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

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Abstract

Previous research on inflation targeting (IT) has focused on high-income countries (HICs) and emerging market economies (EMEs). Only recently has enough data accumulated for the performance of IT in low-income countries (LICs) to be assessed. We show that IT has not so far been effective in reducing inflation in LICs, unlike in EMEs. Weak institutions, a typical feature in LICs, help explain this result, particularly under floating exchange rate regimes. Our interpretation is that poor institutions, leaving fiscal policy unconstrained, impair central banks' ability to conduct monetary policy in a way consistent with IT.

Keywords: Inflation targeting, Low-income countries, Institutions
JEL: E52, E58, O23

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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). 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 using inflation expectations as an intermediate target. Existing empirical studies suggest that IT has significantly reduced inflation in EMEs, but has made little difference in HICs. Only in the twenty-first century have low-income countries (LICs) begun to adopt IT. To our knowledge this is the first study to analyze the performance of IT in LICs *as a separate group*.[1] This study adds to the literature by showing that IT effects in LICs are significantly different from in EMEs, and by providing possible explanations behind these heterogeneous effects within non-HICs.

Specifically, using an updated dataset covering up to 182 countries for the 1980-2016 period, we show that IT is not effective in reducing inflation in LICs, unlike in EMEs. With IT being less effective in HICs than in EMEs, the relation between the effectiveness of IT and income levels is non-monotonic. To understand why IT effects are different between LICs and EMEs, we examine the role of institutional quality. In particular, acknowledging that institutions in LICs often fail to make governments accountable to the public, we test if government accountability plays a role in the effect of IT on inflation rates. We find that, within a pooled sample of LICs and EMEs, accountability is negatively associated with the effectiveness of IT. This is the case particularly when exchange rate flexibility is taken into account as a prerequisite for successful IT framework. Our interpretation is that low government accountability tends to be associated with fiscal dominance, i.e., the subordination of monetary policy to fiscal requirements, and impairs central banks' ability to conduct monetary policy in a way consistent with IT.

The rest of the paper is organized as follows. Section 2 provides a background for this study. Section 3 motivates why it is interesting to study IT effects in LICs, and presents

[1] How exactly we define LICs is clarified below.

testable hypotheses. Section 4 explains the empirical methodology to address the hypotheses. Section 5 describes the data. Section 6 presents the results. Section 7 offers discussion and concluding remarks.

2 Background

The theoretical foundation of inflation targeting is rooted in the literature on commitment and discretion in monetary policy propounded by Kydland and Prescott (1977) and Barro and Gordon (1983). The theoretical literature has proposed a number of ways to deal with the inflation bias, which can be classified broadly into: reputational approaches (Barro and Gordon (1983)), delegation to a conservative central banker (Rogoff (1985)), the optimal contracts approach (Walsh (1995)) and inflation targeting (Svensson (1997)). In line with Svensson (1997), the empirical literature has tested whether inflation is significantly lower under IT than without it. This section highlights that little is known about whether IT works in LICs.

Table 1 lists the countries with IT experiences, together with their income classes and the adoption dates. We ensure that our income classification reflects income levels over the sample period. Specifically, we classify countries through the following three steps. First, for *each* of the years when PPP-adjusted GDP per capita are available (1990-2016), countries are sorted into four groups: the highest 25th percentile, 25th-50th, 50th-75th and 75th-100th.[2] Second, counting the number of times each country appears in those four groups over the period, we classify countries that appear in the top 25th percentile most frequently as high income countries; likewise countries appearing in the 25th-50th (50th-75th, 75th-100th) most frequently as upper-middle (lower-middle, low) income countries. Last, we reclassify the four groups into three, by combining the bottom two groups, resulting in HICs, EMEs, and LICs.[3] This yields 11 (14, 14) IT adopting countries in LICs (EMEs, HICs). For information, the

[2]PPP-adjusted GDP per capita is from World Bank's World Development Indicator (WDI).

