Received: 11 July 2019 | Revised: 20 May 2020 | Accepted: 20 May 2020

DOI: 10.1111/rode.12690

WILEY

REGULAR ARTICLE

Inflation targeting in low-income countries: Does IT work?

Atsuyoshi Morozumi[1] | **Michael Bleaney**[1] | **Zakari Mumuni**[2]

[1]School of Economics, University of Nottingham, University Park, Nottingham, UK

[2]Central Bank of Ghana, Accra, Ghana

Correspondence
Atsuyoshi Morozumi, School of Economics, University of Nottingham, University Park, Nottingham NG7 2RD, UK.
Email: atsuyoshi.morozumi@nottingham.ac.uk

Abstract

Previous research on inflation targeting (IT) has focused on high-income countries and emerging market economies (EMEs). Only recently have sufficient data accumulated for the performance of IT in low-income countries (LICs) to be assessed. We show that IT has not so far been as effective in reducing inflation in LICs as in EMEs. Relatively low central banks' instrument independence in LICs, associated with weak restrictions limiting a central bank's lending to the government, helps explain this result.

KEYWORDS

inflation targeting, instrument independence, low-income countries

JEL CLASSIFICATION

E31; E52; E58; O23

1 | INTRODUCTION

Inflation targeting (IT) was first adopted in 1990 by New Zealand, followed by a number of other high-income countries (HICs) and emerging market economies (EMEs). Existing empirical studies suggest that IT has significantly reduced inflation in EMEs but has made little difference in HICs (see Walsh (2009) for a useful survey).[1] Only in the 21st century have low-income countries (LICs) begun to adopt IT as a new monetary policy framework to pursue low inflation. This paper, using a data set covering up to 185 countries for the 1980–2016 period, empirically evaluates the effectiveness of IT in reducing the level of inflation in LICs. In particular, we examine *how* and *why* the effectiveness of

IT in LICs may differ from that in EMEs, an income group where IT is known to be generally effective in reducing inflation.

Our main findings are as follows. First, we find that IT is *not* effective in reducing inflation in LICs, *unlike* in EMEs. Since IT has also been less effective in HICs than in EMEs, these results suggest that the relation between the effectiveness of IT and income levels is non-monotonic. Next, we explore why IT effects are different between LICs and EMEs, paying particular attention to the role of the central bank's instrument independence. We show that, within a pooled sample of LICs and EMEs, when independence is low because of weak restrictions limiting a central bank's lending to the government, IT loses its effectiveness in reducing inflation rates. Since LICs are generally associated with relatively low independence, this result is consistent with ineffective IT in LICs. Our interpretation is that, whereas an IT central bank, which has price stability as its overriding objective, aims to align future expected inflation with its publicly announced target rate by adjusting policy instruments today, under low instrument independence where fiscally driven inflationary pressure is present, the central bank lacks the ability to adjust instruments, eventually failing to anchor actual inflation to the target.

This paper is closely related to previous empirical work on IT effects that highlights the role of income levels. For example, Mishkin and Schmidt-Hebbel (2007), de Mendonça and de Guimarães e Souza (2012), and Samarina, Terpstra, and De Haan (2014) examine the IT effects both in advanced and non-advanced economies, and show that IT is effective in reducing inflation only in the latter. We add to the literature by showing that the IT effects are heterogeneous among non-advanced economies (i.e., LICs vs. EMEs), and also by investigating the role of institutions as a possible reason behind it. To note, Gemayel, Jahan, and Peter (2011) include some case studies of IT in LICs such as Armenia and Ghana, but their econometric investigation is based on IT-adopting EMEs, because IT in LICs is a relatively new phenomenon and their data run only up to 2008. Using data that run up to 2016, we conduct a formal analysis of IT effects in LICs, highlighting the difference from the effects in EMEs.

The rest of the paper is organized as follows. Section 2 describes the adoption of IT in LICs. Section 3 explains the empirical methodology, and Section 4 describes the data. Section 5 presents results. Last, Section 6 offers concluding remarks.

2 | BACKGROUND: IT ADOPTION IN LOW-INCOME COUNTRIES

Table 1 lists the countries with IT experiences, together with their income classes and the adoption dates. To take account of the fact that some countries grow fast, while others stay stagnant over decades, our income classification takes the following three steps.

1. For each of the years during the sample period (1980–2016), we first sort all the available countries into four groups using per capita real GDP in terms of purchasing power parity (PPP): the highest 25th percentile, 25th–50th, 50th–75th, and 75th–100th.[2]
2. Then, based on the number of times each country appears in those four groups, we denote countries that appear in the top 25th percentile most frequently as high-income countries and countries that appear in the 25th–50th, 50th–75th, and 75th–100th most frequently as upper-middle, lower-middle, and low-income countries, respectively.
3. Last, we re-categorize the four groups into *three* by combining the bottom two groups, which yields our final classification of HICs, EMEs, and LICs.

TABLE 1 Income classification and IT adoption years

	Income classification		IT adoption year	
Country	**This study**	**World Bank 2016**	**Strict IT**	**LooseIT**
Albania	LIC	Upper middle	2009	2009
Armenia	LIC	Lower middle	2006	2006
Georgia	LIC	Upper middle	2009	2009
Ghana	LIC	Lower middle	2007	2002
Guatemala	LIC	Lower middle	2005	2005
Indonesia	LIC	Lower middle	2006	2005
Moldova	LIC	Lower middle	2009	2009
Paraguay	LIC	Upper middle	2013	2013
Peru	LIC	Upper middle	2002	1994
Philippines	LIC	Lower middle	2002	2001
Uganda	LIC	Low	2011	2011
Brazil	EME	Upper middle	1999	1999
Chile	EME	High	2001	1991
Colombia	EME	Upper middle	1999	1991
Dominican Republic	EME	Upper middle	2012	2012
Hungary	EME	High	2001	2001
Mexico	EME	Upper middle	2001	1999
Poland	EME	High	1999	1998
Romania	EME	Upper middle	2005	2005
Russian Federation	EME	Upper middle	2014	2014
Serbia	EME	Upper middle	2006	2006
Slovak Republic	EME	High	2005	2005
South Africa	EME	Upper middle	2001	2000
Thailand	EME	Upper middle	2000	2000
Turkey	EME	Upper middle	2006	2002
Australia	HIC	High	1994	1993
Canada	HIC	High	1995	1991
Czech Republic	HIC	High	1998	1998
Finland	HIC	High	1994	1993
Iceland	HIC	High	2003	2001
Israel	HIC	High	1997	1992
Japan	HIC	High	2013	2013
Korea, Rep.	HIC	High	2001	1998
New Zealand	HIC	High	1993	1990
Norway	HIC	High	2001	2001
Spain	HIC	High	1995	1994
Sweden	HIC	High	1995	1993
Switzerland	HIC	High	2000	2000
United Kingdom	HIC	High	1993	1992

Notes: This study categorizes countries into different income levels (LICs, EMEs, and HICs) using per capita real GDP in PPP terms (in 2011 international dollars, from IMF's World Economic Outlook) over the 1980–2016 period. World Bank's 2016 income classification is based on income levels in 2015 alone. IT adoption dates are from Samarina et al. (2014) except that for countries that they do not cover, we take dates from other sources including respective central bank websites. Finland, Spain, and Slovak Republic left IT after adopting the Euro in 1999, 1999, and 2009, respectively.

Following this procedure, 11, 14, and 14 IT-adopting countries are classified as LICs, EMEs, and HICs, respectively. For information, Table 1 also shows the income classification used by the World Bank in 2016, which is based on income levels in 2015 alone.

The last two columns in the table provide alternative years of IT adoption for each country: strict and loose adoption dates. The difference between these years is that the latter corresponds to the time when countries simply announce inflation targets without strong commitment, possibly using other nominal anchors at the same time. The former, on the other hand, is the year when a strong commitment is made to achieve the target. Those years largely follow Samarina et al. (2014), except that for countries not included in their study, the dates are taken from other sources, including respective central bank websites. For some countries such as Israel, Colombia, Chile, Peru, and Ghana, the time gap between loose and strict adoption dates is substantial (more than 5 years). Importantly, Table 1 clarifies that IT is a recent phenomenon in LICs, regardless of the definition of adoption dates. For example, according to strict IT adoption years, 9 out of 11 LICs adopted IT after the end of 2004, and 5 adopted IT after the end of 2008. Since only recently have sufficient data become available to assess IT in LICs, little is known about the effects of IT in those countries. This paper aims to fill in this gap.

