Impact of Inflation Targeting on Inflation Volatility

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Abstract

In this study, we investigate the impact of the inflation targeting (IT) regime on inflation volatility by applying treatment effects to a panel of 186 countries for the 1980–2018 period. We apply the differences-in-differences estimation to evaluate the pre-and post-adoption impact of the IT policy on reducing inflation volatility. Our estimation results demonstrate that IT countries have significantly reduced inflation volatility compared with non-IT countries. However, several countries suffer from historic hyperinflation, which significantly impacts IT after its adoption. Central banks adopt a similar price stability-centric approach in monetary policy execution. The crucial elements needed for effective IT policy implementation include financial market maturity, effective monetary policy transmission, and the overall macroeconomic stability of countries.

Keywords: Monetary Policy, Macroeconomic Impact, Inflation Targeting

1. Introduction

New Zealand was among the first countries to adopt the inflation targeting (IT) regime in 1989, which has since gained popularity among developing nations. Many central banks in the developing world have shifted to the IT monetary policy framework, which has now emerged as their core objective, with a clear mandate to pursue price stability, straightforward communication, transparency, and accountability (Coats et al., 2000). Generally, inflation rates have declined since the 1990s and most countries (both IT and non-IT) have managed to stabilize inflation and anchor inflation expectations. However, several developing countries continue to suffer from volatile inflation because of their monetary policy ineffectiveness. Therefore, theoretically, an IT regime provides a better anchor for controlling inflation volatility and reducing uncertainty in developing countries.

The applicability of IT regimes, the effects of IT on macro-financial stability, and comparative analysis with non-IT countries have been extensively studied. At the same time, IT regimes have sparked a debate over policy choices among practitioners and academicians on whether central banks should apply a mainstream macroeconomic policy and abandon monetary targeting, exchange rate peg, and other traditional monetary policy regimes. The IT regime countries have reduced their inflation volatility. However, empirical

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studies illustrate that country-based fundamentals play a crucial role in financial market maturity, economic structure, and resilience to external shocks (Fouejieu, 2017; Lin & Ye, 2007, 2013).

We expect this study to contribute significantly to the literature on the effects of IT on inflation volatility and macroeconomic performance. First, we cover the dataset of 186 countries between 1980 and 2018. We consider the impact of the IT regime on inflation volatility from a broader perspective. The core focus is to compare the impact of the IT regime on two sub-samples: the IT and non-IT countries dataset. IT has gained popularity among developing countries since the early 2000s. Nevertheless, the advantages that accrue to these countries may differ based on their experiences and financial system maturity.

The remainder of this study is organized as follows. Section 2 illustrates the motivation and aim of the study on the IT regime. Section 3 discusses the theoretical and empirical literature on the effectiveness of IT policies. Section 4 describes the methodological framework, model, and data, while Section 5 provides empirical outcomes and discusses them. Finally, Section 6 summarizes the results and discussion and proposes additional enhancements.

2. Literature Review

Many central banks have explored various methods to improve monetary policy effectiveness. The IT regime is one such policy mechanism that originated in developed nations during the 1990s. New Zealand was the first country to introduce an IT regime after the collapse of the Bretton Woods system (White, 2013). The IT regime gained popularity in developing countries during the 2000s. Thus, monetary aggregate targeting has been primarily used to implement an effective monetary policy. However, developing financial innovations and weakening the link between nominal income and money supply is not sufficient for monetary policy transmission to create a stable policy environment (White, 2013).

IT implies a monetary policy regime in which the central bank uses its tools to maintain price stability (inflation rates) within the announced inflation target in the medium term. According to the International Monetary Fund (IMF), this implies a public declaration of numerical inflation targets, and the commitment of the monetary authority to utilize tools toward achieving these targets, generally in the medium term. Other key features tend to include better public communication about the strategies and purposes of decision-makers and greater central bank responsibility for achieving inflation targets. Monetary policy decisions are usually directed by the deviation of future inflation projections from the declared inflation target, with inflation projections being an intermediate target for monetary policy (Roger, 2010b; Svensson, 2010). According to Bernanke and Mishkin (1997), most economists agree that monetary policy is the most efficient in the short-to-medium term. Therefore, central banks set short-to-medium-term targets to maintain inflation and output stability. However, achieving or missing the target affects central banks' credibility, and communicating with the public through the Inflation Report, Monetary Policy Report, and press releases after policymaking decisions are crucial (Bernanke & Mishkin, 1997).

Countries set inflation targets primarily in three different forms: (i) target points, (ii) target points and ranges, and (iii) target ranges. Most advanced economies provide a lower inflation target of 2% between the range of +/−1 percentage points. By contrast, target points are usually higher with a broader corridor range in developing economies (Figure 1). We can attribute this to highly volatile inflation dynamics, less developed financial systems, financial dollarization, low monetary policy credibility, and the money market mechanism (Roger, 2010a).