[3]We take this measure, to ensure that we have sufficient number of IT adopters in LICs.

table 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 give the year of IT adoption for each country. Following the literature, we consider two alternative dates: strict and loose adoption dates. The difference between these years is that the former corresponds to the time when countries simply announce inflation targets without strong commitment, possibly using other nominal anchors at the same time. The latter, 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 difference between the alternative years is substantial (more than 5 years).

The main message of Table 1 is that IT is a *recent* phenomenon particularly in LICs. For example, according to strict IT adoption years, 9 out of 11 LICs adopted IT after 2005 (inclusive), and 5 adopted IT after 2009. Thus, samples used in many of the previous works omit IT-adopting LICs. To illustrate, Table 2 lists several empirical studies on IT, divided into three categories according to their country coverage: both advanced countries (roughly our HICs) and non-advanced countries (EMEs and LICs); only advanced countries; only non-advanced countries. The recurrent finding is that IT helps reduce inflation in non-advanced economies, but not in advanced economies. Importantly, however, because the time periods covered by many of those studies end in the mid-2000s, little is known about the effects of IT in LICs as a separate group. This paper aims to fill in this gap.[4]

[4]To note, a few works include LICs in their sample. First, Samarina et al. (2014), using data till 2011, cover a few IT adopters from LICs. However, they highlight the difference in IT effects between advanced economies and others, and do not consider the possible heterogeneity in the effects within non-advanced economies. Next, Gemayel et al. (2011) highlight IT in LICs, defined as countries eligible for the Poverty Reduction and Growth Trust (PGRT), which include Albania, Armenia, and Ghana (we also categorize these countries as LICs). However, due to the fact their data covers only till 2008, they use IT-adopting EMEs as a proxy for IT-adopting LICs, while acknowledging this approximation as one of caveats of their analysis (page 17 of their paper). Last, Bleaney and Francisco (2016) use a more updated dataset till 2013, but their focus is Sub-Saharan African countries, thus missing out a number of IT adopting 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 classifies income based on PPP adjusted GDP per capita (from World Development Indicator, WDI) over the 1990-2016 period. World Bank's 2016 income classification is based on income levels in 2015. 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.

Table 2: Previous empirical studies

Study	Time period	Method	Results
Both advanced and non-advanced countries			
Mishkin and Schmidt-Hebbel (2007)	1989-2004	DiD, Panel	No effect for advanced Negative for non-advanced
Vega and Winkelried (2005)	1990-2004	PSM	Negative
de Mendonça and de Guimarães e Souza (2012)	1990-2007	PSM	No effect for advanced Negative for non-advanced
Samarina et al. (2014)	1985-2011	DiD, PSM	No effect for advanced Negative for non-advanced
Advanced countries only			
von Hagen and Neumann (2002)	1978-2001	DiD	Negative
Ball and Sheridan (2004)	1985-2001	DiD	No effect
Lin and Ye (2007)	1985-1999	PSM	No effect
Ball (2010)	1985-2007	DiD	Very small effect
Willard (2012)	1985-2002	Panel	No effect
Non-advanced countries only			
Batini and Laxton (2006)	1985-2004	DiD	Negative
Gonçalves and Salles (2008)	1980-2005	DiD	Negative
Lin and Ye (2009)	1985-2004	PSM	Negative
Brito and Bystedt (2010)	1980-2006	Panel	Negative
Gemayel et al. (2011)	1990-2008	DiD, Panel	Negative
Bleaney and Francisco (2016)	1996-2013	Panel	No effect (Sub-Saharan Africa)

Notes: A negative effect on inflation means that IT implementation significantly reduces the inflation level. Did (PSM) stands for differences-in-differences (propensity score matching).