3 | EMPIRICAL METHODOLOGY

To examine the role of income levels in the effectiveness of IT, we apply a panel regression method. This method allows us to control for unobserved country characteristics through country fixed effects, which mitigates an endogeneity problem caused by omitted variables. However, there is also a key estimation issue of the self-selection problem of IT adoption, which arises when country-specific factors that are correlated to IT adoption may affect inflation rates. To mitigate a bias in the IT estimates caused by this problem, we explicitly control for various factors that might affect the likelihood of IT adoption (as well as inflation). Specifically, in line with Samarina and De Haan (2014), these controls include past inflation rates, exchange rate regimes, and exchange rate volatility (in the form of parity changes and currency crises).[3] Although the alternative method such as propensity score matching (PSM) also helps tackle self-selection problems (e.g., de Mendonça & de Guimarães e Souza, 2012; Lin & Ye, 2007; Samarina et al., 2014), we prefer to use a panel regression method for simplicity and greater robustness.[4] Indeed, the use of country-specific time trends allows us to control for variations in the speed of disinflation in different countries, and also helps mitigate so-called regression-to-the-mean, the possibility that initially high-inflation countries converge to the mean *irrespective of* implemented policies, including IT (see Ball & Sheridan 2004).

The standard approach is to test for an IT effect by adding to an inflation regression a dummy variable that is equal to 1 when an IT regime is in place, and 0 otherwise. The reference regression model for inflation in country i in year t is of the form:

$$\pi_{i,t} = \alpha\, \pi_{i,t-1} + \beta\, IT_{i,t} + \sum_{j=1}^{n} \theta_j\, z_{i,j,t} + \mu_i + \gamma_i\, t + \epsilon_{i,t}, \tag{1}$$

The lagged inflation term, $\pi_{i,t-1}$, is expected to be always positive and significant, reflecting the persistence of inflation shocks. $IT_{i,t}$, a dummy variable, takes the value of 1 if an IT regime is in place in country i in year t, and $z_{i,j,t}$ represent a vector of control variables, including exchange rate regime dummies (for a hard peg and for a float, so the omitted category is a soft peg), a dummy for a parity change (usually a devaluation) in a pegged regime in the current or previous year, and a dummy for a currency crisis in the current or the previous year. The latter two variables reflect the fact that devaluations and currency crises tend to

be associated with spikes in the inflation rate and also, as suggested earlier, possibly affect IT adoption decisions (e.g., countries that have experienced currency crises often adopt IT, including UK, and Sweden). Further, we control for world oil and food price inflation as a possible common source of inflationary pressures in the world economy.[5] μ_i is the country fixed effect, capturing unobserved time-invariant country characteristics. Last, $\gamma_i t$ is country-specific linear time trends, mitigating regression-to-the-mean.

Based on Equation (1), the following model allows us to investigate how the effects of IT may differ across different income groups:

$$\pi_{i,t} = \alpha\pi_{i,t-1} + \beta_L LIC_i * IT_{i,t} + \beta_E EME_i * IT_{i,t} + \beta_H HIC_i * IT_{i,t} + \sum_{j=1}^{n} \theta_j z_{i,j,t} + \mu_i + \gamma_i t + \epsilon_{i,t}, \tag{2}$$

where LIC_i is a time-invariant dummy variable, which takes the value of 1 if country i is LIC (as defined earlier) and 0 otherwise. EME_i and HIC_i are also dummies defined likewise. Thus, essentially, we estimate the slope coefficient on the IT dummy separately for the three income groups.[6] Here, our primary interest is to investigate the heterogeneity of IT effects between LICs and EMEs, by testing the equality of the interaction coefficients of β_L and β_E. In line with the previous works that compare IT effects in HICs and in EMEs, we also include the interaction term between HIC_i and IT in the model.

For robustness, we consider the following equation that complements Equation (2) by examining the relation between IT effects and income levels more directly:

$$\pi_{i,t} = \alpha\pi_{i,t-1} + \beta IT_{i,t} + \delta y_{i,t} + \zeta y_{i,t} * IT_{i,t} + \chi y_{i,t}^2 + \psi y_{i,t}^2 * IT_{i,t} + \sum_{j=1}^{n} \theta_j z_{i,j,t} + \mu_i + \gamma_i t + \epsilon_{i,t}, \tag{3}$$

where $y_{i,t}$ is the log of per capita real GDP in PPP terms (in 2011 international dollars, from IMF's WEO) in country i in year t. This way, Equation (3) makes use of the time-variation of income levels to estimate how they interact with the IT effect. Notice that to allow for possible non-monotonicity between income levels and the IT effect, we add the interaction between squared income and the IT dummy as well. The coefficients of our interest are the ones on interaction terms, that is, ζ and ψ.

Having clarified the regression equations, it is important to realize that the estimation of the above dynamic panel data models using ordinary least squares (OLS) produces biased coefficients, because the lagged dependent variable is endogenous with respect to the fixed effects. However, this dynamic panel bias becomes smaller as the number of time periods increases. Therefore, the fact that our sample of annual data spans a comparatively long panel (1980–2016) makes it reasonable to estimate a fixed effects model. To illustrate, in the reference estimation below with 185 countries (Table 3), the average number of annual observations per country is 32.4.

4 | DATA

Annual consumer price index (CPI) inflation rate is measured as the annual log difference of the CPI multiplied by 100 (i.e., inflation = 100*Δlogcpi). To avoid disproportionately large inflation rates affecting estimation results, our reference data set excludes countries with average CPI inflation of over 50% per year (over the sample period, 1980–2016), yielding a cross-country panel data set of

up to 185 countries over the 1980–2016 period, of which 93 countries are categorized as LICs, 47 as EMEs, and 45 as HICs.[7] The list of the 185 countries is found in the Supporting Information. Out of 37 IT countries included, 10 are LICs, 13 are EMEs, and 14 are HICs.[8] To address the dynamic panel bias mentioned earlier, the reference analysis only uses countries that offer at least 10 observations over the sample period. The data for inflation are from the World Bank's World Development Indicators (WDI), complemented by IMF's World Economic Outlook (WEO) when WDI does not provide data.[9]

Table 2 presents descriptive statistics for different income levels, showing that average inflation rates in LICs, EMEs, and HICs are 11.11%, 13.16%, and 3.84%, respectively. Per capita real GDP in

TABLE 2 Descriptive statistics across different income groups

Variable	Mean	*SD*	Min.	Max.
Low-income countries (LICs)				
CPI inflation rates (%)	11.11	23.29	−129.94	477.49
Real GDP in PPP terms, pc (2011 international dollars)	3,649.66	3,814.17	276.18	52,810.23
Hard peg (dummy)	0.21	0.41	0	1
Soft peg (dummy)	0.54	0.5	0	1
Float (dummy)	0.25	0.43	0	1
Parity change (dummy)	0.11	0.32	0	1
Currency crisis (dummy)	0.28	0.45	0	1
Emerging market economies (EMEs)				
CPI inflation rates (%)	13.16	24.83	−17.58	298.44
Real GDP in PPP terms, pc (2011 international dollars)	13,127.13	4,918.07	3,701.46	29,051.53
Hard peg (dummy)	0.17	0.38	0	1
Soft peg (dummy)	0.52	0.5	0	1
Float (dummy)	0.31	0.46	0	1
Parity change (dummy)	0.11	0.31	0	1
Currency crisis (dummy)	0.24	0.43	0	1
High-income countries (HICs)				
CPI inflation rates (%)	3.84	7.62	−10.31	155.57
Real GDP in PPP terms, pc (2011 international dollars)	39,567.48	21,630.52	5,365.09	150,632.11
Hard peg (dummy)	0.17	0.37	0	1
Soft peg (dummy)	0.55	0.5	0	1
Float (dummy)	0.28	0.45	0	1
Parity change (dummy)	0.05	0.22	0	1
Currency crisis (dummy)	0.18	0.39	0	1
World variables				
World oil price inflation rates	1.04	25.83	−65.82	45.12
World food price inflation rates	0.66	9.43	−18.91	21.77

Notes: Statistics correspond to the reference data set where countries with the average CPI inflation of over 50% are excluded. The numbers of countries covered in LICs, EMEs, and HICs are up to 93, 47, and 45 countries, respectively. The sample period is up to 1980–2016. Clarifications required on each variable are given in the text. Statistics for world variables are based on the entire reference data set.

