Evidence from Propensity Score Matching

This section compares an inflation-targeting regime with an exchange-rate–targeting regime using a variety of propensity score matching methods. The outcome variables are inflation and growth. We use the annual percentage growth rate of the CPI to measure inflation. However, to avoid having results be affected by high values of inflation, the actual variable we use is a log transformation, ln(1 + CPI inflation rate/100). Growth is measured by the annual growth rate of real GDP per capita.

Estimating the Propensity Scores

We first estimate the propensity scores using a probit model. The dependent variable is the exchange-rate–targeting dummy, and inflation targeting is the omitted group. We consider two groups of control variables in our benchmark probit specification.[9] The first group of variables is used to control for factors that affect the likelihood of choosing an exchange-rate–targeting regime. We include GDP as a percentage of world total GDP as a measure of a country's economic size and the sum of imports and exports as a percentage of GDP as a measure of openness to trade in this group. Since exchange-rate targeting is more attractive to smaller economies, we expect to see a negative sign on country size in the probit regression. The effect of trade openness on policy adoption choice is less obvious. While openness increases the benefits of a fixed exchange rate on trade, it also makes a country more likely to be affected by adverse external shocks, which increases the cost associated with surrendering independent monetary policy. The choice of the second group is based on the literature showing that inflation targeting should be adopted only after some preconditions are met.[10] We include the following four variables: the lagged inflation rate, broad money growth, a five-year central bank governor turnover rate as an inverse proxy of central bank independence, and real GDP

[9] It is important to note that the goal of estimating the propensity score is not to find a best statistical model to explain the probability of policy adoption. It is not a problem to exclude variables that systematically affect the probability of policy adoption but do not affect the outcome variables in the probit regressions. See Lin and Ye (2007) for detailed discussions.

[10] See, for example, Truman (2003).

per capita. We expect the first three variables to be negatively correlated with the probability of adopting inflation targeting (thus positively correlated with the probability of adopting exchange-rate targeting) and the last one to be positively correlated with the probability of adopting inflation targeting.

The first column of Table 2 shows the results of our benchmark model. All estimated coefficients have the expected signs. We find that trade openness, the lagged inflation rate, broad money growth, and real GDP per capita systematically affect a country's policy adoption. Specifically, countries with higher levels of trade openness, higher previous inflation, faster money growth, or lower real GDP per capita are more likely to adopt exchange-rate targeting (less likely to adopt inflation targeting). Other variables are not significant. The overall fit of the regression is reasonable, with a pseudo-R^2 around 0.25.[11]

Results from Matching

The benchmark matching results are presented in the first rows of Tables 3 and 4.[12] Table 3 reports the estimated effect of exchange-rate targeting (compared to inflation targeting) on inflation, and Table 4 shows the estimated effect of exchange-rate targeting on real GDP per capita growth rate. The first two columns of each table show the results from one-to-one-nearest-neighbor and three-nearest-neighbor matching. The next three columns report the results from radius matching, with radii ranging from 0.05 to 0.2. Local linear regression matching and kernel matching results are shown in the last two columns of each table.

The matching estimates reported in the first row of Tables 3 are all found to be positive and statistically significant at least at the 5% level. That is, the inflation rate under an exchange-rate–targeting regime is significantly higher than that under an inflation-targeting regime on average. Furthermore, the estimated difference in the impact on inflation is also quantitatively large. The average value across different matching methods is 0.023, implying that, compared to inflation targeting, exchange-rate targeting is associated with an inflation rate roughly 2.468 percentage points higher on average.[13]

On the other hand, the matching estimates reported in the first row of Table 4 suggest that the effect of exchange-rate targeting on growth is not statistically different from that of inflation targeting. The seven matching estimates carry mixed signs, and none of them is statistically significant. There is no evidence that the lower inflation rate associated with inflation targeting comes at the cost of a slower growth rate.

Robustness Checks

Since the controls used in first-stage probit regression are essential to the matching results, here we check whether our results are robust to different specifications of the predictive

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[11] A pseudo-R^2 around 0.2 is comparable to an ordinary least squares (OLS) adjusted R^2 of 0.7. See Louviere, Hensher, and Swait (2000) for detailed discussions.

[12] Matching estimates are obtained by using Stata command PSMATCH2 developed by Leuven and Sianesi (2003).