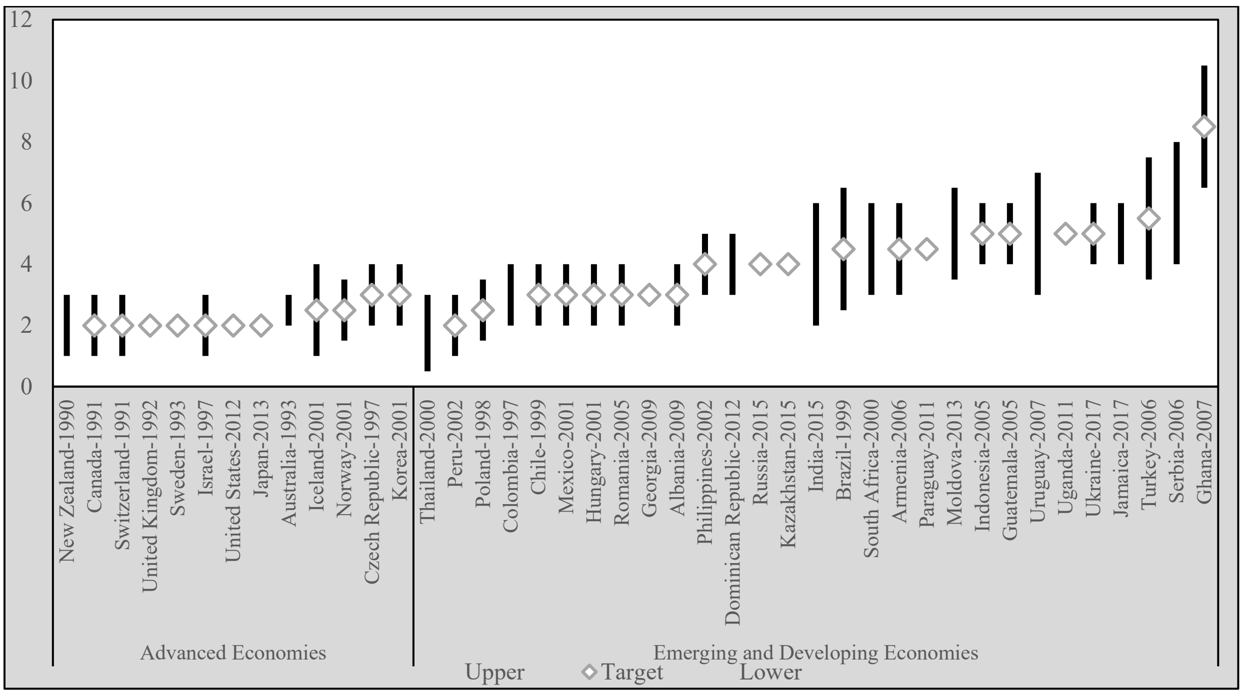

Figure 1. Inflation Targets, Points, Ranges for IT Countries

Source: IMF and author *Note: Countries classified as IT regimes used from The Annual Report on Exchange Arrangements and Exchange Restrictions Report 2018 of the IMF.

Monetary policy conducted under the IT regime was criticized by King (1997) with the famous *cliché* "inflation nutters," arguing that a strict IT framework is not favorable for achieving financial stability goals and real economic growth (King, 1997). According to Lars E. O. Svensson[2], IT, by itself, does not achieve macro-financial stability (Heise, 2019). However, a flexible IT regime allows room for policy trade-offs, such

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as adjusting inflation in the medium-to-long term and sustaining output growth in the long term (Svensson, 2010).

Previous studies have mainly investigated samples of advanced economies, as IT originated in the developed world before being adopted by emerging economies (Table 1). Hence, in this study, we focus on emerging market economies, specifically comparing them with advanced economies. An assessment of the current literature shows that several approaches have been applied to measure the impact of IT policy on inflation volatility, including matching methods, difference-in-differences (DID) models, and panel data analysis. Specifically, to estimate the effect of IT policy vis-à-vis non-IT policy on macroeconomic performance, the matching and DID methods have been applied. The primary empirical approach for analyzing the impact of IT policy on reducing inflation, output, money growth, and exchange rate volatility (Lin & Ye, 2013) reveals that the average treatment effect of the overall IT policy effectively reduced the level of dollarization in 106 developing economies. The impact of IT on reducing inflation volatility was quantitatively small and statistically insignificant in the seven advanced economies (Lin & Ye, 2007). Similarly, Fouejieu (2017) applied the propensity score matching method to investigate the power of IT in cooperation with macroprudential instruments in 26 emerging-developing economies (Fouejieu, 2017).

Table 1. Selected Cross-Country Studies on Panel Data Analysis

Author	Period	Number of countries	Technique	Main findings of IT performance
Ball & Sheridan, 2003	1960–1994	20	Panel data, DID	No clear evidence, similar monetary policy
Pétursson, 2004	1981–2002	Three samples 21, 13, 7	Panel data analysis, seemingly unrelated	No clear evidence of IT reducing inflation and output volatility or the central bank's credibility
Batini & Laxton, 2006		31 country's central banks' survey	A detailed survey of central banks, treatment effects, DID model	Developing economies improve macroeconomic stability more than developed countries by implementing IT policy
Lin & Ye, 2007	1985–1999	7	Treatment effects, propensity score matching	The impact of IT policy on inflation variability is statistically insignificant and quantitatively unimportant
Lin, 2010	1985–2005	22 advanced and	Panel data, treatment effects using the	The impact of IT on the exchange rate, reserves, and current account

		52 developing countries	propensity score matching method	significantly raises the exchange rate strength and reserves in developing nations, although it lowers both in the advanced economies
Lee, 2011	1993–2006	13 IT countries and 47 non-IT countries	Panel data, synthetic control method for comparative cases	Many emerging market economies experience no significant reduction in inflation in the post-adoption period, and not all emerging market economies benefit from IT
Lin & Ye, 2013	1985–2004	106 developing countries from International Financial Statistics (IFS)	Panel data, average treatment effects, nearest neighbor matching method, a probit model	The treatment effects of IT policy on the dollarization level are adverse in emerging market economies, statistically significant, and have a quantitatively tremendous impact in 13 IT countries

Source: Author's compilation based on literature review.

Ball and Sheridan (2003) found no substantial evidence on the role of IT policy in diminishing inflation volatility during the sample period between 1960 and 1994. The rationale is that countries that implement a similar monetary policy based on the Taylor rule are most likely to reduce inflation volatility by using the interest rate channel (Ball & Sheridan, 2003; Taylor, 1998). Further, the authors contended that IT policy might improve macroeconomic conditions in the future and countries must test IT regimes for a broader range of analyses (Ball & Sheridan, 2003; Batini & Laxton, 2006).

Recent literature has argued that IT improves macroeconomic performance and reduces inflation volatility, provided a set of prerequisites is met, such as effective monetary transmission mechanism, financial system development, and the effectiveness of the interest rate channel (Fouejieu, 2017b; Lee, 2011; Lin & Ye, 2007, 2012, 2013). Policy practitioners and academics have been debating on the effectiveness of the IT regime. Despite its advantages, the IT framework has raised several controversies among scholars. The first advantage is that the framework offers a nominal anchor for monetary policy to anchor inflation expectations through intermediate targets to accomplish the ultimate goal of price stability. Central banks publish inflation forecasts for the medium-term horizon, which shows a clear monetary policy path, and utilize their tools to achieve long-term goals. Communication on published inflation forecasts increases central banks' credibility and transparency and enables them to accomplish their monetary policy objectives (Green, 2014).

In the early adoption stage, the financial sector is more vulnerable in IT than in non-IT countries. Therefore, the central banks in former countries are keener to shift toward this policy regime and likely to criticize their excessive focus on inflation rather than financial stability. However, central banks should use macroprudential tools to maintain financial stability in line with the IT framework. Indeed, IT has proven to be a more active monetary policy regime than other monetary policies for stabilizing inflation in emerging market economies (Fouejieu, 2017).

The current literature, both from the academic and policy practitioner perspectives, illustrates that IT reduces inflation volatility to some extent. Moreover, IT-implementing emerging market economies have greater control over the domestic money market than those implementing managed-float or fixed exchange rate regimes. However, the IT framework itself does not reduce inflation and output volatility; instead, developing the financial sector and technical infrastructure is crucial.