PPP terms (in 2011 international dollars) is from IMF's WEO. The average figure is highest in HICs ($39,567) and lowest in LICs ($3,650). Turning to control variables (that help mitigate that self-selection problem), exchange rate regime data and information on parity changes are dummy variables based on Bleaney and Tian (2017).[10] When countries are estimated to adopt a hard peg, soft peg, or floating regime in a given year, the respective variable takes the value of 1 (0 otherwise). In LICs, the average of the hard peg dummy is 0.21, meaning that 21% of the observations (across all the LICs and years) are categorized as hard peg. The parity change dummy takes the value of 1 in the case of parity changes in fixed exchange rate regimes. The currency crisis variable created by Bleaney, Saxena, and Yin (2018) takes the value of 1 when an exchange market pressure index (EMPI), the sum of the percentage depreciation in the exchange rate and the percentage loss in foreign exchange reserves, is large.[11] Across LICs and years in our data set, 28% of all observations take the value of 1. Last, world oil and food price inflation (common across countries) take the average of 1.04% and 0.66%, respectively, with the former showing a much larger standard deviation.[12]

5 | RESULTS

First we examine how the effectiveness of IT differs across income levels, particularly between LICs and EMEs. Next, we investigate the possible reason why the effectiveness of IT may differ between the two income groups, highlighting central banks' instrument independence.

5.1 | IT effects across different income levels

5.1.1 | Reference results

Table 3 shows estimation results of Equation (1) for an unconditional effect of IT on inflation, and also results of Equation (2) for conditional effects upon income levels. The conditional effects are estimated using time-invariant country group dummies. Acknowledging the difficulty in defining IT adoption dates, we estimate equations using both strict and loose adoption dates. While controlling for both world oil and food price inflation rates routinely, because using other extra control variables restricts the sample size substantially, results are shown with and without them.[13] Country-fixed effects and country-specific linear trend are always included. Here, the possibly disproportionate effects of hyper-inflation cases are addressed by excluding countries with an average inflation rate of over 50% over the sample period.

The first two columns estimate the equations without the extra controls, using the strict IT adoption dates. Column (1) shows the unconditional IT effects, based on all the observations regardless of country's income levels. The coefficient on the IT dummy of −0.48 is insignificant, implying that the adoption of IT is *not* associated with a change in inflation rates when using the entire set of observations. However, Column (2), which estimates the IT effects conditional on income levels, shows that for EMEs, the adoption of IT is significantly associated with lower inflation by 4.57 percentage points, while for LICs and HICs, the effect is insignificant. In fact, the coefficient on IT*EME is significantly smaller than the one on IT*LIC, indicating that IT is more effective in EMEs than in LICs (see the *p*-value of 0.013 from testing the equality of those coefficients in the row on LIC_EME). Also, when EMEs and HICs are compared, IT is again more effective in the former (see the row on HIC_EME, which gives *p*-values from testing the equality of coefficients between IT*HIC and IT*EME). Columns (3) and (4) add extra control variables and confirm the

TABLE 3 IT effects on inflation across different income levels

Adopt dates	Strict				Loose			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
*Dependent variable: 100*Δlogcpi*								
L.Infl	0.529***	0.528***	0.438***	0.436***	0.529***	0.527***	0.438***	0.436***
	(19.788)	(19.765)	(8.923)	(8.824)	(19.788)	(19.778)	(8.927)	(8.842)
IT	−0.476		−2.167		−1.741		−3.604**	
	(−0.414)		(−1.496)		(−1.349)		(−2.285)	
IT*LIC		3.852		−0.215		3.354		0.042
		(1.419)		(−0.114)		(1.192)		(0.021)
IT*EME		−4.567**		−7.540***		−5.782**		−8.014**
		(−2.299)		(−2.845)		(−2.317)		(−2.342)
IT*HIC		0.240		1.481		−1.393		−2.041
		(0.344)		(1.073)		(−1.329)		(−1.436)
Oil infl	−0.003	−0.002	0.017*	0.017*	−0.003	−0.002	0.017*	0.017**
	(−0.290)	(−0.268)	(1.960)	(1.913)	(−0.291)	(−0.239)	(1.966)	(1.995)
Food infl	0.076***	0.077***	0.112***	0.115***	0.076***	0.076***	0.111***	0.111***
	(3.081)	(3.136)	(5.201)	(5.323)	(3.089)	(3.114)	(5.167)	(5.201)
Hard peg			−5.314	−5.329			−5.320	−5.346
			(−1.376)	(−1.379)			(−1.378)	(−1.380)
Float			3.260***	3.295***			3.293***	3.359***
			(3.707)	(3.786)			(3.737)	(3.851)
Parity chg			3.271***	3.302***			3.262***	3.301***
			(3.007)	(3.035)			(2.995)	(3.026)
L.Parity chg			−0.895	−0.878			−0.903	−0.898
			(−1.521)	(−1.506)			(−1.526)	(−1.522)
Cur crisis			3.240***	3.226***			3.222***	3.173***
			(5.352)	(5.377)			(5.353)	(5.345)
L.Cur crisis			2.360***	2.352***			2.357***	2.295***
			(5.188)	(5.261)			(5.165)	(5.164)
LIC_EME		0.0133		0.0228		0.0159		0.0400
HIC_EME		0.0227		0.00296		0.107		0.109
Observations	5,994	5,994	4,511	4,511	5,994	5,994	4,511	4,511
Countries	185	185	166	166	185	185	166	166
IT adopters	37	37	33	33	37	37	33	33
Adj. R^2	0.532	0.532	0.455	0.456	0.532	0.532	0.456	0.456

Notes: Fixed-effect estimations. Countries with the average inflation of over 50% are omitted. Constant and country-specific linear trends, included in all the models, are not shown for brevity. LIC_EME (HIC_EME) gives *p*-value from testing the equality of coefficients on IT between LIC and EME (HIC and EME). Inflation rate (dependent variable) is calculated as a log difference of CPI. *t*-statistics are in parentheses. Clustered standard errors are used to adjust for correlation of error terms within countries.

***$p < .01$; **$p < .05$; *$p < .1$.

heterogeneous effects of IT across income levels: only for EMEs is the IT dummy negatively associated with inflation rates, and the coefficient is significantly more negative than in LICs and HICs. Columns (5)–(8) present results using loose IT adoption dates. The results are quite similar, except that the difference in the effectiveness of IT between EMEs and HICs becomes marginally insignificant (with the *p*-values of just above 0.1).

Regarding the control variables, higher world food price inflation is always associated with higher inflation, while world oil price inflation is positively associated with (CPI) inflation only when the other extra controls are added. A floating exchange rate is (always) related to significantly higher inflation than the omitted category of a soft peg with no parity change, and the coefficient on a hard peg is negative, though insignificant. A currency crisis in the current or the past year is associated with significantly higher inflation, as is a current (but not lagged) parity change in a pegged regime. The lagged inflation variable is significant, showing that inflation is persistent.

The preceding analysis excludes countries with an average inflation rate of over 50% over the sample period. For robustness, Table 4 presents results excluding countries with an average inflation of over 30%, which makes the results less susceptible to disproportionately large inflation rates, although the sample size becomes smaller (covering 171, instead of 185 countries, when the extra controls are omitted). For brevity, only coefficients on the income interaction terms (cf. even-numbered columns in Table 3) are presented. Even with this alternative threshold, results are essentially the same for the two definitions of IT adoption dates, with or without extra controls: IT is effective in reducing inflation only in EMEs, and it is in fact significantly more effective in EMEs than in LICs as well as in HICs (in case of strict adoption dates). Overall, results indicate that IT is more effective in reducing inflation in EMEs than in LICs.[14]

TABLE 4 IT effects across different income levels: Hyper-inflation thresholds of 30%

Adopt dates	**Strict**		**Loose**	
	(1)	**(2)**	**(3)**	**(4)**
*Dependent variable: 100*Δlogcpi*				
IT*LIC	3.993	0.914	3.421	1.132
	(1.316)	(0.496)	(1.088)	(0.586)
IT*EME	−5.238**	−6.566**	−5.508**	−5.723**
	(−2.264)	(−2.366)	(−2.456)	(−2.062)
IT*HIC	0.215	1.658	−1.685	−1.964
	(0.266)	(1.129)	(−1.325)	(−1.281)
Extra controls	No	Yes	No	Yes
LIC_EME	0.0178	0.0237	0.0224	0.0403
HIC_EME	0.0254	0.00905	0.145	0.239
Observations	5,608	4,236	5,608	4,236
Countries	171	153	171	153
IT adopters	34	31	34	31
Adj. R^2	0.430	0.404	0.430	0.403

Notes: Countries with the average inflation of over 30% are omitted. For brevity, only coefficients on interactions between IT and income dummies are shown. Extra controls are exchange rate regime dummies, a dummy for a parity change in a pegged regime in the current and previous year, and a dummy for a currency crisis in the current and the previous year. For further relevant information, see Notes for Table 3.