[13] A coefficient of 0.023 implies that, compared to an exchange-rate–targeting regime, inflation targeting lowers inflation by 2.3 percentage points plus 0.023 × inflation rate. Given that the average inflation rate in the 13 inflation-targeting and 37 non-inflation-targeting developing countries is 7.31 percentage points, the average effect is 2.468 percentage points.

Table 2. Probit Estimates of Propensity Scores

	1	2	4	3	5	6
Trade openness	0.014***	0.014***	0.014***	0.011***	0.014***	0.014***
	(0.002)	(0.003)	(0.002)	(0.004)	(0.002)	(0.002)
Country size	−2.354	−2.277	−1.771	−2.160	0.287	−2.359
	(2.260)	(2.340)	(2.691)	(2.583)	(2.490)	(2.259)
Lagged inflation	2.821**	2.776*	2.252	3.385*	3.649**	2.822**
	(1.401)	(1.425)	(1.422)	(1.785)	(1.528)	(1.401)
Broad money growth	2.196***	2.196***	2.035***	2.759***	2.213***	2.218***
	(0.708)	(0.708)	(0.731)	(0.914)	(0.770)	(0.729)
Turnover rate	0.710	0.707	0.785	1.354**	0.723	0.714
	(0.492)	(0.495)	(0.505)	(0.615)	(0.498)	(0.492)
Real GDP per capita	−0.132***	−0.132***	−0.131***	−0.178***	−0.156***	−0.132***
	(0.019)	(0.019)	(0.019)	(0.023)	(0.022)	(0.019)
Reserves		−0.178				
		(0.778)				
Current account			−0.025			
			(0.018)			
Fiscal balance				−0.097		
				(3.073)		
Financial openness					0.277***	
					(0.062)	
U.S. inflation						−0.018
						(0.103)
No. of obs.	431	431	383	317	420	412
Pseudo-R^2	0.25	0.25	0.25	0.31	0.29	0.25

Constant terms are included but not reported. Robust standard errors are reported in parentheses.
* Significant at the 10% level.
** Significant at the 5% level.
*** Significant at the 1% level.

Table 3. Matching Estimates of the Effect of an Exchange-Rate–Targeting Regime on Inflation

	Matching Methods						
	Nearest Neighbor Matching	Three Nearest Neighbor Matching	Radius Matching			Local Linear Regression Matching	Kernel Matching
			$r = 0.2$	$r = 0.1$	$r = 0.05$		
Benchmark model	0.034***	0.019*	0.018***	0.021***	0.022**	0.026**	0.021**
	(0.012)	(0.010)	(0.006)	(0.008)	(0.009)	(0.012)	(0.009)
Add reserves	0.028**	0.020**	0.018***	0.021***	0.022**	0.021*	0.022***
	(0.012)	(0.010)	(0.006)	(0.008)	(0.009)	(0.012)	(0.008)
Add current account	0.012	0.025**	0.017**	0.023**	0.022**	0.026**	0.023**
	(0.014)	(0.011)	(0.007)	(0.010)	(0.009)	(0.012)	(0.010)
Add fiscal balance	0.039***	0.041***	0.023***	0.038***	0.040***	0.040***	0.040***
	(0.009)	(0.008)	(0.007)	(0.007)	(0.012)	(0.009)	(0.011)
Add financial openness	0.019**	0.024***	0.018**	0.025***	0.027***	0.022**	0.027***
	(0.009)	(0.008)	(0.007)	(0.007)	(0.007)	(0.009)	(0.007)
Add U.S. inflation	0.024*	0.019*	0.018***	0.021***	0.021**	0.025**	0.021**
	(0.013)	(0.010)	(0.006)	(0.008)	(0.009)	(0.012)	(0.009)

A default 0.06 fixed bandwidth and an Epanechnikov kernel are used for kernel and local linear regression matching. Bootstrapped standard errors based on 500 replications of the data are reported in parentheses.

* Significant at the 10% level.