3 Hypotheses

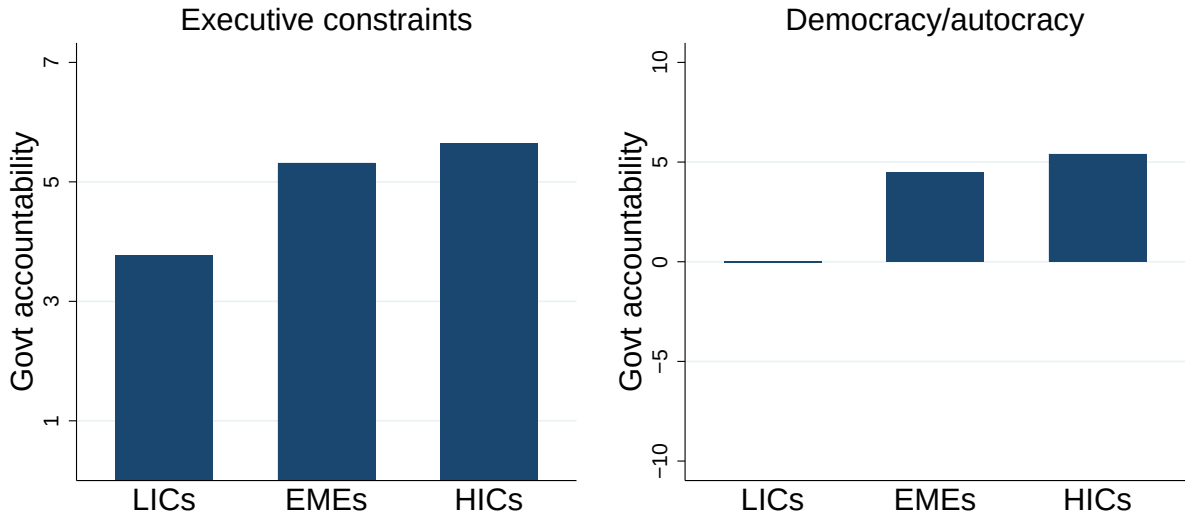
Why is it interesting to examine the effect of IT on inflation in LIC as a separate group? Indeed, if IT performances in LICs and EMEs are alike, such a study may not be necessary, because as seen in Table 2 the previous studies already suggest that IT helps reduce the level of inflation in non-advanced countries. However, in what follows, we indicate that LICs and EMEs are not necessarily alike, and argue why IT performances might be different between them. We then clarify hypotheses which we test in the following sections.

First, the relevant fact is that the quality of institutions is generally lower in LICs than EMEs.[5] Figure 1 compares the quality of institutions between LICs and EMEs, alongside

[5]We define institutions generally as the rules and organizations of a society which affect economic incentives of different agents and thus shape interactions between them. In particular, we highlight institutions

HICs, using the measures of "executive constraints" and "democracy/autocracy" (both from Polity IV, Marshall et al. (2013)). Each bar represents the cross-country average of a country-level average of the corresponding variable over the sample period (1980-2016) for each income group. As elaborated below, these variables essentially reflect the degree to which a government is constrained and made accountable to the general public. With the larger value corresponding to stronger institutions, the message is that a government in LICs is generally less accountable to the public than in EMEs.

Figure 1: Institutional quality in different income groups



Notes: Executive constraints (Democracy/autocracy) ranges between 1 and 7 (−10 and 10).
Each bar represents an average of country−level averages across LICs, EMEs, and HICs over the sample period.
Larger values correspond to stronger institutions.
Source: Authors' calculations

Next, why may the degree of government accountability be relevant for IT performance? We argue that this is because an unaccountable government may be associated with fiscal dominance, defined as the subordination of monetary policy to fiscal requirements. While it is admittedly difficult to measure the degree of dominance, one proxy would be the extent to which legal restrictions limit a central bank's lending to the government, as quantified

that affect interactions between a government and the general public. For example, institutions such as competitive elections and free media can help a government to be more accountable to the public.