3. Data

We used secondary data from the World Bank and IMF databases. The dataset comprises 186 countries and covers critical macroeconomic indicators from 1980 to 2018. The sample contains 38 IT countries and 148 non-IT countries. The IT countries group comprises 13 advanced economies and 25 emerging market economies. Targeting dummy variables are introduced to identify the IT and non-IT countries and country classifications for emerging-developing and advanced economies. The time dummy for the starting period of the IT policy adoption of the 38 IT countries is specified; each country in the sample has a different starting year of adoption. The classifications of IT policy implementing countries and advanced and emerging-developing economies were based on the *World Economic Outlook* and The Annual Report on Exchange Arrangements and Exchange Restrictions Report in 2018 (IMF, 2018, 2019), respectively.

In Table 2, we summarize the statistics for the dataset. It covers the key macroeconomic indicators for 186 countries during the 1980–2018 period.

Table 2. Summary of Statistics of Data from 1980–2018 for 186 Countries

Variable	Label	N	Mean	SD
M2 (billion)	*Broad money (current Local Currency Unit)*	*4536*	*29500.0*	*302000.0*
GDPC (USD)	*Gross domestic product (GDP) per capita in Purchasing Power Parity (PPP) terms (constant=2011)*	*4472*	*15685.89*	*18518.35*
M2_G	*Broad money growth (annual %)*	*4490*	*31.30*	*261.45*
π	*Inflation, consumer prices (annual %)*	*5128*	*21.02*	*172.68*
HYPER	*Dummy variables for hyperinflation*	*7254*	*0.30*	*0.46*

DEF	*Deflator of GDP (various base year country; linked series)*	*4623*	*134.65*	*343.57*
$\bar{\pi}$	*Consumer Price Indices (CPI) (2010 = 100)*	*4873*	*70.93*	*88.66*
M2_RES	*M2 to total reserves ratio*	*4170*	*8.61*	*63.67*
REER	*Real Effective Exchange Rate (2010 = 100)*	*2593*	*116.86*	*131.86*
$\bar{\bar{\pi}}$ **(inf_sd)**	*Standard deviation of inflation*	*6318*	*0.99*	*0.42*
M2_RES_SD	*Standard deviation of M2_RES*	*4104*	*5.64*	*60.22*
CPI_SD	*Standard deviation of CPI*	*4744*	*6.62*	*37.39*
REER_SD	*Standard deviation of REER*	*2520*	*16.86*	*96.32*
ER	*Exchange rate (annual change in %)*	*5482*	*2.33*	*3.24*
RIR	*Real interest rate (%)*	*3227*	*7.03*	*31.30*
M2_GDP	*Broad money (% of GDP)*	*4674*	*49.72*	*33.12*
GDP_G	*GDP (growth)*	*5893*	*3.51*	*5.69*
GDPC_G	*GDP per capita(growth)*	*5893*	*1.92*	*5.61*
INF	*CPI truncated at 100% as the maximum*	*5023*	*8.40*	*12.05*
RES	*Total reserves in terms of months of imports*	*4697*	*4.15*	*4.13*
TAX_GDP	*Tax revenue (% of GDP)*	*3040*	*17.63*	*6.92*
TREATED	*Dummy variable for IT countries*	*7254*	*0.19*	*0.39*
TIME	*Time dummy for starting point of IT*	*7254*	*0.06*	*0.24*
DID	*Difference-in-differences dummy*	*7254*	*0.02*	*0.13*

Source: World Bank, *World Development Indicators* and IMF, *International Financial Statistics*.

We use the standard deviations of the five-year moving averages of annual inflation rates as the proxy for inflation volatility. This technique was previously applied to measure stock market volatility (Officer, 1973).

The mathematical definition of inflation volatility is given below: First, we assume that the mathematical representation of the inflation rate is:

$$\Delta \ln p_t = \ln p_t - \ln p_{t-1} \tag{1}$$

(Suppose pt is the level of price at time t)

Then, price volatility is defined as the double-difference in the logarithm of price:

$$\Delta^2 \ln p_t = (\ln p_t - \ln p_{t-1}) - (\ln p_{t-1} - \ln p_{t-2}) = \ln p_t - 2\ln p_{t-1} + \ln p_{t-2}$$

Price volatility is defined as the standard deviation of sample inflation rates:

$$SD\ (\Delta lnp) = \sqrt{\frac{1}{T-1}\sum_{t=2}^{T}\left(\Delta lnp_t - \overline{\Delta lnp}\right)^2} \tag{2}$$

$$(\overline{\Delta lnp} \equiv \frac{1}{T-1}\sum_{\tau=2}^{T}\Delta lnp_t) \tag{3}$$

Before estimating the model, we conducted a pre-estimation procedure to check for unit root issues in the dataset. Table 3 shows that all the variables displayed are nonstationary according to the augmented Dickey–Fuller (ADF) test. Assuming that the variables are nonstationary, we estimate the error correction model (ECM). However, as the number of explanatory variables is too large in this model, the ECM is unsuitable for this estimation. We found no unit root issues based on the ADF unit root test, and the variables were stationary (Dickey & Fuller, 1979). The test statistics for the variables used in the model were stationary and significant (Table 3).

Table 3. ADF Unit Root Test

Variable	Coefficient	Test statistic
INF	−.2970759	−30.468***
INF_SD	−.2141915	−25.634**
GDP	−.6932378	−26.965***
RIR	−.4934206	−31.853***
REER	−.1090542	−9.682***
GDPC	−.0578432	−5.960***
M2	−.0766022	−6.659 **
RES	−.1026541	−7.598***
M2/GDP	−.0817078	−6.906***
ER	−.0751549	−6.494**

Source: Author's estimation.

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. "INF_SD" denotes the standard deviation of the inflation rate.

4. Methodology

The DID estimation is applied by introducing the time dummy for the pre-and post-adoption periods of IT policy for 38 countries. The sample countries adopted the IT policy regime at different periods. We interact a time dummy with a treated dummy to obtain DID interactions with countries implementing IT policy at the starting point of adoption.

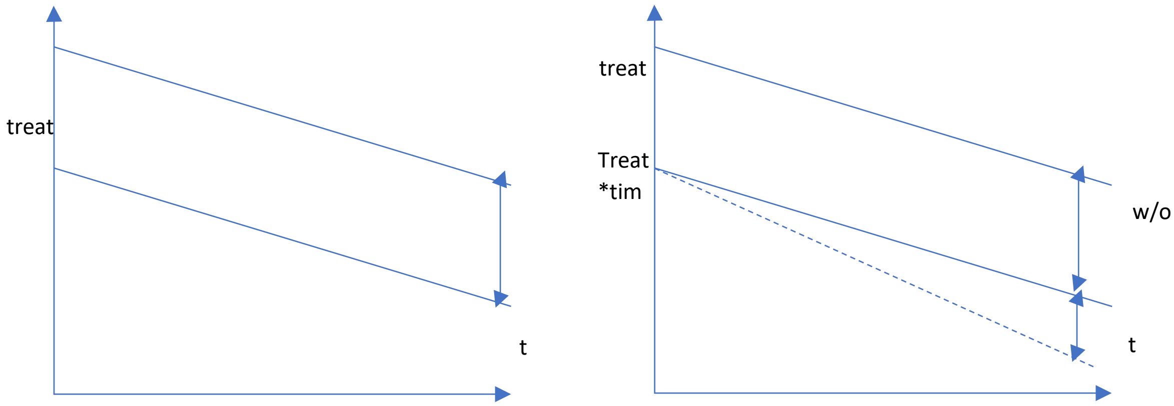


Figure 2. DID Estimation Graph

Source: Author derived based on Hill et al. (2011, p. 282).