** Significant at the 5% level.

*** Significant at the 1% level.

Table 4. Matching Estimates of the Effect of an Exchange-Rate–Targeting Regime on Growth

	Matching Method						
			Radius Matching				
	Nearest Neighbor Matching	Three Nearest Neighbor Matching	$r = 0.2$	$r = 0.1$	$r = 0.05$	Local Linear Regression Matching	Kernel Matching
Benchmark model	0.500	0.198	0.234	−0.108	−0.136	0.186	−0.137
	(0.787)	(0.595)	(0.449)	(0.491)	(0.545)	(0.774)	(0.558)
Add reserves	0.605	0.192	0.243	−0.098	−0.123	0.026	−0.115
	(0.759)	(0.588)	(0.435)	(0.473)	(0.535)	(0.774)	(0.543)
Add current account	0.069	0.237	0.140	−0.216	−0.124	0.392	−0.169
	(0.812)	(0.686)	(0.435)	(0.546)	(0.596)	(0.826)	(0.638)
Add fiscal balance	0.856	0.486	0.801	0.558	0.616	1.055	0.632
	(0.836)	(0.705)	(0.506)	(0.533)	(0.587)	(0.785)	(0.631)
Add financial openness	0.082	0.104	0.163	−0.031	0.098	0.342	0.116
	(0.581)	(0.504)	(0.441)	(0.463)	(0.448)	(0.571)	(0.451)
Add U.S. inflation	0.500	0.197	0.241	−0.093	−0.105	0.208	−0.114
	(0.790)	(0.582)	(0.449)	(0.494)	(0.552)	(0.773)	(0.558)

A default 0.06 fixed bandwidth and an Epanechnikov kernel are used for kernel and local linear regression matching. Bootstrapped standard errors based on 500 replications of the data are reported in parentheses.

* Significant at the 10% level.

** Significant at the 5% level.

*** Significant at the 1% level.

equations. Columns 2–6 of Table 2 illustrate the probit regression results of these alternative specifications. In columns 2 and 3, we add reserves (exclusive of gold) to GDP ratio as a measure of reserve adequacy and current account balance to GDP ratio, respectively, to control for their effects on the probability of selecting a fixed exchange-rate regime. These two additional controls, however, are found to be statistically insignificant in the probit regressions. Since a sound fiscal policy might be an important precondition for adopting an inflation-targeting regime, we include fiscal balance to GDP ratio in the probit regression as an additional control in column 4 of Table 2. While the estimated coefficient on this variable is indeed negative, it is not significant. In column 5, we control for Chinn and Ito's (2007) financial openness index. The estimated coefficient is positive and significant at the 1% level, suggesting that financially more open countries are more likely to adopt a fixed exchange-rate regime. Finally, we include in column 6 the U.S. inflation rate as a proxy of world inflation to control for worldwide inflation trend.[14] U.S. inflation does not seem to have a significant effect on a country's monetary regime choice, as the estimated coefficient on this variable is statistically insignificant.

The matching results of these robustness checks are shown in rows 2–6 of Tables 3 and 4. The estimated treatment effects on inflation are reported in Table 3, and the estimated effects on growth are demonstrated in Table 4. We find that our results hold strongly in all robustness checks. All the estimated treatment effects in rows 2–6 of Table 3 are positive, and most of them are significant. The only exception is the one-to-one matching estimate when current account balance is included as an additional control. Nonetheless, in Table 4, the matching estimates reported in rows 2–6 have mixed signs, and no single one of them is statistically significant. The evidence from the robustness checks thus further confirms our finding that, compared to an exchange-rate–targeting regime, an inflation-targeting framework is associated with significantly lower inflation with no worse growth performance.

In addition to the previous robustness checks, we have also examined the robustness of our results using an alternative measure of inflation (GDP inflation), alternative starting years of inflation targeting identified by other studies in the literature, including Batini, Kuttner, and Laxton (2005), Fraga, Goldfajn, and Minella (2003), and Rose (2007), and the de facto exchange-rate regime classification of Levy-Yeyati and Sturzenegger (2003). While not reported, our results hold strongly in all cases.

De Facto Inflation Targeting

A potential concern of our previous matching analysis is that we are comparing a de facto fixed exchange-rate regime with a de jure inflation-targeting regime. A more appropriate comparison should be comparing the two de facto regimes.[15] The literature on identifying a de facto inflation-targeting regime is still at its very early stage. However, there are some existing studies, notably Aizenman, Hutchinson, and Noy (2011) and Miao (2009), that have made important progress towards this goal. While developing a formal algorithm to identify de facto inflation targeting is not the main objective of our study and remains a fruitful area for future research, here we do attempt to address this issue using a simple and straightforward method. Our identification strategy follows the work of Miao (2009). In that study, the author examines

[14] We would like to thank an anonymous referee for this suggestion.