by Cukierman et al. (1992) for the 1980-89 period and subsequently updated by Crowe and Meade (2007) for 2003.[6] Figure 2 shows the correlation between government accountability and the degree of legal restrictions for LICs and EMEs. The larger value of the lending restriction measure means tighter restrictions, implying that fiscal dominance is less of a problem. The left sub-figure correlates lending restrictions in 1980-89 period and/or in 2003 with the contemporaneous value of executive constraints, for a pooled sample of 82 observations from 52 LICs and EMEs.[7] Note that it is an added variable (partial regression) plot based on OLS estimations where income levels are controlled for, so that the positive and significant coefficient (at the 1 percent level) means that lower government accountability is associated with increasing fiscal dominance for a given income level. The right sub-figure repeats the exercise using democracy/autocracy as a proxy for government accountability, and gives the same result.[8]

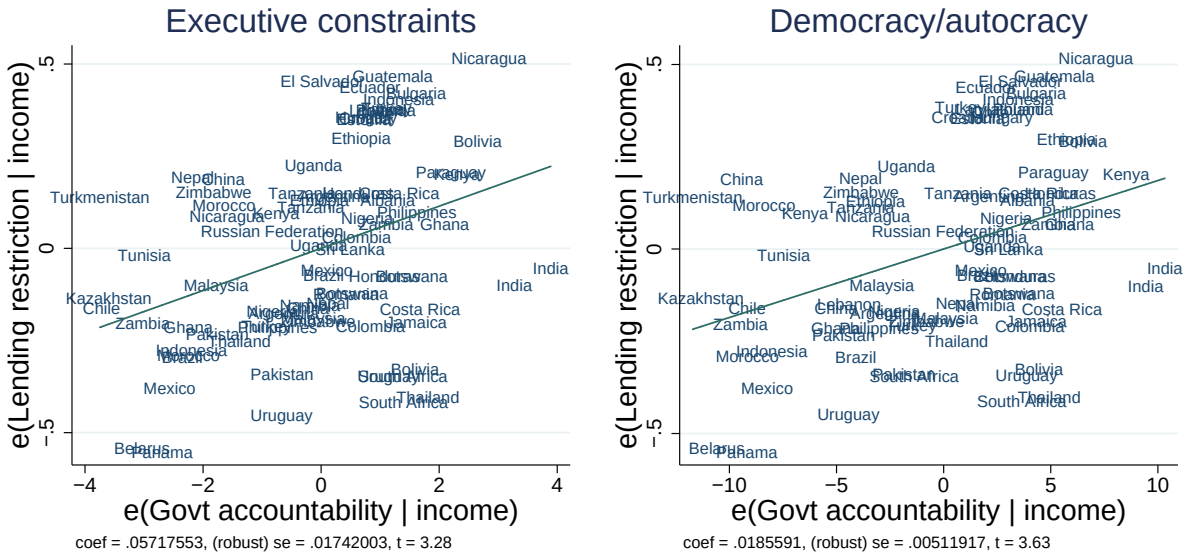
Then, fiscal dominance under an unaccountable government, in turn, is expected to impair central banks' ability to conduct monetary policy in a way consistent with IT. More specifically, as Masson et al. (1997) argue, to the extent that government borrowing from the central bank is not properly restricted, inflationary pressures of a fiscal origin are present, inducing the creation of formal and informal indexation mechanisms in the private sector. This undermines the effectiveness of IT, in that it makes it difficult for the central bank to align inflation expectations, an intermediate target under IT, to its publicly announced target rate. Therefore, even if IT has a potential to help reduce inflation (as shown by the previous studies for EMEs), fiscal dominance under an unaccountable government may hinder the potential from being fulfilled.

[6]Legal restrictions that limit a central bank (CB)'s lending to government is one of the four aspects of a central bank's independence measured by Cukierman et al. (1992) and Crowe and Meade (2007). Other three aspects of independence are 1) whether CB's management is protected from political pressure by secure tenure and independent appointment, 2) whether the government can participate in or overturn the CB's policy decisions, 3) whether the legal mandate of the CB sets a clear objective for monetary policy.