According to Wooldridge (2009), this method has many applications, particularly when data arise from a quasi-experiment. A natural experiment seeks to capture exogenous consequences—such as changes in government policy that change the way people, families, businesses, or cities operate—and comprises a control group unaffected by the policy transformation and treatment set affected by the change in policy. Therefore, we split the sample into four groups: the control group before the policy transition, the control group after the policy transition, the treatment group before the adoption period, and the treatment group after the adoption period (Wooldridge, 2016, p. 435).

Table 4. DID Estimators

	Pre	Post	Pre-Post
C	α	$\alpha+\gamma$	γ
T	$\alpha+\beta$	$\alpha+\beta+\gamma+\delta$	$\gamma+\delta$
T-C	β	$\beta+\delta$	δ

Note: C—Control groups and T—treated groups during the pre-and post-adoption periods.

Source: Wooldridge (2009).

The DID model is used in observational studies to measure the effect of policy intervention or treatment impact by mimicking the differential effects between the “treatment” group, which received the treatment, and the “control” group, which did not receive the treatment. For the analysis, we use the log of the price indicator ($\ln P_t$), treatment dummy (treated), time dummy (time), and interaction dummy (DID).

We employ the treatment dummy for IT and non-IT countries.

$$IT_i = \begin{pmatrix} 1 & \text{for an IT country} \\ 0 & \text{for a non} - \text{IT country} \end{pmatrix}$$

The time dummy is the pre-and post-adoption period for identifying the adoption period and capturing the impact before and after the policy adoption.

$$TIME_{it} = \begin{pmatrix} 0 & \text{Before IT policy adopted} \\ 1 & \text{After IT policy adopted} \end{pmatrix}$$

We use the following equation (4):

$$\pi_{it} = \alpha + \beta IT_i + \gamma TIME_{it} + \delta(IT_i * TIME_{it}) + e_{it} \tag{4}$$

where α is a constant term, the treatment group-specific effect is captured in β, γ is the time trend common to IT and non-IT countries, and δ is the effect of treatment, indicating the impact of the IT regime.

First, for a non-IT country

$$E(\pi_{it}|IT_i) = \alpha + \beta IT_i \tag{5}$$

Second, for an IT country before the adoption period

$$E(\pi_{it}|IT_i) = \alpha + \beta IT_i + \gamma \tag{6}$$

Third, for an IT country after the adoption period

$$E(\pi_{it}|IT_i) = \alpha + \beta IT_i + \gamma + \delta \tag{7}$$

Here, γ is a difference in inflation (π) before the adoption period among IT and non-IT countries, γ + δ is the difference in inflation after the adoption period between IT and non-IT, δ is the difference in inflation (π) before and after the adoption period for IT and non-IT countries. In Section 5, we apply this estimation procedure to estimate our model.

5. Empirical Findings

In this section, we estimate the treatment effects: fixed-effects with an interaction dummy variable, DID, and matching estimations to determine the impact of IT on both IT and non-IT countries. The dependent variables are annual inflation rates (π_{it}) and standard deviation of inflation rate moving averages ($\bar{\pi}_{it}$). Figure 3 shows a trend in inflation rates (π_{it}) for both IT and non-IT countries during 1980–2018. From Figure 3, we can observe that some uncontrolled factors affect both country groups.

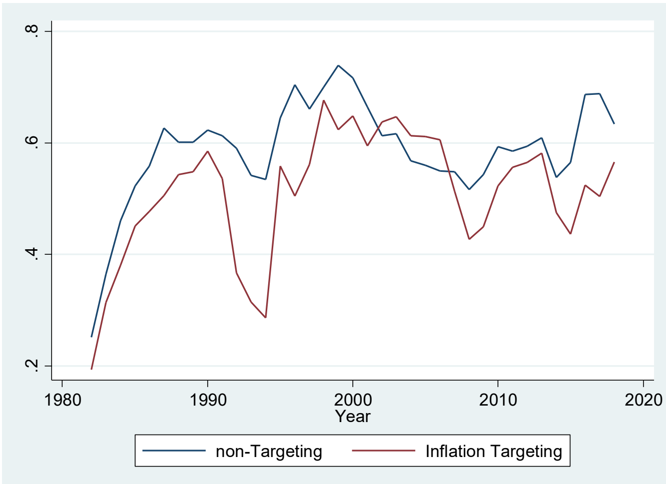
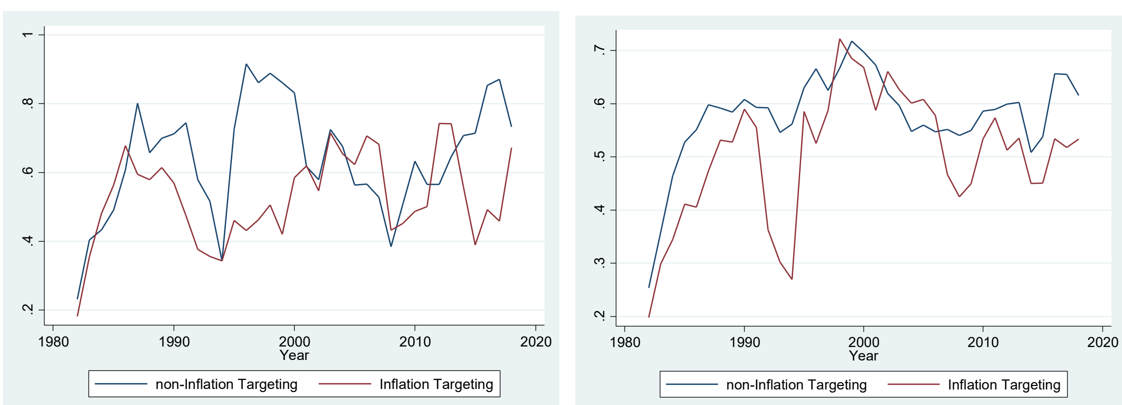


Figure 3. Trends in Inflation Volatility and Difference between IT and Non-IT Countries

As evident from Figure 3, overall inflation volatility is low in both IT and non-IT countries, although a fair inflation margin exists between the two groups. However, IT countries have been more successful in reducing inflation volatility than non-IT countries.