[15] The authors would like to thank an anonymous referee for this suggestion.

the two key characteristics of a de facto inflation-targeting regime, flexibility and transparency, and creates a flexibility index and a transparency index for each de jure inflation-targeting country. Both indices are time varying and are scaled 0–1. According to Miao (2009), a de facto inflation-targeting regime should have a low level of flexibility in its policy objectives and a high level of transparency. Following this spirit, we create two de facto inflation-targeting indices. The first index is simply constructed as the sum of the transparency index and one minus the flexibility index. The second index is the first principal component of the four subcategories of Miao's (2009) flexibility measure: target range, target horizon, reporting requirement, escape clauses, and the four subcategories of his transparency measure: number of inflation reports, quantitative forecast, fan chart, and central bank Web site coverage. Our two de facto inflation-targeting indices, by construction, assign higher values to country-year observations with lower levels of flexibility and/or higher levels of transparency. For each index, we consider the 80% of de jure inflation-targeting country-year observations that have the highest index values as a de facto inflation-targeting regime and drop the bottom 20% of the observations. The rationale is that the observations comprising the 20% portion are characterized by high levels of flexibility and/or low levels of transparency. To ensure robustness, we also use 10% and 30% as alternative threshold values.

We then compare the de facto fixed exchange-rate regime with the identified de facto inflation-targeting regime using the same propensity score matching methods and report the results in Tables 5 and 6. Table 5 shows the estimated effects on inflation, and Table 6 illustrates the estimated effects on growth. Panels A and B of each table report the matching results using our first and second index, respectively. The first row of each panel shows our benchmark results that exclude 20% of the de jure inflation-targeting regime observations with the lowest index values. In the next two rows, we also report matching results that exclude bottom 10% and bottom 30% of the de jure inflation-targeting observations as robustness checks. Using a de facto inflation-targeting regime does not alter our main findings. We find that, in Table 5, all the matching estimates are positive, and most of them are statistically significant. The ones shown in Table 6, however, have mixed signs, and none is significant. While the results reported in Tables 5 and 6 are those obtained using our benchmark probit regression specification, we have also tried the same alternative specifications as we did in Tables 3 and 4 to further establish robustness. The results are similar and are not reported for the sake of saving space.

All in all, the results from propensity score matching tell a quite consistent story: Compared to an inflation-targeting regime, an exchange-rate–targeting regime is associated with significantly higher inflation without any significant gain in growth in developing countries.

5. Additional Evidence from Dynamic Panel GMM

In this section, we present some additional evidence using a dynamic panel GMM regression method, which allows us to compare inflation targeting with both exchange-rate–targeting and other policy regimes. The inflation and growth regression results are reported in Tables 7 and 8, respectively. In inflation regressions, we control for broad money growth, a five-year central bank governor turnover rate, trade openness, real GDP

Table 5. Comparing De Facto Exchange-Rate Targeting with De Facto Inflation Targeting (Inflation)

	Matching Method						
	Nearest Neighbor Matching	Three Nearest Neighbor Matching	Radius Matching			Local Linear Regression Matching	Kernel Matching
			$r = 0.2$	$r = 0.1$	$r = 0.05$		
Panel A: Use Index 1							
Drop bottom 20%	0.014	0.017*	0.018***	0.020**	0.020*	0.014	0.020**
	(0.014)	(0.011)	(0.006)	(0.010)	(0.011)	(0.013)	(0.010)
Drop bottom 10%	0.028**	0.020*	0.019***	0.022**	0.021**	0.027**	0.022**
	(0.013)	(0.010)	(0.006)	(0.008)	(0.009)	(0.012)	(0.010)
Drop bottom 30%	0.004	0.017*	0.016**	0.018**	0.021*	0.014	0.020**
	(0.014)	(0.010)	(0.007)	(0.009)	(0.011)	(0.014)	(0.010)
Panel B: Use Index 2							
Drop bottom 20%	0.020	0.022**	0.021***	0.019**	0.020**	0.020	0.020**
	(0.013)	(0.010)	(0.007)	(0.008)	(0.009)	(0.014)	(0.010)
Drop bottom 10%	0.022*	0.024**	0.018***	0.021***	0.022**	0.022*	0.022**
	(0.012)	(0.010)	(0.006)	(0.008)	(0.010)	(0.013)	(0.010)
Drop bottom 30%	0.001	0.014	0.020***	0.017*	0.019*	0.001	0.019*
	(0.015)	(0.011)	(0.007)	(0.009)	(0.011)	(0.015)	(0.010)

A default 0.06 fixed bandwidth and an Epanechnikov kernel are used for kernel and local linear regression matching. Bootstrapped standard errors based on 500 replications of the data are reported in parentheses.