[7]A value of lending restrictions in 1980-89 period (one value per country) is from Cukierman et al. (1992), and a value in 2003 is from Crowe and Meade (2007). Only for a limited number of countries, two observations (1980-90, and 2003) are available.

[8]For democracy/autocracy, 83 observations from 53 countries are available.

Figure 2: Government accountability and fiscal dominance in LICs and EMEs



Notes: Added variable plots based on OLS estimations, with standard errors clustered by country. Lending restriction reflects the degree of restrictions that limit central bank's lending to governmnet. The larger value of lending restriction corresponds to less of a fiscal dominance problem.

Source: Authors' calculations

As a caveat, however, while we argue that different qualities of institutions within non-HICs may yield different IT effects on inflation, it is important to acknowledge that there are other factors which affect the IT performance. In particular, as highlighted by Masson et al. (1997), the type of exchange rate scheme should also have a critical bearing as a prerequisite for a successful IT framework. This is because when countries use the pegging of nominal exchange rates as an alternative anchor, monetary policy is already significantly constrained, so that the additional effect of IT on inflation expectation may be small. Thus, under fixed exchange rates, whether or not institutions eliminate fiscal dominance may be of second-order relevance.[9]

To summarize, our argument is that in low-income countries, where government accountability is generally low, the problem of fiscal dominance is present, which in turn reduces

[9]While considering the strict IT adoption dates often precludes the case where a central bank pursues exchange rates as a nominal anchor, we confirm that exchange rates are often categorized as soft peg even after the strict adoption dates. Therefore, it is still important to pay an attention to exchange rate flexibility.

prospect for a successful IT performance, particularly under a floating exchange rate regime. Based on this argument, this paper tests the following two hypotheses.

1: *IT is significantly less effective in reducing level of inflation in LICs than in EMEs. With IT also being less effective in HICs than in EMEs (as the previous literature shows), the relation between the IT effect and income levels is non-monotonic.*

2: *The different IT effects between LICs and EMEs are explained by differences in the degree of government accountability across the country groups. The role of accountability is particularly evident under floating exchange rate regimes.*

4 Empirical Methodology

The standard regression specification tests for an IT effect by adding to an inflation regression a dummy variable that is equal to one when an IT regime is in place, and zero otherwise. The reference regression model for inflation in country i in year t is as follows:

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

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 one if an IT regime is adopted in country i in year t. $z_{i,j,t}$ 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. μ_i and ν_t are the country fixed effect and time dummies, capturing unobserved time-invariant country characteristics and global variations in inflation, respectively. Last, importantly, the right-hand side also

contains a country-specific linear time trend, $trend_{i,t}$. This is to address the possibility that initially high-inflation countries converge to the mean irrespective of implemented policies, including IT. This so-called "regression-to-the-mean" is consistent with the observation that even amongst non-IT countries, there are significant differences in time trend of inflation over the sample period.

To investigate how the effects of IT may differ across different income levels (Hypothesis 1), we consider two alternative specifications. The first is:

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

where LIC_i is a time-invariant dummy variable, which takes the value of one if country i is LIC (as defined above) and zero otherwise. EME_i and HIC_i are also dummies defined likewise. Our main interest is to compare coefficients on the interactions between income group and IT (i.e., β_L, β_E and β_H). The second equation is:

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

where $y_{i,t}$ is the log of real GDP per capita (in US dollar) in country i in year t. The idea is to make use of the time-variation of income levels to estimate how they interact with the IT effect. 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, i.e., ζ and ψ. Both Eqs.2 and 3 include a country-specific linear trend to control for regression-to-the-mean.