Advanced Economies Emerging-Developing Economies

Figure 4. Inflation Volatility in Advanced Economies and Emerging-Developing Economies

If the sample is divided into two sub-samples, we observe from Figure 4 that IT benefits the developing IT countries more than the advanced IT countries. Advanced economies have more stable inflation volatility, sound financial systems, and a more robust transmission mechanism than emerging markets and developing economies. Therefore, how the IT regime benefits developing countries in reducing inflation volatility, unlike advanced economies, is unclear. Developing countries have less control over their monetary policy given the underdeveloped financial sector and are vulnerable to external shocks. Hence, by adopting an IT regime, developing countries seek to enhance monetary policy tools, develop the financial sector, and further reduce inflation volatility.

Next, we will present various estimations on the inflation rate and its volatility.

5.1. Estimation

We apply the fixed-effects and random-effects models with the DID interaction dummy variable of treatment and time dummies. The reason for applying the interaction DID dummy is to capture the group-specific for each group. We estimate our model using two inflation measures: the annual inflation rates and inflation rates excluding hyperinflation episodes. Equation (4) can be expressed as follows:

$$\pi_{it} = \beta_1 + \beta_2 \pi_{it-1} + \beta_3 GDP_{it} + \beta_4 REER_{it} + \beta_5 RIR_{it} + \beta_6 GDPC_{it} + \beta_7 ER_{it} + \beta_8 M2_{it} + \beta_9 M2/GDP_{it} + \beta_{10} RES_{it} + \delta IT_{it} * TIME_{it} + u_i + \varepsilon_t + e_{it} \quad (8)$$

where π_{it}, the dependent variable, denotes inflation rates with i representing countries and t time; on the right-hand side are the independent variables GDP_{it}—output growth rates; $REER_{it}$—real effective exchange rates; RIR_{it}—real interest rates; $GDPC_{it}$—GDP per capita in PPP terms; ER_{it}—exchange rates; $M2_{it}$—broad money (M2); $M2/GDP_{it}$—M2–GDP ratio; RES_{it}—reserves in terms of three months of imports; $ITD_{it} * TIME_{it}$—interaction term between the time and treatment dummy variable (referred to as "DID dummy"); u_i—fixed-effect or individual (country) effect; ε_t—time effects; and e_{it}—error or disturbance term.

5.1.1. Determinants of Inflation Rates

In this section, we explore the impact of countries with and without inflation targets on the inflation rate. We estimate our model using equation 8. As shown in Table 5, we include the pooled sample and two different sub-samples: IT and non-IT countries, and estimate the following model:

$$\pi_{it} = \beta_0 + \beta_1 RIR_{it} + \beta_2 REER_{it} + \beta_3 ER_{it} + \beta_4 GDP_{it} + \beta_5 GDPC_{it} + \beta_6 M2_{it} + \beta_7 RES_{it} + \beta_8 M2/GDP_{it} + \delta IT_{it} * TIME_{it} + u_i + \varepsilon_t + e_{it} \quad (9)$$

Table 5. Estimation of Output Fixed-Effects with DID Dummy

Inflation rate (π_{it})	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Pooled Sample	FE IT	FE non-IT	FE IT	FE non-IT	FE IT	FE non-IT
		Overall		Advanced economies		Developing economies	
RIR	−0.0770	−0.0793	−0.0912	−0.484	−0.0298	−0.0541	−0.147
	(−1.51)	(−0.90)	(−1.49)	(−1.78)	(−0.33)	(−0.88)	(−1.17)
REER	−0.751*	−0.311	−0.714	−1.414	−2.406	−0.673	−1.332*
	(−2.42)	(−0.87)	(−1.95)	(−2.48)	(−2.34)	(−1.72)	(−2.93)
ER	0.425*	1.655*	0.352	0.0774	−2.327	0.352	1.588
	(2.05)	(2.42)	(1.68)	(0.04)	(−0.73)	(1.63)	(2.14)
GDP	−0.0331	−0.0619	−0.0312	0.138	−0.123	−0.0428	−0.0730
	(−0.86)	(−0.65)	(−0.77)	(0.68)	(−9.64)	(−1.09)	(−0.38)
GDPC	0.0774	−0.449	0.0830	−0.763	10.36	0.110	0.548
	(0.20)	(−0.76)	(0.17)	(−0.51)	(1.58)	(0.21)	(0.84)
M2	−0.249**	−0.113	−0.265*	−0.0734	−3.827	−0.269*	−0.265*
	(−2.92)	(−1.06)	(−2.51)	(−0.22)	(−2.21)	(−2.39)	(−3.37)
RES	−0.0422	−0.0392	−0.0452	−0.154	0.0772	−0.0439	−0.00931
	(−1.98)	(−0.96)	(−1.97)	(−1.56)	(0.20)	(−1.88)	(−0.20)
M2-to-GDP	0.00219	0.00963	0.00132	0.003	0.0717	0.0005	−0.00184
	(0.58)	(1.60)	(0.32)	(0.41)	(4.32)	(0.11)	(−0.27)
DID dummy	−0.115*	−0.313*			0.262*		
	(−2.23)	(−3.44)			(23.77)		
Constant	10.88***	9.145	11.21**	17.82	5.027	10.85**	10.35
	(3.67)	(2.24)	(3.26)	(1.78)	(0.20)	(2.96)	(1.97)
Adj. R^2	0.169	0.095	0.181	0.127	0.161	0.193	0.143

Note: t-statistics are in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. FE represents the fixed-effects estimation. IT implies that the samples are limited only to IT countries, while non-IT implies that only non-IT countries are included in the estimation.

According to the estimation of the fixed-effects model with the interaction DID dummy variable, we find that the DID dummy is highly significant in reducing inflation rates in the pooled and overall samples of IT countries.