* Significant at the 10% level.

** Significant at the 5% level.

*** Significant at the 1% level.

Table 6. Comparing De Facto Exchange-Rate Targeting with De Facto Inflation Targeting (Growth)

	Matching Method						
			Radius Matching				
	Nearest Neighbor Matching	Three Nearest Neighbor Matching	$r = 0.2$	$r = 0.1$	$r = 0.05$	Local Linear Regression Matching	Kernel Matching
Panel A: Use Index 1							
Drop bottom 20%	−0.581	−0.608	−0.115	−0.594	−0.741	−0.581	−0.720
	(0.838)	(0.728)	(0.456)	(0.602)	(0.669)	(0.820)	(0.626)
Drop bottom 10%	0.325	0.077	0.083	−0.189	−0.268	0.065	−0.217
	(0.472)	(0.619)	(0.412)	(0.492)	(0.532)	(0.821)	(0.569)
Drop bottom 30%	−1.192	−0.969	−0.123	−0.590	−0.656	−1.191	−0.663
	(0.825)	(0.692)	(0.462)	(0.578)	(0.637)	(0.816)	(0.609)
Panel B: Use Index 2							
Drop bottom 20%	0.188	−0.317	0.065	−0.174	−0.283	0.188	−0.314
	(0.893)	(0.674)	(0.451)	(0.534)	(0.582)	(0.941)	(0.615)
Drop bottom 10%	0.249	0.410	0.325	−0.015	−0.079	0.249	−0.122
	(0.884)	(0.644)	(0.401)	(0.493)	(0.566)	(0.851)	(0.598)
Drop bottom 30%	−1.192	−1.031	−0.231	−0.791	−0.799	−1.192	−0.831
	(0.836)	(0.685)	(0.467)	(0.590)	(0.682)	(0.844)	(0.641)

A default 0.06 fixed bandwidth and an Epanechnikov kernel are used for kernel and local linear regression matching. Bootstrapped standard errors based on 500 replications of the data are reported in parentheses.

* Significant at the 10% level.

** Significant at the 5% level.

*** Significant at the 1% level.

per capita, and total debt service as a percentage of national income. We also include the number of coups to capture the effect of political instability on inflation (Aisen and Veiga 2006). The controls used in the growth regression include trade openness, real GDP per capita, primary and secondary school enrollment as proxies of human capital, population growth rate, a quality of institution measure constructed as the scaled (0–1) mean value of the International Country Risk Guide's corruption, law and order, and bureaucracy quality indices, and private credit to GDP ratio as a measure of financial development. In addition, we also control for a lagged dependent variable and country fixed effects in all regressions.

Panel A of each table shows the regression results using de jure measure of inflation targeting, while Panels B and C of each table report the results using our two de facto measures of inflation targeting by dropping the bottom 20% of the de jure inflation-targeting observations. We run three regressions in each panel. Column 1 is our benchmark specification that regresses the outcome variable on its own lag, an exchange-rate–targeting dummy (*ERT*), a dummy for the third regime category (*OTHER*), and the control variables. As discussed in the data section, there are 31 country-year observations in our data that adopted a hybrid monetary policy regime by targeting both inflation and exchange rate. Those observations were discarded in our previous analysis. We now include them in our sample as an additional regime category (*HYBRID*) and report the results in column 2. Finally, in column 3 of each panel, we decompose an exchange-rate–targeting regime further into a hard-peg regime (*HP*) and a soft-peg regime (*SP*).