5.1.2 | Using an alternative approach

As a further robustness check on the role of income levels in the effectiveness of IT, we estimate Equation (3), which makes use of within-country variations in income levels (instead of time-invariant income dummies). As in Table 3, countries with an average inflation of over 50% are omitted. This exercise is useful because there is inherent arbitrariness in classifying countries into different income groups when panel data cover a long time period, albeit our income classification addresses this issue to some degree.

Table 5 presents results for both strict and loose adoption dates, and with and without extra control variables. Denoting y (see Equation (3), the log of per capita real GDP in PPP terms, in 2011 international dollars) as *Income*, the marginal effect of the IT dummy on inflation, incorporating the interaction

TABLE 5 IT effects across different income levels: Alternative approach

Adopt dates	Strict		Loose	
	(1)	(2)	(3)	(4)
*Dependent variable: 100**Δ*logcpi*				
L.Infl	0.528***	0.406***	0.528***	0.405***
	(17.298)	(7.209)	(17.322)	(7.193)
IT (β)	371.142***	508.447***	329.329**	502.140***
	(3.324)	(3.471)	(2.259)	(4.060)
IT*Income (ζ)	−78.677***	−110.379***	−70.048**	−107.319***
	(−3.271)	(−3.447)	(−2.281)	(−4.004)
IT*Income_squared (ψ)	4.133***	5.919***	3.679**	5.656***
	(3.216)	(3.409)	(2.289)	(3.931)
Income	−11.589	−5.185	−11.121	−4.645
	(−0.949)	(−0.370)	(−0.910)	(−0.334)
Income_squared	0.812	0.384	0.792	0.363
	(1.150)	(0.484)	(1.122)	(0.459)
Oil infl	−0.004	0.015*	−0.004	0.016*
	(−0.427)	(1.808)	(−0.419)	(1.859)
Food infl	0.075***	0.106***	0.075***	0.103***
	(3.138)	(5.420)	(3.112)	(5.333)
Extra controls	No	Yes	No	Yes
Observations	5,857	4,411	5,857	4,411
Countries	184	166	184	166
IT adopters	37	33	37	33
Adj. R^2	0.520	0.436	0.520	0.436

Notes: Fixed-effect estimations. Countries with the average inflation of over 50% are omitted. Constant and country-specific linear trends are not shown for brevity. Coefficients on the extra controls are also not shown in Columns 2 and 4. Extra controls are exchange rate regime dummies, a dummy for a parity change in a pegged regime in the current and previous year, and a dummy for a currency crisis in the current and the previous year. Inflation rate is calculated as a log difference of CPI. Real GDP per capita, PPP-adjusted (Income) is log transformed. *t*-statistics are in parentheses. Clustered standard errors are used to adjust for correlation of error terms within countries.

***$p < .01$; **$p < .05$; *$p < .1$.

with *Income* squared, is given by $\beta + \zeta * Income + \psi * Income^2$. In Column (1), the marginal effect is $371.14 - 78.68 * Income + 4.13 * Income^2$, which indicates that the IT effect is non-monotonic, with the maximum negative effect occurring at $Income = 9.28$, corresponding to 10,721.4 (international) dollars. Likewise, Column (2) implies that with the extra controls, the relation is again non-monotonic with the maximum negative effect occurring at $11,159.0. These values are reasonably close to the mean of per capita real GDP in PPP terms among EMEs ($13,127.1, see Table 2).[15] Columns (3) and (4) show that the results are robust to the use of loose IT adoption dates. Overall, the preceding result that IT is more effective in reducing inflation in EMEs than in LICs appears robust.

5.2 | What makes IT ineffective in LICs unlike EMEs?

5.2.1 | Possible relevance of central banks' instrument independence

Having found robust evidence that IT is less effective in reducing inflation in LICs than in EMEs, we now investigate what may explain this result. To proceed, we first confirm the defining features of IT as a monetary policy framework. An IT central bank, which has price stability as its overriding objective, publicly announces a medium-term numerical target for inflation and commits to it. With the transmission lag in monetary policy, the central bank aims to align expected future inflation with its publicly announced target rate by adjusting monetary instruments today. Once expected inflation is aligned to the target under this forward-looking feedback policy rule, actual inflation can be better anchored to the target.[16]

For this monetary policy framework to be effective, central bank independence (CBI), and *instrument independence* in particular, is arguably required, such that an IT central bank is given full control over setting the policy instrument (see, e.g., Eichengreen, Masson, Savastano, & Sharma, 1999).[17] Otherwise, the central bank's ability to adjust instruments to affect expected future inflation is compromised, and actual inflation is unlikely to be anchored to the target rate over time. To ensure instrument independence, in turn, it is necessary that *fiscal dominance* does not prevail. That is, monetary policy cannot be severely constrained by fiscal requirements to finance public spending through money creation (i.e., seigniorage), the ultimate source of inflation. This implies that for IT to be successful, there should be restrictions limiting a central bank's lending to the government, from not only *de jure* but also *de facto* perspectives.

Here, we investigate if the preceding result on ineffective IT in LICs, unlike EMEs, can be interpreted through the lens of the central bank's instrument independence associated with lending restrictions to the government. To proceed, we first examine the relevance of legal CBI measure proposed by Cukierman, Webb, and Neyapti (1992), particularly the aspect of *restrictions limiting a central bank's lending to the government*.[18] Since their original measure is available only for the period 1980–1989, we use the updated annual data of Garriga (2016), which covers 182 countries over the 1970–2012 period.[19] However, it is well known that *de jure* (legal) independence can differ substantially from *de facto* independence, particularly when governments are able to circumvent the legal delegation of monetary policy. To mitigate this concern, the analysis below follows the argument of Bodea and Hicks (2015) that democracy, as opposed to dictatorships, provides legal CBI with a *de facto bite*. Their argument, based firmly on the previous political economy works such as Broz (2002) and Keefer and Stasavage (2003), is that democratic elements such as the constraints on the decision-making powers of chief executives, checks and balances in the political system, and freedom of speech help ensure the de facto enforcement of the law and also make legislative amendments more difficult.

We test the conjecture that legal restrictions on lending by the central bank to the government, when combined with the degree of democracy, may play a role in the inflation-reducing benefit of IT. The analyses that follow focus on the subsample of LICs and EMEs. Specifically, we estimate the following two alternative models. In both models, as in the previous models to investigate IT effects across income levels, we mitigate possible endogeneity issues by controlling for country fixed effects, possible factors affecting country's IT adoption decision, and country-specific time trends. In the first model, we construct a *composite* variable of legal lending restrictions and a democracy measure as a product of these variables, and then interact it with the IT dummy to consider its role in IT effects:

$$\pi_{i,t} = \alpha\pi_{i,t-1} + \beta IT_{i,t} + \theta Comp_{i,t} * IT_{i,t} + \delta Comp_{i,t} + \sum_{j=1}^{n} \theta_j z_{i,j,t} + \mu_i + \gamma_i t + \epsilon_{i,t}, \tag{4}$$

where $Comp_{i,t}$ $(= l_{i,t} \times d_{i,t})$ is the product of legal lending restrictions, $l_{i,t}$, and the democracy measure, $d_{i,t}$. The alternative model adds the interaction terms of the IT dummy with legal lending restrictions and democracy measures *simultaneously*:

$$\pi_{i,t} = \alpha\pi_{i,t-1} + \beta IT_{i,t} + \zeta l_{i,t} * IT_{i,t} + \eta d_{i,t} * IT_{i,t} + \chi l_{i,t} + \psi d_{i,t} + \sum_{j=1}^{n} \theta_j z_{i,j,t} + \mu_i + \gamma_i t + \epsilon_{i,t}. \tag{5}$$

In Equation (4), our interest is the interaction coefficient of θ, whereas in Equation (5), we examine the joint effect of legal lending constraints and democracy on IT effectiveness, by testing the hypothesis that the coefficients on both of the two interaction terms, ζ and η, are 0.