5.1.2. Determinants of Inflation Volatility ($\bar{\pi}_{it}$)

In this section, we examine the impact of adopting an IT regime on inflation volatility in the overall sample, including advanced and developing countries, and compare the two subgroups of countries: IT and non-IT countries. Further, we estimate the following equation:

$$\bar{\pi}_{it} = \beta_1 + \beta_2\pi_{it-1} + \beta_3 GDP_{it} + \beta_4 REER_{it} + \beta_5 GDPC_{it} + \beta_6 ER_{it} + \beta_7 M2_{it} + \beta_8 M2/GDP_{it} + \beta_9 RES_{it} + \delta IT_{it} * TIME_{it} + u_i + \varepsilon_t + e_{it} \quad (10)$$

Table 6. Output Table of Fixed-Effects model with DID Interaction Dummy Variable

	(1)	(2)	(3)	(4)
Standard Deviations of inflation rates $\bar{\pi}_{it}$	OLS	FE Pooled sample	FE IT	FE non-IT
Inflation rates(lagged)	−0.215***	−0.171***	−0.146***	−0.177***
	(−17.10)	(−12.96)	(−5.95)	(−11.95)
REER	−0.286***	−0.185**	−0.243*	−0.173*
	(−4.95)	(−2.90)	(−2.18)	(−2.16)
ER	0.573***	0.469***	0.964***	0.470***
	(14.13)	(11.14)	(5.05)	(10.39)
GDP	−0.0297*	−0.0424**	0.00668	−0.0550***
	(−2.07)	(−3.08)	(0.32)	(−3.45)
GDPC	−0.0621***	−0.169*	0.0156	−0.266**
	(−4.89)	(−2.21)	(0.13)	(−2.81)
M2	−0.0182***	−0.0267	−0.0644*	−0.0104
	(−5.01)	(−1.77)	(−2.11)	(−0.58)
RES	0.00633*	0.00136	−0.00331	0.000130

	(2.04)	(0.34)	(−0.38)	(0.03)
M2-to-GDP	−0.00153***	−0.00328***	−0.000892	−0.00414***
	(−3.59)	(−3.60)	(−0.61)	(−3.90)
DID dummy	−0.0619	−0.201	−0.216*	
	(−0.48)	(−1.20)	(−2.06)	
Constant	3.261***	4.093***	3.329**	4.624***
	(10.26)	(7.02)	(2.99)	(6.71)
N	1183	1183	190	993
Adj. R^2	0.248	0.164	0.235	0.168

Note: t-statistics are in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. FE represents the fixed-effects estimation. IT implies that the samples are limited only to IT countries, while non-IT implies that only non-IT countries are included in the estimation.

The estimation result indicates that the DID dummy, at an average of −0.216%, is highly significant in reducing inflation volatility in IT countries. The pooled sample has a relatively low effect (0.201%) and an insignificant impact (see Table 6).

The lagged value of inflation has a significant negative impact for all cases, implying that monetary authorities have less control over domestic inflation rates in most countries with historically high inflation and a relatively low impact on IT countries.

The REER reduces inflation volatility in IT and non-IT countries by −2.43% and −0.173%, respectively, and in the overall sample by −0.185% on average. An increase in the REER, meaning an appreciation in the local currency, leads to a decrease in the price of imported items, which in turn leads to a decline in the overall inflation rate.

Exchange rate volatility reduces inflation volatility in both country groups, implying that most developing economies suffer from dollarization. The IT regime pays more attention to inflation stability than to exchange rate stability. Hence, the average reduction in exchange rate volatility at 0.47% is less in non-IT countries than the average 0.964% in IT countries because of pegged or managed-float regimes focusing on exchange rate stability. We use the standard deviations of the five-year moving averages of the inflation rate and observe a significant reduction in inflation variability in both countries.

5.2. Discussion

First, we investigated the impact of IT on inflation volatility in IT and non-IT countries by applying the DID estimation method and various matching estimations. Our results demonstrated a significant reduction in inflation volatility in IT countries. Second, we excluded hyperinflation episodes (outliers) from the dataset and found no significant decrease in inflation volatility in IT countries compared with non-IT countries.

We mainly focused on the impact of IT on inflation rates and inflation volatility in the two sub-samples of IT and non-IT countries. The previous study by Lin and Ye (2010) covered inflation volatility with fewer country datasets and in the shorter range because of data availability constraints. Therefore, we emphasize inflation volatility by using a larger sample of countries and additional control variables, such as REER and real interest rates. Although previous literature established that IT has a less significant impact, recent investigations reveal that it has a more significant impact on inflation volatility when combined with macroprudential and fiscal policies (Fouejieu, 2017; Ismailov, Kakinaka, & Miyamoto, 2016).

The findings of this study are consistent with those in previous studies, although we found more action on inflation volatility. However, the experience of IT countries illustrates that although many countries did not have a proper monetary transmission mechanism and financial system development before adoption (Lavigne et al., 2012), after the adoption period, IT countries have gradually improved and developed a framework for policy conduct.

6. Concluding Remarks

In this study, we investigated inflation variability after the adoption of IT policy. Our findings using the DID analysis demonstrated that IT policies have a significant and quantitatively substantial impact on reducing inflation variability. Countries with high and volatile inflation are more likely to apply an IT policy to reduce inflation. In summary, the IT regime reduces inflation volatility, but financial market development, economic base, and exchange rate vulnerability to external sector development are important factors in emerging market economies.

Our empirical findings are consistent with those in previous studies. We found that the IT regimes significantly impact inflation by reducing the actual inflation and volatility. Previous studies also confirm that in practice, monetary policy is not the only option for reducing inflation and maintaining a stable macroeconomic environment. The implementation of monetary policy is coordinated with fiscal policy, macroprudential policy, and the financial system, all of which play a vital role in maintaining the overall macroeconomic stability. Central banks should consider the main elements of the policy framework and economic issues while formulating policy decisions during the transition period. This study can be further elaborated in the future by considering exchange rate regimes and fiscal policy in the case of a specific country's experience.

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Appendix

This appendix provides supplementary analyses. In the following exercises, we excluded the outliers (hyperinflation episodes) from the dataset and found the IT impact on reducing inflation volatility to be less significant in IT than in non-IT countries.

A1. Inflation Rate Regression Analysis Excluding Hyperinflation Episodes (Outliers)

In this section, we estimate the model excluding hyperinflation episodes from the dataset. The dataset suffers from outliers; therefore, we exclude the hyperinflation period comprising inflation rates higher than 100% in annual terms.