To save space, we report only the estimation results on the monetary policy regime dummies in Tables 7 and 8. The results are quite strong and robust, and they clearly show that using an alternative estimation method and adding additional monetary policy regime categories do not alter our main findings. In all inflation regressions, the estimated coefficients on the exchange-rate–targeting dummy and the other policy regime dummy are all positive and statistically significant, meaning that, compared to inflation targeting, these two regimes are associated with significantly higher inflation. These estimated coefficients are also found to be quantitatively large. For example, the average of the estimated coefficients on the exchange-rate–targeting dummy in column 1 of each panel is 0.053, indicating that the inflation rate under an exchange-rate–targeting regime is about 5.68 percentage points higher than that under an inflation-targeting regime. Another interesting finding is that countries that adopt a hybrid regime seem to have the lowest inflation, as the estimated coefficients in this additional category are negative and significant in Table 7. This result is consistent with Roger, Restrepo, and Garcia's (2009) finding, which showed that it is helpful to incorporate exchange-rate smoothing in an inflation-targeting central bank's policy reaction function. Moreover, the results in column 3 of each panel suggest that inflation targeting even outperforms a hard peg in lowering inflation. As for economic growth, the estimated coefficients reported in Table 8 have mixed signs and are all statistically insignificant. While not reported, our results are also robust to different model specifications, alternative starting dates of inflation targeting, exchange-rate regime classifications, threshold values (10% and 30%) of de facto inflation targeting, and inclusion of time fixed effects. Our findings from both the dynamic panel GMM regressions and the propensity score matching exercises thus deliver a consistent message. That is, inflation targeting leads to a significantly lower inflation rate than exchange-rate targeting, and this lower inflation rate does not come at a cost of a worse growth performance.

Table 7. Additional Evidence from Dynamic Panel GMM Regressions (Inflation Regressions)

	Panel A: De Jure IT			Panel B: De Facto IT (Using Index 1)			Panel C: De Facto IT (Using Index 2)		
	1	2	3	1	2	3	1	2	3
ERT	0.057***	0.062***		0.063***	0.070***		0.038***	0.045***	
	(0.016)	(0.016)		(0.019)	(0.020)		(0.011)	(0.009)	
OTHER	0.049***	0.050***	0.049***	0.056***	0.059***	0.057***	0.025**	0.028***	0.026**
	(0.018)	(0.018)	(0.018)	(0.022)	(0.021)	(0.012)	(0.011)	(0.009)	(0.012)
HYBRID		−0.037***			−0.039***			−0.032***	
		(0.012)			(0.015)			(0.008)	
HP			0.045***			0.052***			0.029**
			(0.016)			(0.019)			(0.014)
SP			0.063***			0.070***			0.045***
			(0.017)			(0.021)			(0.013)

Constant terms and controls are included but not reported. Robust standard errors are reported in parentheses.

* Significant at the 10% level.

** Significant at the 5% level.

*** Significant at the 1% level.

Table 8. Additional Evidence from Dynamic Panel GMM Regressions (Growth Regressions)

	Panel A: De Jure IT			Panel B: De Facto IT (Using Index 1)			Panel C: De Facto IT (Using Index 2)		
	1	2	3	1	2	3	1	2	3
ERT	−1.094	−0.786		−2.337	−2.071		−0.109	0.512	
	(1.553)	(1.474)		(1.496)	(1.671)		(2.402)	(1.647)	
OTHER	−1.017	−0.796	−1.034	−2.456	−2.232	−2.491	0.083	0.667	0.022
	(1.706)	(1.626)	(1.708)	(1.694)	(1.808)	(1.694)	(2.611)	(1.860)	(2.647)
HYBRID		−0.688			−0.639			−1.503	
		(1.160)			(1.206)			(1.355)	
HP			−1.499			−2.783			−0.514
			(1.816)			(1.807)			(2.705)
SP			−1.018			−2.271			−0.081
			(1.562)			(1.494)			(2.420)

Constant terms and controls are included but not reported. Robust standard errors are reported in parentheses.

* Significant at the 10% level.

** Significant at the 5% level.

*** Significant at the 1% level.

6. Conclusions

Inflation targeting and exchange-rate targeting are two popular monetary policy frameworks adopted by many developing monetary authorities to achieve price stability. In this study, we employ a sample of 50 developing countries for the years 1990–2006 to empirically compare the effects of these two policy regimes on inflation and growth. Using both propensity score matching and dynamic panel GMM methods, we find strong and robust evidence that inflation targeting leads to a significantly lower inflation rate than an exchange-rate–targeting regime, and the lower inflation rate does not come at the cost of slower growth, as the effects of inflation targeting and exchange-rate targeting on growth are not significantly different.