As noted, we use Garriga (2016)'s update of Cukierman et al. (1992) for legal lending restrictions. As for a democracy measure, we use "democracy/autocracy (democracy for short)" from Polity IV, which measures not only the extent of institutionalized constraints on the decision-making powers of chief executives but also other democratic elements such as the extent to which citizens' political participation is guaranteed.[20] The choice of this variable follows Bodea and Hicks (2015), who investigate the interaction between legal CBI and democracies. To check robustness, we also consider the relevance of factors that may affect the likelihood of fiscally driven inflation through seigniorage. Specifically, we control for the shares of public debt to GDP (as a proxy for public finance condition), total taxes to GDP (a taxable capacity proxy), and private credit by deposit money banks and other financial institutions to GDP (a financial development proxy), and interact each with the IT dummy. The idea is thus to estimate the relevance of central banks' instrument independence while taking account of those factors that may affect the necessity of seigniorage.

Table 6 presents the extract of summary statistics relevant for the following analysis. They are shown separately for LICs and EMEs to see how the variables differ across income levels. The broad CBI index, which ranges between 0 and 1, contains lending restrictions to the government as a component (with the weight of 50%). The average is slightly lower in LICs (0.49) than in EMEs (0.53), suggesting that CBI is somewhat lower in LICs. Focusing on the lending restrictions component, it follows the same pattern, again with a seemingly subtle difference across the income groups. *However*, "democracy," which ranges from 0 to 20, takes a substantially lower average of 10.46 in LICs than 14.63 in EMEs, indicating that EMEs are more democratic. This is still the case when highlighting "executive constraints (constraints for short)," a component of "democracy" that ranges from 1 to 7

TABLE 6 Descriptive statistics for newly considered variables for LICs and EMEs

Variable	Mean	*SD*	Min.	Max.
Low-income countries (LICs)				
CBI index	0.49	0.17	0.13	0.9
Lending restrictions	0.49	0.24	0.02	1
Democracy/autocracy	10.46	6.24	0	20
Executive constraints	3.89	1.98	1	7
Public debt/GDP	61.13	45.5	0	495.2
Tax revenue/GDP	13.61	5.87	2	39.26
Private credit/GDP	19.23	17.47	0.01	137.15
Emerging market economies (EMEs)				
CBI index	0.53	0.22	0.1	0.9
Lending restrictions	0.52	0.29	0.01	1
Democracy/autocracy	14.63	5.85	0	20
Executive constraints	5.33	1.87	1	7
Public debt/GDP	41.29	36.14	1.27	302.19
Tax revenue/GDP	16.59	4.96	1.3	27.85
Private credit/GDP	37.85	29.11	3.63	163.21

Notes: Statistics for CBI index and Lending restrictions (both from Garriga 2016), Democracy/autocracy and Executive constraints (both from Polity IV) correspond to the data used to estimate regressions in Columns 1 to 3 of Table 7. Larger values indicate higher CBI, tighter lending restrictions, higher degree of democracy, and tighter institutional constraints on executives. CBI index is a weighted average of four components: central bank CEO (weight of 0.20), central bank objective (0.15), policy formulation (0.15), and central bank lending (0.50). The final component is lending restrictions in the table. Democracy/autocracy, whose original variable name is Polity2, ranges from 0 to 20, being rescaled from the original range of −10 to 10. The shares in GDP of Public debt (from Mbaye et al., 2018), Tax revenue (from World Bank's WDI), and Private credit by deposit money banks and other financial institutions (from Financial Development and Structure Dataset, cf. Beck et al., 2000) are all in percentage.

with a larger value corresponding to tighter institutional constraints on the decision-making powers of chief executives.[21] Turning to factors that may affect the necessity of money creation, although the data availability is generally lower (cf. Table 9), in LICs, public debt is evidently higher, tax revenue is lower, and private credit in GDP is lower than in EMEs.[22] The implication is that a relatively worse public finance condition, lower taxable capacity, and less-developed financial markets in LICs may necessitate seigniorage more to begin with, potentially compromising central banks' instrument independence.

5.2.2 | Interacting with composite of lending restrictions and democracy

Table 7 presents estimation results of Equation (4), highlighting the role of lending restrictions in IT effects on inflation within LICs and EMEs. Possible factors affecting the necessity of seigniorage are considered here. Only results using strict IT adoption dates are shown for brevity. Columns (1)–(3) ([4]–[6]) are results without (with) extra controls such as exchange rate regime dummies. In Column (1), the IT dummy is interacted only with the legal restrictions limiting a central bank's lending to the government. Although the sign of the interaction coefficient, ζ, is negative as expected, it is not statistically significant. In Column (2) we consider instead the role of a composite (i.e., product) of lending restrictions and "democracy" called "Comp1," to incorporate the de facto element

TABLE 7 Lending restrictions and IT effects within LICs and EMEs: Using composite of lending restrictions and democracy (cf. Equation (4))

Adopt dates	Strict					
	(1)	(2)	(3)	(4)	(5)	(6)
*Dependent variable: 100*Δlogcpi*						
L.Infl	0.501***	0.506***	0.505***	0.423***	0.426***	0.425***
	(13.328)	(13.250)	(13.238)	(7.339)	(7.427)	(7.376)
IT (β)	1.998	5.358	5.928	3.638	3.735	4.911
	(0.506)	(1.382)	(1.493)	(1.133)	(1.082)	(1.432)
IT*Lending restrictions (ζ)	−6.213			−11.672**		
	(−1.197)			(−2.484)		
IT*Comp1 (θ)		−0.610**			−0.667**	
		(−2.196)			(−2.352)	
IT*Comp2 (θ)			−1.885**			−2.164***
			(−2.333)			(−2.713)
Lending restrictions	−10.701**			−5.701		
	(−2.527)			(−1.625)		
Comp1		−0.131			−0.015	
		(−0.985)			(−0.108)	
Comp2			−0.623			−0.278
			(−1.558)			(−0.674)
Oil infl	0.011	0.010	0.011	0.021	0.020	0.020
	(0.701)	(0.638)	(0.651)	(1.434)	(1.380)	(1.394)
Food infl	0.120***	0.123***	0.122***	0.124***	0.126***	0.125***
	(2.707)	(2.796)	(2.775)	(3.666)	(3.742)	(3.718)
Extra controls	No	No	No	Yes	Yes	Yes
Observations	2,711	2,711	2,711	2,554	2,554	2,554
Countries	108	108	108	103	103	103
IT adopters	20	20	20	20	20	20
Adj. R^2	0.516	0.514	0.515	0.439	0.439	0.439

Notes: Based on the subsample of LICs and EMEs. Strict IT adoption dates are used. Countries with the average inflation of over 50% are omitted. Comp1 (Comp2) is the product of lending restrictions and "democracy" ("constraints"). Constant and country-specific linear trends are not shown for brevity. Coefficients on the extra controls are also not shown in Columns 4–6. They are exchange rate regime dummies, a dummy for a parity change in a pegged regime in the current and previous year, and a dummy for a currency crisis in the current and the previous year. Inflation rate is calculated as a log difference of CPI. *t*-statistics are in parentheses. Clustered standard errors are used to adjust for correlation of error terms within countries.

***$p < .01$; **$p < .05$; *$p < .1$.

of restrictions. When "Comp1" is interacted with the IT dummy, the interaction coefficient, θ, is negative and significant, suggesting that the tighter effective restrictions are associated with more effective IT. Column (3) uses "constraints" to create "Comp2," to highlight the particular aspect of democracy that constraints decision making powers of executives. The interaction coefficient is still significantly negative. Turning to models with extra controls, in Columns (4), the interaction between