Table A1. Regression Analysis of Inflation Rates Excluding the Hyperinflation Episodes

Inflation rate (π_{it})	(1) Pooled Sample	(2) FE IT	(3) FE non-IT	(4) FE IT	(5) FE non-IT	(6) FE IT	(7) FE non-IT
RIR	0.0679	−0.845	0.0673	−2.210	−1.197	0.260	−1.126
	(0.13)	(−1.54)	(0.12)	(−2.62)	(−0.98)	(0.40)	(−1.12)
REER	−10.33*	−4.234*	−9.375*	−2.171	−28.43	−9.991*	−12.81
	(−2.41)	(−3.00)	(−2.18)	(−0.64)	(−6.09)	(−2.17)	(−2.37)
ER_SD	4.050	15.84*	3.248	10.22	−16.09	3.147	15.69**
	(1.40)	(2.76)	(1.16)	(1.79)	(−1.02)	(1.15)	(4.56)
GDP_G	−0.288	−0.690	−0.176	0.160	−0.965	−0.185	−1.133
	(−0.99)	(−0.91)	(−0.54)	(0.28)	(−1.90)	(−0.52)	(−0.76)
GDPC	2.146	−0.410	2.399	−5.381	120.5	2.896	8.728*
	(0.58)	(−0.09)	(0.43)	(−0.72)	(1.37)	(0.48)	(2.57)
M2	−3.692*	−1.444	−4.160*	−0.662	−43.99	−4.345*	−2.695**
	(−2.46)	(−1.62)	(−2.16)	(−0.40)	(−1.72)	(−2.13)	(−4.33)
RES_IMP	−0.196	−0.278	−0.177	−0.678	1.587	−0.137	−0.0928
	(−1.26)	(−0.98)	(−0.97)	(−1.19)	(0.89)	(−0.71)	(−0.25)
M2_GDP	0.103	0.0797	0.113	0.0382	0.947	0.122	−0.0282
	(1.97)	(1.09)	(1.92)	(0.81)	(2.31)	(1.83)	(−0.70)
DID dummy	−0.245	−1.452			2.735		
	(−0.59)	(−1.44)			(1.33)		
Constant	124.8**	62.27	130.2**	84.42	26.68	132.0**	67.52
	(3.21)	(2.07)	(3.06)	(1.40)	(0.14)	(2.95)	(2.44)

N	923	159	764	79	43	685	116
Adj. R^2	0.319	0.125	0.353	0.090	0.431	0.369	0.209

Note: t-statistics in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. FE represents the fixed-effects estimation. IT implies that the samples are limited only to IT countries, while non-IT implies that only non-IT countries are included in the estimation.

Figure A1 shows that removing the outliers from the dataset does not result in a significant drop in inflation in IT countries compared with non-IT countries after the 2000s. Most countries' central banks follow the same monetary policy rules. Ball and Sheridan (2005) revealed that countries are most likely to follow the same Taylor rule when controlling inflation rates. We observe that IT countries experienced higher inflation rates than non-IT countries; hence, they are most likely to adopt the IT regime to reduce inflation.

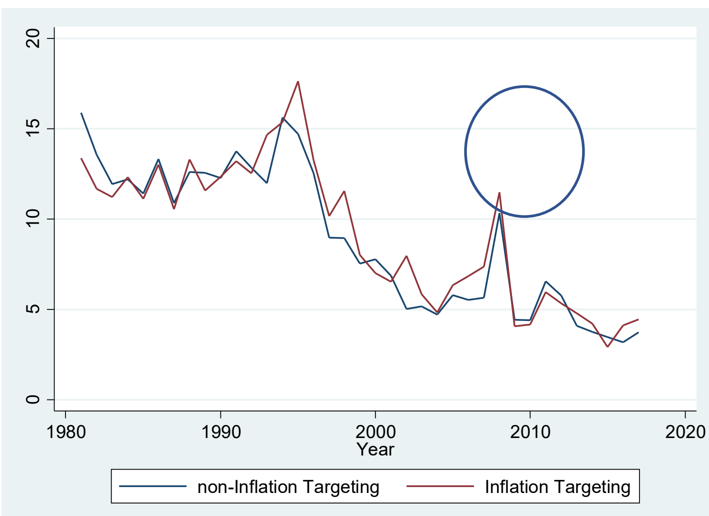

Figure A1. Annual Rates of Inflation (Natural logs)

We examine inflation reduction by breaking down the dataset into two sub-samples of advanced and emerging market economies. Advanced economies have similar inflation rate dynamics in both groups. Emerging market economies have benefited from the adoption of IT policies to reduce inflation rates to a lower level.

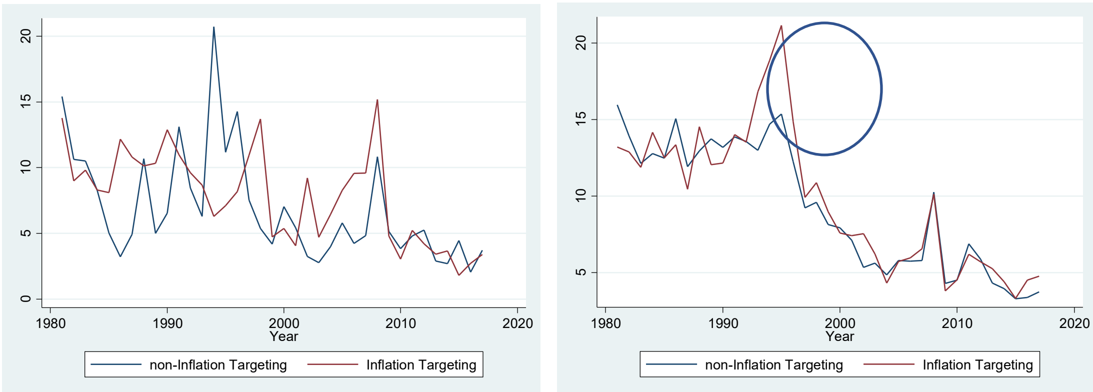

Figure A2. Trends in Inflation Rates in Advanced Economies (left) and Emerging Market Economies (right)

Why IT countries have adopted a route similar to non-IT countries in recent years merits a discussion. The first reason is that most central banks have price stability as a primary objective and follow a similar Taylor rule to control inflation rates (Ball & Sheridan, 2003). We discussed this issue in more detail in the Discussion section (subsection 5.2).

A2. Inflation Volatility Regression Analysis Excluding the Hyperinflationary Episodes (Outliers)

In this section, we estimate the inflation volatility model by excluding outliers from the dataset. Our data suffer from outliers that have historical problems with high inflation. Several countries have suffered from hyperinflation episodes. Estimation using the actual dataset will result in a more significant impact on IT countries. Therefore, we exclude the data on annual inflation rates if it is higher than 100%.

$$\bar{\pi}_{it} = \beta_1 + \beta_2\pi_{it-1} + \beta_3 GDP_{it} + \beta_4 REER_{it} + \beta_5 RIR_{it} + \beta_6 GDPC_{it} + \beta_7 ER_{it} + \beta_8 M2_{it} + \beta_9 M2/GDP_{it} + \beta_{10} RES_{it} + \delta IT_{it} * TIME_{it} + u_i + \varepsilon_t + e_{it} \quad (9)$$

Table A2. Regression Analysis of Inflation Volatility Excluding Hyperinflation Episodes