Our study makes several important contributions to the literature. First, while various studies have compared inflation targeting with a broadly defined non-inflation-targeting regime, we are the first to make a direct comparison between inflation targeting and exchange-rate targeting, and our findings have important policy implications. Second, from a methodological perspective, we use a propensity score matching method that allows us to effectively address the potential self-selection issue of policy adoption. Finally, following Aizenman, Hutchinson, and Noy (2011) and Miao (2009), we also make an attempt to identify a de facto inflation-targeting regime based on two key elements of inflation targeting: flexibility and transparency.

A limitation of this study is that, due to data availability, we are not able to examine whether the global crisis has shifted paradigms, and even countries that are avowed inflation targeters now may respond to other policy objectives. We also believe that it is important and useful to develop a more formal method to identify the de facto inflation-targeting regime. Although these two issues are not the main objectives of this study, they certainly remain fruitful areas for future research.

Appendix 1. Country List

Panel A: Inflation-Targeting Countries			
Brazil	Chile	Colombia	Czech Republic
Hungary	Israel	Korea	Mexico
Peru	Philippines	Poland	South Africa
Thailand			
Panel B: Non-Inflation-Targeting Countries			
Algeria	Argentina	Belarus	Bulgaria
Cape Verde	China	Costa Rica	Croatia
Dominican Republic	Egypt	Estonia	Georgia
Guatemala	Hong Kong, China	Indonesia	Iran
Jamaica	Jordan	Kazakhstan	Latvia
Lebanon	Lithuania	Mauritius	Morocco
Paraguay	Romania	Russia	Singapore
Slovak	Slovenia	Syria	Trinidad & Tobago
Tunisia	Turkey	Ukraine	Uruguay
Venezuela			

Indonesia, Romania, the Slovak Republic, and Turkey adopted inflation targeting after 2005. We still treat them as non-inflation-targeting countries since a two-year experience or less is too short to tell meaningful treatment effects of inflation targeting.

Appendix 2: Variable Definitions and Sources

Inflation Targeting: An inflation-targeting regime dummy. Source: Gonçalves and Salles (2008).
ERT: An exchange-rate–targeting regime dummy defined as either a hard peg or a soft peg according to Reinhart and Rogoff (2004). Source: Ilzetzki, Reinhart, and Rogoff (2009).
OTHER: A dummy for other monetary policy regime defined as neither inflation targeting nor exchange-rate targeting. Sources: Ilzetzki, Reinhart, and Rogoff (2009) and Gonçalves and Salles (2008).
HYBRID: A dummy variable for a hybrid monetary policy regime that targets both inflation and exchange rate. Sources: Ilzetzki, Reinhart, and Rogoff (2009) and Gonçalves and Salles (2008).
Hard Peg: A hard-peg dummy. Source: Ilzetzki, Reinhart, and Rogoff (2009).
Soft Peg: A soft-peg dummy. Source: Ilzetzki, Reinhart, and Rogoff (2009).
Inflation: Ln(1 + CPI inflation rate/100). Source: WDI.
Growth: Annual growth rate of Real GDP per capita. Source: WDI.
Broad Money Growth: Annual growth rate of broad money. Source: WDI.
Turnover Rate: Central bank governor turnover rate in every five years. Source: Dreher, de Haan, and Sturm (2008).
Trade Openness: Sum of exports and imports as a percentage of GDP. Source: WDI.
Country Size: GDP as a percentage of world GDP. Source: WDI.
Real GDP Per Capita: Real GDP/population in constant 2000 thousand dollars. Source: WDI.
Reserves: Reserves minus gold to GDP ratio. Source: WDI.
Current Account: Current account as a percentage of GDP. Source: WDI.
Fiscal Balance: Cash surplus/deficit as a percentage of GDP. Source: WDI.
Financial Openness: A financial openness index, with larger values indicating higher levels of openness. Source: Chinn and Ito (2007).
Debt: Total debt service as a percentage of national income. Source: WDI.
Coup: Number of coups. Source: Dreher, de Haan, and Sturm (2008).
Population Growth: Annual population growth rate. Source: WDI.
Primary School: Primary school enrollment. Source: WDI.
Secondary School: Secondary school enrollment. Source: WDI.
Quality of Institution: Scaled (0–1) mean value of ICRG's corruption, law and order, and bureaucracy quality indices. Source: University of Gothenburg's Quality of Government Database.
Financial Development: Private credit as a percentage of GDP. Source: WDI.

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