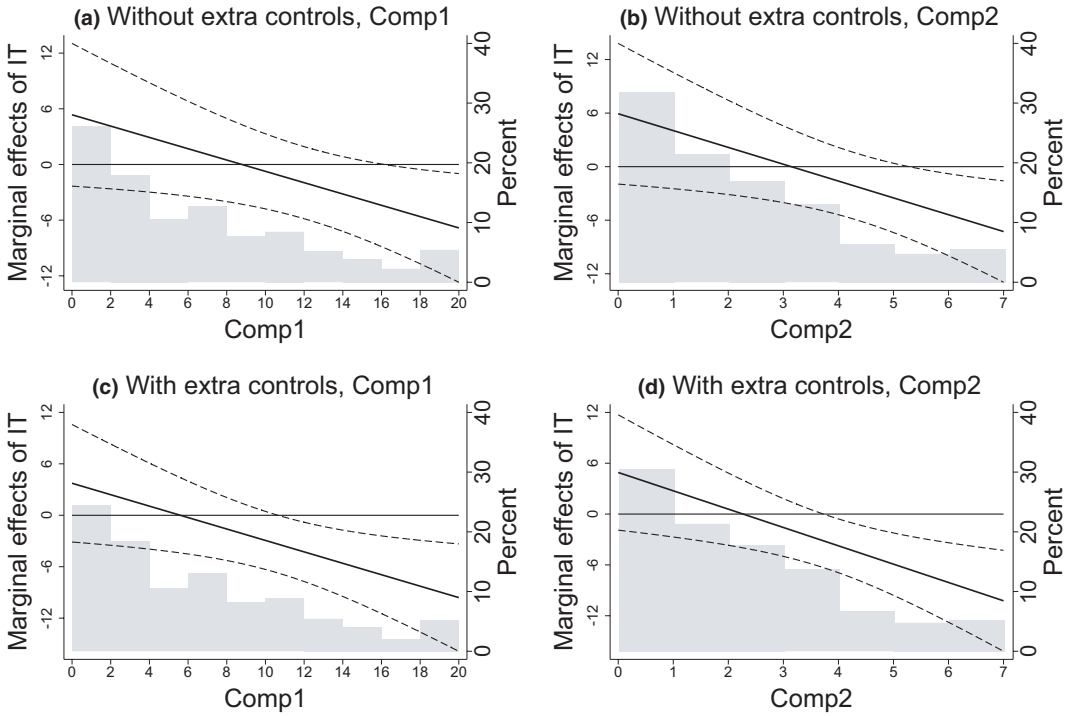

FIGURE 1 Role of lending restrictions in IT effects within LICs and EMEs. A marginal effect of IT with the 95% confidence interval is shown, supplemented by the histogram of the composite lending restriction variable. "Comp1" ("Comp2") is a composite of lending restrictions and "democracy" ("constraints"). Marginal effects (histogram) is plotted against left (right) *y*-axis. Subfigures (a) to (d) correspond to Columns (2), (3), (5), and (6) of Table 7, respectively. *Source:* Authors' calculations

the IT dummy and legal lending restrictions is negative and significant. Columns (5) and (6) show that results considering de facto perspectives are robust to controlling for additional variables.

Next, to visualize the results, Figure 1 plots marginal effects of IT together with the 95% confidence interval for different levels of "Comp1" and "Comp2." Figure 1a–d corresponds to Columns (2), (3), (5), and (6) of Table 7, respectively. The effects are plotted against the left *y*-axis. Each part figure is supplemented by a histogram indicating the distribution of the composite variable, plotted against the right *y*-axis. In all the cases, IT has a significant inflation-reducing effect only when the composite variable shows relatively high values, that is, when lending restrictions are effectively strong. Further, results with extra controls (Figure 1c and d) reveal that the range of effective lending restrictions corresponding to a significant IT effect is broader. Results are robust to the use of loose IT adoption dates (see Table S1 and Figure S1 in Supporting Information).

5.2.3 | Interacting with lending restrictions and democracy simultaneously

Table 8 presents estimation results of Equation (5). Again, only results using strict IT adoption dates are shown for brevity. Columns (1) and (2) ([3] and [4]) are results without (with) extra controls. In Column (1), IT dummy is interacted both with the legal restrictions limiting a central bank's lending to the government and "democracy." While both interaction coefficients of ζ and η are negative, only the latter is significant. Nonetheless, despite the potential multicollinearity problem between lending

TABLE 8 Lending restrictions and IT effects within LICs and EMEs: Testing joint significance of IT interactions with lending restrictions and democracy (cf. Equation (5))

Adopt dates	**Strict**			
	(1)	**(2)**	**(3)**	**(4)**
*Dependent variable: 100**Δ*logcpi*				
L.Infl	0.496***	0.498***	0.419***	0.421***
	(13.214)	(13.260)	(7.202)	(7.242)
IT (β)	19.473**	24.997**	13.721*	20.233**
	(2.231)	(2.582)	(1.853)	(2.457)
IT*Lending restrictions (ζ)	−3.764	−4.550	−10.158**	−10.319***
	(−0.737)	(−1.055)	(−2.196)	(−2.665)
IT*Democracy (η)	−0.990**		−0.562	
	(−2.106)		(−1.625)	
IT*Constraints (η)		−3.662**		−2.675**
		(−2.388)		(−2.355)
Lending restrictions	−11.978***	−11.587***	−6.832*	−6.323*
	(−2.772)	(−2.695)	(−1.827)	(−1.756)
Democracy	0.487***		0.361**	
	(3.116)		(2.526)	
Constraints		1.052**		0.709*
		(2.335)		(1.744)
Oil infl	0.009	0.011	0.019	0.020
	(0.579)	(0.650)	(1.342)	(1.403)
Food infl	0.127***	0.124***	0.128***	0.126***
	(2.889)	(2.790)	(3.853)	(3.760)
Extra controls	No	No	Yes	Yes
Independence joint, *p*-value	0.0615	0.0279	0.0445	0.0115
Observations	2,711	2,711	2,554	2,554
Countries	108	108	103	103
IT adopters	20	20	20	20
Adj. R^2	0.518	0.517	0.441	0.440

Notes: Based on the subsample of LICs and EMEs. Strict IT adoption dates are used. Countries with the average inflation of over 50% are omitted. Constant and country-specific linear trends are not shown for brevity. Coefficients on the extra controls are also not shown in Columns 3 and 4. They are exchange rate regime dummies, a dummy for a parity change in a pegged regime in the current and previous year, and a dummy for a currency crisis in the current and the previous year. Independence joint, *p*-value is the *p*-value of testing the joint significance of ζ and η. Inflation rate is calculated as a log difference of CPI. *t*-statistics are in parentheses. Clustered standard errors are used to adjust for correlation of error terms within countries.

***$p < .01$; **$p < .05$; *$p < .1$.

restrictions and democracy (which are positively correlated with each other), coefficients on their interactions are *jointly* significant with the *p*-value of 0.062 (see Independence joint, *p*-value), suggesting that lending restrictions, when the de facto element is considered, increase the effectiveness of IT in reducing inflation rates. Column (2) uses instead "constraints," yielding the even lower *p*-value of the joint significance test (0.028). In Columns (3) and (4), where extra controls are added, the

TABLE 9 Controlling for other factors affecting fiscally driven inflation: Based on Equation (4)

Adopt dates	**Strict**					
Other factors considered	**Public debt**		**Tax revenue**		**Private credit**	
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
*Dependent variable: 100*Δlogcpi*						
L.infl	0.453***	0.371***	0.493***	0.468***	0.511***	0.433***
	(6.824)	(4.688)	(9.391)	(10.722)	(15.116)	(9.418)
IT (β)	5.551	6.081	22.622**	22.422**	12.743	4.488
	(0.941)	(1.064)	(2.308)	(2.548)	(1.432)	(0.497)
IT*Comp2 (θ)	−1.614	−1.734*	−1.796	−2.059*	−2.040**	−1.586*
	(−1.566)	(−1.682)	(−1.521)	(−1.896)	(−2.239)	(−1.842)
IT*Public debt	0.016	−0.029				
	(0.169)	(−0.277)				
IT*Tax revenue			−1.019**	−1.010**		
			(−2.279)	(−2.613)		
IT*Private credit (log)					−1.937	−0.459
					(−1.112)	(−0.247)
Comp2	−0.144	−0.052	−0.084	−0.235	−0.465	−0.343
	(−0.382)	(−0.127)	(−0.170)	(−0.507)	(−1.185)	(−0.894)
Public debt	0.073**	0.059**				
	(2.441)	(2.071)				
Tax revenue			1.650**	1.138*		
			(2.577)	(1.992)		
Private credit (log)					0.390	−2.733
					(0.150)	(−1.246)
Oil infl	0.007	0.010	0.031	0.042	0.014	0.019
	(0.446)	(0.625)	(0.967)	(1.241)	(0.961)	(1.318)
Food infl	0.103**	0.125***	0.040	0.068	0.100***	0.119***
	(2.560)	(3.671)	(0.519)	(0.872)	(2.727)	(4.056)
Extra controls	No	Yes	No	Yes	No	Yes
Observations	2,303	2,218	1,143	1,081	2,599	2,503
Countries	95	93	57	55	105	103
IT adopters	17	17	16	16	20	20
Adj. R^2	0.434	0.388	0.513	0.496	0.524	0.471

Notes: Strict IT adoption dates are used. "Comp2" is a composite of lending restrictions and "constraints." Public debt, Tax revenue, and Private credit are all shares in GDP, all in percentage. Private credit is log transformed. For further relevant information, see Notes for Table 7.

interaction between the IT dummy and lending restrictions, ζ, is negative and significant on its own. Although in Column (3), the coefficient of the interaction with "democracy" loses significance, the joint significance of the two interaction coefficients still remains. In Column (4), the interaction term

with "constraints" is individually significant, and the joint effect is also significant. Results are robust to the use of loose IT adoption dates (see Table S2 in Supporting Information).