Next, we examine the role of institutions as a factor which differentiates IT effects between LICs and EMEs (Hypothesis 2). The reference equation is:

$$\begin{aligned}\pi_{i,t} = \alpha\pi_{i,t-1} + \beta IT_{i,t} + \eta Account_{i,t} + \lambda IT_{i,t} * Account_{i,t} \\ + \sum_{j=1}^{n} \theta_j z_{i,j,t} + \mu_i + \nu_t + \gamma_i\, trend_{i,t} + \epsilon_{i,t}.\end{aligned} \tag{4}$$

$Account_{i,t}$ is an institution variable which measures the degree to which governments are accountable to the public in country i in period t. As indicated above, we use "executive constraints" and "democracy/autocracy" as a proxy. Although these variables vary over our sample period, particularly within the sample of LICs and EMEs, they generally do not show frequent year-to-year variations. Thus, we estimate Eq.4 without country fixed effects as well to make use of cross-country variations in government accountability. Further, to take account of exchange rate flexibility as a prerequisite for successful IT performance, we interact $IT_{i,t}$, $Account_{i,t}$ and $Float_{i,t}$, which takes the value of one when exchange rate is floating and zero when a soft peg is adopted or there is no legal tender of their own.[10] The resulting equation is:

$$\begin{aligned}\pi_{i,t} = \alpha\pi_{i,t-1} + \beta IT_{i,t} + \eta Account_{i,t} + \kappa Float_{i,t} + \lambda IT_{i,t} * Account_{i,t} \\ + \rho IT_{i,t} * Float_{i,t} + \sigma Account_{i,t} * Float_{i,t} + \upsilon IT_{i,t} * Account_{i,t} * Float_{i,t} \\ + \sum_{j=1}^{n} \theta_j z_{i,j,t} + \mu_i + \nu_t + \gamma_i\, trend_{i,t} + \epsilon_{i,t}.\end{aligned} \tag{5}$$

The three-way interactions allow us to examine the role of institutions in the IT effects on inflation *conditional on* an exchange rate regime. We estimate Eq.5 without country time fixed effects as well.

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

[10] $z_{i,j,t}$ in Eq.5 do not include exchange rate regime dummies.

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 rises. Thus, the fact that our sample of annual data spans the 1980-2016 period makes it reasonable to estimate a fixed effects model. For example, in the reference estimation below with 182 countries (Table 4), the average number of observations per country is 32.6.[11]

However, this estimation method is still open to other biases, including the one caused if the decision to adopt IT is endogenous to the explanatory variables. This particular consideration has led a few investigators to adopt propensity score matching (PSM, cf. Table 2), which models the decision to adopt IT and then matches IT adopters with non-adopters that, according to the model, had a similar probability of adopting IT. Still, however, PSM has its own weaknesses: (1) 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; (2) it cannot control for unobserved country fixed effects; and (3) the model of which countries choose to adopt IT and in which year tends to be weak. Another possible option is to use a differences-in-differences approach (DiD, cf. Table 2) to address the causality of IT on inflation.[12] However, this method is not free from weaknesses either. In particular, a non-negligible arbitrariness is bound to arise when defining the dividing line for non-IT-targeters used as a control group. Therefore, on balance, we prefer the panel regression approach for simplicity and greater robustness.

[11] In theory, there are other methods to address the problem of dynamic panel bias such as difference and system Generalized Method of Moments (GMM), developed by Holtz-Eakin et al. (1988), Arellano and Bond (1991), and Blundell and Bond (1998). However these methods are not suitable in the current context, because the (relatively) large time dimension tends to increase the number of instruments exponentially, which in turn makes it difficult to check the validity of instruments (Roodman (2009)).

[12] Samarina et al. (2014) compare the effects of IT between PSM and DiD, and show that the two approaches lead to the same conclusion that the development level of countries matters in the effectiveness of IT. However, their interest is HICs vs non-HICs, not the possible heterogeneous effects within non-HICs.