Inflation volatility $\bar{\pi}_{it}$	(1)	(2)	(3)	(4)	(5)	(6)
Estimation Method and Sample	FE Overall	RE Overall	FE IT	RE IT	FE Non-IT	RE Non-IT
Inflation lagged	0.167	0.530***	−0.0587	0.23	0.114	0.436**
	−1.09	−3.51	(−0.13)	−0.5	−0.72	−2.8
REER	−1.480*	−0.294	−1.535	1.956	−1.475*	−1.970*
	(−2.09)	(−0.43)	(−0.79)	−1.45	(−1.67)	(−2.33)

RIR	0.0174	0.0282*	−0.0242	−0.047	0.0538**	0.0714***
	−1.09	−1.83	(−0.79)	(−1.53)	−2.81	−4.02
ER	9.018***	10.76***	27.49***	27.11***	7.744***	8.978***
	−12.2	−14.5	−8.39	−8.89	−10.5	−12.05
GDP_G	−0.346*	−0.329*	−0.151	0.0486	−0.302*	−0.370*
	(−2.24)	(−2.09)	(−0.40)	−0.12	(−1.82)	(−2.19)
GDPC	1.442*	−0.659*	3.653*	−1.512**	1.534	−0.571*
	−1.63	(−2.33)	−1.68	(−2.65)	−1.46	(−1.70)
M2	−1.865***	−0.379***	−1.861***	−0.286*	−1.876***	−0.352***
	(−9.83)	(−4.97)	(−3.48)	(−1.76)	(−8.12)	(−4.14)
RES	0.0904	0.0995*	0.0577	0.0955	0.0959	0.0885
	−1.41	−1.69	−0.33	−0.7	−1.35	−1.33
M2_GDP	0.0151	−0.0103	−0.0201	0.0214	0.0215*	−0.0118
	−1.47	(−1.35)	(−0.68)	−0.99	−1.95	(−1.38)
DID dummy	0.74	−0.448	1.192	2.038		
	−0.44	(−0.29)	−0.67	−1.38		
Constant	43.84***	19.23***	25.24	9.435	42.95***	25.72***
	−6.39	−4.4	−1.31	−0.91	−5.69	−5.24
N	932	932	165	165	767	767
Adj. R^2	0.335	0.399	0.444	0.596	0.348	0.395

Note: t-statistics in parentheses. * p < 0.10, ** p < 0.05, *** p< 0.01. FE represents the fixed-effects estimation, while RE represents the random-effects estimation. IT implies that the samples are limited only to IT countries.

Table A2 displays the inflation volatility estimation outcomes, excluding hyperinflation episodes as a dependent variable. We estimate the impact of the IT policy on the reduction in inflation volatility by excluding outliers from our dataset.

As an immediate result of the exclusion of outliers, the remaining variables become insignificant. The random-effects model shows that the lagged value of inflation raises inflation volatility by increasing inflation volatility by 0.53% point in the overall sample and 0.436% point in the non-IT sample.

According to the random-effects model, broad money (M2) and GDP per capita negatively impact inflation volatility in IT countries by −1.5% point and −0.28% point, respectively. In the non-IT sample, we find that M2 and GDP per capita have significant power to reduce the volatility of inflation by −0.57% point and −0.35% point, respectively.

The DID dummy variable becomes insignificant and quantitatively small compared with the previous estimation, that is, without hyperinflation episodes. The other variables were not significant.

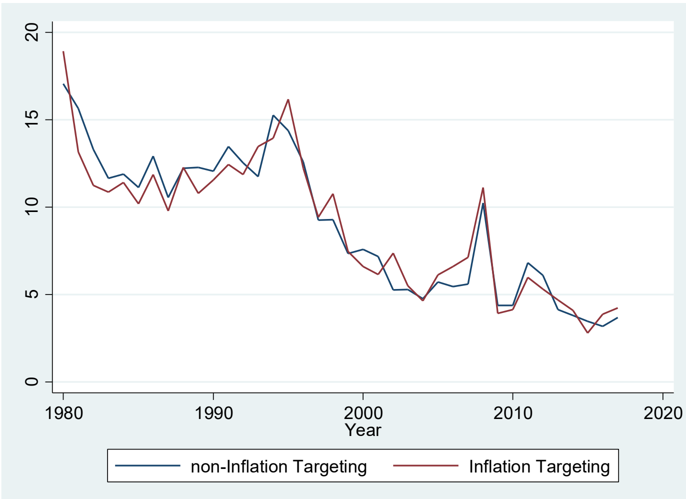

Figure A3. Trend in Inflation Volatility Excluding Hyperinflation Episodes

After excluding the hyperinflation episodes from our sample, inflation volatility does not decrease considerably, unlike the case with the IT and non-IT countries (see Figure A3). We found that inflation volatility did not reduce significantly in IT countries compared with non-IT countries after excluding outliers from the dataset.

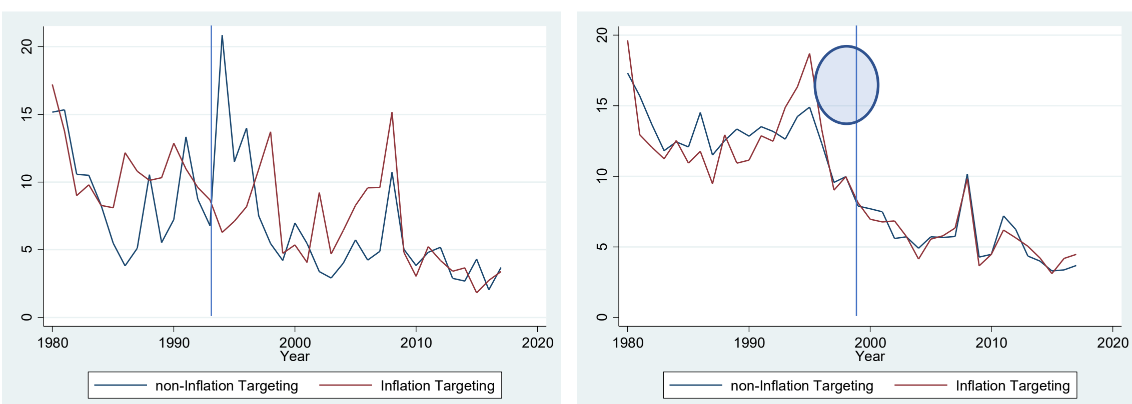

Figure A4. Trends in Inflation Volatility in Advanced Economies (left) and Emerging-Developing Economies (right) (FE-DID)

Source: Author's Estimation.

Finally, we examine the impact on advanced and emerging economies separately. No clear significant impact of reducing inflation volatility is evident compared with non-IT in advanced economies. Moreover, we can observe that IT in emerging market economies had a slight spike before the adoption period (Figure A4) and that IT countries previously had relatively higher volatility and achieved lower inflation volatility. The IT and non-IT samples had a similar path to reducing volatility in the past 20 years.

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