5.2.4 | Incorporating factors affecting the necessity of money creation

For robustness, we analyze the role of lending restrictions in IT effects considering factors that may affect the necessity of money creation as a government's revenue source. The first factor to consider is the ratio of public debt to GDP as an indicator of public finance conditions. This may be relevant since higher debt generally requires higher interest payments, which, in turn, potentially necessitates seigniorage. The second and third factors are total tax to GDP and private credit to GDP ratios as a proxy for taxable capacity and financial development, respectively. Because seigniorage is essentially an alternative to raising taxes or borrowing from the public, lower taxable capacity and a shallow financial market that absorbs little public debt may prompt the government to rely more on seigniorage. Remember from Table 6 that in LICs public debt (total tax, private credit) is generally higher (lower, lower) than in EMEs, implying that fiscally driven inflationary pressure may be stronger in LICs. Thus, these factors may also help explain the result on the role of income levels in IT effects.

Table 9 presents estimation results. It focuses on strict IT adoption dates and uses the composite of legal lending restrictions and a democracy variable (cf. Equation (4)). For brevity, "constraints" is used to create the composite, that is, "Comp2." Public debt, tax revenue, and private credit (all relative to GDP) are controlled for separately, together with the interaction term with the IT dummy. Results are shown with and without extra controls. In all cases, the limited availability of these variables reduces the number of observations (particularly when tax revenue is considered). In Columns (1) and (2) (without and with extra controls, respectively), the coefficients of interaction terms of IT dummy with "Comp2" are still negative. Although it is not significant in Column (1), the coefficient and robust t-statistics are similar to the ones in Column (2). The interaction between the IT dummy and the public debt to GDP ratio is actually insignificant.[23] Columns (3) and (4) turn to the share of tax revenue in GDP as a proxy for taxable capacity. Although the scarcity of tax data substantially reduces the sample, lending restrictions still appear to matter for IT effects. Further, the interaction between the IT dummy and tax revenue is significantly negative, implying that a larger taxable capacity may help improve the IT effects. Columns (5) and (6) examine the role of the (log transformed) share of private credit in GDP as a financial development proxy. While lending restrictions still affect IT effects, private credit does not, albeit the coefficient is negative as expected. This may be because the variable does not reflect enough the capacity of financial markets to absorb public debt. Table S3 in the Supporting Information shows results using "democracy" to create the composite variable, that is, "Comp1." Results on the role of the composite in IT effects are similar, though somewhat weaker.

5.2.5 | Summary of results and implications

Overall, the aforementioned results indicate that tighter restrictions limiting a central bank's lending to the government, particularly when the de facto perspective is considered, are associated with IT being more effective in reducing inflation. These results are robust to alternative ways of interacting the IT dummy with the composite of legal lending restrictions and a democracy measure, and interacting with these variables simultaneously. The results are also largely robust to controlling for various factors that may affect the degree to which a country may need seigniorage. The key implications are that since, in LICs, lending restrictions tend to be effectively looser (see Table 6) and thus instrument

independence is weaker than in EMEs, these factors may be a driving factor of the result that IT is less effective in LICs than in EMEs.

6 | CONCLUDING REMARKS

The standard result in previous research is that inflation targeting has made little difference to the inflation rate in the advanced countries, but has significantly reduced inflation in non-advanced countries. Because LICs have been slower to adopt inflation targeting than EMEs, the samples of non-advanced countries used in previous research have contained very few LICs. Now that more time has passed, it is possible to consider the effectiveness of IT in LICs separately from EMEs. Our basic result is that IT has been far less effective in LICs than in EMEs, highlighting the presence of significant heterogeneity in IT effects within non-advanced countries.

We have presented a story as to why this should be the case. Specifically, we have examined the role of central banks' instrument independence in the effectiveness of IT in a sample of LICs and EMEs. Instrument independence, which can be argued essential for the IT central bank to align future inflation expectations to the published target rate, is compromised when restrictions limiting a central bank's lending to the government are not strong enough. Given that lending restrictions are effectively weaker in LICs than in EMEs, our results indicate that the lower degree of instrument independence in LICs can help explain the result that in those countries IT is not effective in reducing inflation rates. This is still largely true even when we control for the factors that affect the degree to which the government needs seigniorage as a revenue source.

In the estimation of IT effects, there is always a concern about the endogeneity of IT, possibly caused by omitted variables. The use of country fixed effects mitigates the problem in general. However, we further control for various factors that possibly affect a country's decision to adopt IT, to alleviate the estimation bias due to the self-selection problem. Thus, given that (a) the frequently used alternative of Propensity Scoring Matching is not free from problems either (as indicated earlier), and (b) fixed effects estimators give us a flexibility such as the use of country-specific time trends to mitigate "regression-to-the-mean," we believe that our decision to use fixed effects methods can be defended.

One possible avenue for future research is to examine empirically the roles of other factors for successful IT performance. For instance, Gemayel et al. (2011) point out that a weak monetary transmission mechanism may reduce the effectiveness of IT. Acknowledging this, it may be fruitful to consider the relevance of factors such as insufficient understanding of the transmission mechanism and impaired transmission channels. For example, if a bank lending channel, which highlights the special nature of bank credit in the financial structure, is impaired, a monetary tightening may not reduce bank lending, making it more difficult for IT to work in general.

ACKNOWLEDGMENTS

We thank Christopher Bowdler, Michael Ehrmann, Kevin Lee, Oliver Morrissey, Assaf Razin, and an anonymous referee for their comments. Any remaining errors are our own responsibility.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available in "figshare" at https://figshare.com/articles/ITdataset_dta/8859152

ORCID

Atsuyoshi Morozumi https://orcid.org/0000-0002-7081-9850
Michael Bleaney https://orcid.org/0000-0003-0588-1700

ENDNOTES

[1] For example, Batini and Laxton (2006), Brito and Bystedt (2010), Gonçalves and Salles (2008), and Lin and Ye (2009) show that IT is effective in reducing inflation in EMEs, whereas Ball and Sheridan (2004), Ball (2010), von Hagen and Neumann (2002), Lin and Ye (2007), and Willard (2012) find that IT has an insignificant effect on inflation in HICs.

[2] Per capita real GDP in PPP terms is available from IMF's World Economic Outlook over the sample period.

[3] Samarina and De Haan (2014) show that in the case of the full sample including both OECD and non-OECD countries, factors such as the level of government debt and the degree of financial development also affect the probability of a country adopting IT as a monetary policy framework. Other early contributions to the choice of IT adoption include Hu (2006), Gonçalves and Carvalho (2009), and Lucotte (2010).

[4] PSM has its own weaknesses, including the following: (a) it is more open to omitted variable bias than panel regressions, because it does not control for other determinants of inflation that may affect the result but are not related to the IT adoption decision and (b) it cannot control for unobserved country fixed effects.

[5] Even when we include time dummies (to capture global variations in inflation in general) instead, key results on the effectiveness of IT in LICs and EMEs stay the same.

[6] In interaction models with exclusive discrete dummies such as this, it is generally required to include interaction dummy variables as separate explanatory variables (except for one) to differentiate the intercepts across categories. However, in our panel regressions with country fixed effects, those time-invariant dummies are collinear with the fixed effects, making it not possible to add those dummies as an explanatory variable. This is a caveat of this model. However, we check robustness of the result using an alternative model below.

[7] As an alternative way of addressing disproportionately large inflation rates affecting results, we also considered rescaling inflation variable so that the data become less skewed. Specifically, we rescaled inflation using the transformation: $y = 100*x/(100+x)$, where x is inflation (in %). Following this transformation, when x is low, y is very nearly equal to x, while as x tends to infinity, y tends to 100, and differences at the top end do not make too much difference, making the data less skewed (e.g., if $x = 50$, $y = 33.33$; if $x = 100$, $y = 50$; and if $x = 300$, $y = 75$). We confirmed that using this alternative method does not change the key messages of this paper, indicating the robustness to different ways of dealing with the hyper-inflation episodes. Results using this alternative method are available from the authors upon request.

[8] Peru and Brazil (both IT adopters) are excluded from the reference data set due to the high average inflation rates (cf. Table 1).

[9] In our data set, correlation of inflation data (log difference of CPI) between WDI and WEO is 99%.

[10] An alternative is Reinhart and Rogoff (2004), which tends to under-record floats, as discussed in Bleaney and Tian (2017).

[11] Specifically, the authors define that this takes 1 when the EMPI is in the upper quartile of their data set (spanning 1980–2012).

[12] World oil price inflation rate is calculated as a log difference (times 100) using world crude oil price index from IMF's International Financial Statistics (IFS), whereas world food price is a log difference (times 100) using world food price index from IMF's IFS.

[13] Exchange rate variables (regime dummies and a dummy for a parity change) are available from 1980 through 2014 (inclusive), and a currency crisis dummy is available from 1980 through 2012.

[14] To note, IT being ineffective in reducing inflation level in HICs unlike in EMEs is firmly in line with the aforementioned previous studies. One possible explanation, pointed out by Walsh (2009), is related to the so-called good luck hypothesis of the Great Moderation, the substantial fall in macroeconomic volatility advanced economies had experienced since the mid-1980s through 2007, the start of the Global Financial Crisis (see, for example, Galí and Gambetti

(2009)). That is, if the greater macroeconomic stability was primarily due to smaller shocks striking advanced economies during those two decades (i.e., the good luck hypothesis), it may not be easy to identify the marginal contribution of good policies, including the one of IT. In such a benign economic environment, inflation performance might have been satisfactory regardless of the type of a monetary policy regime.

[15] The maximum negative IT effects at *Income* = 9.28 and *Income* = 9.32 in Columns (1) and (2) are −3.34 and −6.07.

[16] Regarding further explanations on defining characteristics of IT relative to other monetary policy strategies, see, for example, Haldane (1998) and Batini and Laxton (2006).

[17] This is a separate independence concept from goal independence that gives the central bank the ability to set macroeconomic objectives.

[18] The legal CBI index covers four aspects of a central bank's independence: (a) whether a central bank (CB)'s management is protected from political pressure by secure tenure and independent appointment, (b) whether the government can participate in or overturn the CB's policy decisions, (c) whether the legal mandate of the CB sets a clear objective for monetary policy, and (d) whether legal restrictions limit a CB's lending to the government. Our focus is on the last aspect.

[19] Bodea and Hicks (2015) also provide the CBI index at a yearly basis, covering 78 countries between 1973 and 2008, and the authors provide a further update (available on the website of Raymond Hicks), covering 144 countries for the years 1972 and 2015. However, the decomposition of the index is not available unlike Garriga (2016), preventing us from isolating the role of legal restrictions on a CB's lending to the government.

[20] The variable name in Polity IV is "POLITY2."

[21] In Polity IV, the variable name is "XCONST."

[22] The share of public debt (central government debt) in GDP is from Mbaye, Moreno-Badia, and Chae (2018). The share of tax revenue (compulsory transfer to the central government for public purposes) in GDP is from World Bank's WDI. The share of private credit by deposit money banks and other financial institutions in GDP is from Financial Development and Structure Dataset (Beck, Demirgüç-Kunt, & Levine, 2000).

[23] This insignificant result persists even when we used budget deficits (based on IMF's Government Finance Statistics) as an alternative public finance indicator. Results are available from authors upon request.

REFERENCES

Ball, L. M. (2010). *The performance of alternative monetary regimes* (NBER Working Paper No. 16124). Cambridge, MA: National Bureau of Economic Research.

Ball, L. M., & Sheridan, N. (2004). Does inflation targeting matter? In B. S. Bernanke & M. Woodford (Eds.), *The inflation-targeting debate* (pp. 249–282). Chicago, IL: University of Chicago Press.

Batini, N., & Laxton, D. (2006). Under what conditions can inflation targeting be adopted? *The experience of emerging markets* (Central Bank of Chile Working Papers No. 406). Santiago: Central Bank of Chile.

Beck, T., Demirgüç-Kunt, A., & Levine, R. (2000). A new database on financial development and structure. *World Bank Economic Review*, *14*, 597–605.

Bleaney, M., Saxena, S., & Yin, L. (2018). Exchange rate regimes, devaluations and growth collapses. *Journal of Macroeconomics*, *57*, 15–25.

Bleaney, M., & Tian, M. (2017). Measuring exchange rate flexibility by regression methods. *Oxford Economic Papers*, *69*, 301–319.

Bodea, C., & Hicks, R. (2015). Price stability and central bank independence: Discipline, credibility, and democratic institutions. *International Organization*, *69*, 35–61.

Brito, R. D., & Bystedt, B. (2010). Inflation targeting in emerging economies: Panel evidence. *Journal of Development Economics*, *91*, 198–210.

Broz, J. L. (2002). Political system transparency and monetary commitment regimes. *International Organization*, *56*, 861–887.

Cukierman, A., Webb, S. B., & Neyapti, B. (1992). Measuring the independence of central banks and its effect on policy outcomes. *World Bank Economic Review*, *6*, 353–398.

de Mendonça, H. F., & de Guimarães e Souza, G. J. (2012). Is inflation targeting a good remedy to control inflation? *Journal of Development Economics*, *98*, 178–191.

Eichengreen, B., Masson, P. R., Savastano, M. A., & Sharma, S. (1999). *Transition strategies and nominal anchors on the road to greater exchange-rate flexibility*. (Essays in International Finance, No 213). Princeton, NJ: International Finance Section, Department of Economics, Princeton University.

Galí, J., & Gambetti, L. (2009). On the Sources of the Great Moderation. *American Economic Journal: Macroeconomics*, *1*, 26–57.

Garriga, A. C. (2016). Central bank independence in the world. A new dataset. *International Interactions*, *42*, 849–868.

Gemayel, E. R., Jahan, S., & Peter, A. (2011). *What can low-income countries expect from adoption inflation targeting?* (IMF, Working Paper No. 11/276). Washington, DC: International Monetary Fund.

Gonçalves, C. E. S., & Carvalho, A. (2009). Inflation targeting matters: Evidence from OECD economies' sacrifice ratios. *Journal of Money, Credit and Banking*, *41*, 233–243.

Gonçalves, C. E. S., & Salles, J. M. (2008). Inflation targeting in emerging economies: What do the data say? *Journal of Development Economics*, *85*, 312–318.

Haldane, A. G. (1998). On inflation targeting in the United Kingdom. *Scottish Journal of Political Economy*, *45*, 1–32.

Hu, Y. (2006). The choice of inflation targeting—An empirical investigation. *International Economics and Economic Policy*, *3*, 27–42.

Keefer, P., & Stasavage, D. (2003). The limits of delegation: Veto players, central bank independence, and the credibility of monetary policy. *The American Political Science Review*, *97*, 407–423.

Lin, S., & Ye, H. (2007). Does inflation targeting really make a difference? Evaluating the treatment effect of inflation targeting in seven industrial countries. *Journal of Monetary Economics*, *54*, 2521–2533.

Lin, S., & Ye, H. (2009). Does inflation targeting make a difference in developing countries? *Journal of Development Economics*, *89*, 118–123.

Lucotte, Y. (2010). *The choice of adopting inflation targeting in emerging economies: Do domestic institutions matter?* (MPRA Paper No. 27118). Munich: Munich Personal RePEc Archive.

Mbaye, S., Moreno-Badia, M., & Chae, K. (2018). *Global debt database: Methodology and sources* (IMF Working Paper No. 18/111). Washington, DC: International Monetary Fund.

Mishkin, F. S., & Schmidt-Hebbel, K. (2007). *Does inflation targeting make a difference?* (NBER Working Paper No. 12876). Cambridge, MA: National Bureau of Economic Research.

Reinhart, C. M., & Rogoff, K. S. (2004). The modern history of exchange rate arrangements: A reinterpretation. *Quarterly Journal of Economics*, *119*, 1–48.

Samarina, A., & De Haan, J. (2014). Right on target: Exploring the factors leading to inflation targeting adoption. *Contemporary Economic Policy*, *32*, 372–389.

Samarina, A., Terpstra, M., & De Haan, J. (2014). Inflation targeting and inflation performance: A comparative analysis. *Applied Economics*, *46*, 41–56.

von Hagen, J., & Neumann, M. J. (2002). Does inflation targeting matter?. *Federal Reserve Bank of St. Louis Review*, 127–148.

Walsh, C. E. (2009). Inflation targeting: what have we learned? *International Finance*, *12*, 195–233.

Willard, L. B. (2012). Does inflation targeting matter? A reassessment. *Applied Economics*, *44*, 2231–2244.

SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

How to cite this article: Morozumi A, Bleaney M, Mumuni Z. Inflation targeting in low-income countries: Does IT work? *Rev Dev Econ*. 2020;24:1529–1550. https://doi.org/10.1111/rode.12690