5 Data

We use a cross-country annual panel dataset of 182 countries over the 1980-2016 period. 90 (46, 46) countries are categorized as LICs (EMEs, HICs), and out of 37 IT countries included, 10 (13, 14) are LICs (EMEs, HICs).[13] To avoid disproportionately large time variations in inflation rates affecting estimation results, countries with average consumer price index (CPI) inflation of over 50% per year (over the sample period) are already excluded. Also, to address the dynamic panel bias mentioned above, we only use countries which offer at least 10 observations over the sample period. Annual CPI inflation rate is measured as the annual log difference of the CPI multiplied by 100 (i.e., inflation=100*$\triangle$logcpi). 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.[14] Table 3 shows that average inflation rates in LICs (EMEs, HICs) are 11.18, 13.31, 3.98%, respectively.

Annual real GDP per capita (in US dollars), used to estimate Eq.3, is from WDI. The average figure is highest in HICs (34,405 dollars) and lowest in LICs (1,583 dollars). We use two proxies for institutional quality to measure the degree to which governments are accountable. The underlying assumption for the choice of proxies is that governments are more (less) accountable when they are more (less) constrained. The first proxy, "executive constraints", is from Polity IV, measuring the degree of institutionalized constraints on the decision-making powers of chief executives.[15] Second, we use "democracy/autocracy", also from Polity IV, which measures not only the degree of institutionalized constraints (as in "executive constraints") but also other democratic elements such as the extent to which citizens' political participation is guaranteed.[16] The participation of the citizens in the governance process should prompt governments to be more accountable for their policy actions. For both variables, the larger value corresponds to the higher government accountability.

[13] See above for how countries are classified by income levels and how IT adoption dates are defined.

[14] In our dataset, correlation of inflation data (log difference of CPI) between WDI and WEO is 99 percent.

[15] This variable is often used in the literature on institutions and development, including Acemoglu et al. (2001). In Polity IV, the variable name is "XCONST".

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

Table 3: Descriptive statistics across different income groups

Variable	Mean	Std. Dev.	Min.	Max.
Low-income countries (LICs)				
Inflation rates	11.18	22.28	-129.94	477.49
Real GDP pc (US dollars)	1582.73	1241.6	131.65	9650.57
Executive constraint	3.89	1.95	1	7
Democracy/autocracy	0.31	6.22	-10	10
Hard peg (dummy)	0.18	0.39	0	1
Soft peg (dummy)	0.56	0.5	0	1
Float (dummy)	0.25	0.44	0	1
Parity change (dummy)	0.12	0.32	0	1
Currency crisis (dummy)	0.29	0.45	0	1
Emerging market economies (EMEs)				
Inflation rates	13.31	27.12	-17.58	298.44
Real GDP pc (US dollars)	7521.32	3514.75	1216.08	19275.09
Executive constraint	5.42	1.91	1	7
Democracy/autocracy	4.87	5.88	-9	10
Hard peg (dummy)	0.2	0.4	0	1
Soft peg (dummy)	0.49	0.5	0	1
Float (dummy)	0.31	0.46	0	1
Parity change (dummy)	0.1	0.3	0	1
Currency crisis (dummy)	0.23	0.42	0	1
High-income countries (HICs)				
Inflation rates	3.98	7.93	-19.41	155.57
Real GDP pc (US dollars)	34405.05	18338.83	486.98	111968.35
Executive constraint	5.65	2.27	1	7
Democracy/autocracy	5.34	7.59	-10	10
Hard peg (dummy)	0.18	0.39	0	1
Soft peg (dummy)	0.55	0.5	0	1
Float (dummy)	0.27	0.44	0	1
Parity change (dummy)	0.05	0.22	0	1
Currency crisis (dummy)	0.19	0.39	0	1

Notes: Statistics correspond to the reference datasets where countries with average CPI inflation of over 50% are excluded. The number of countries covered in LICs (EMEs, HICs) are up to 90 (46, 46) countries. The sample period is up to 1980-2016. Executive constraint (democracy/autocracy) ranges between 1 and 7 (-10 and 10). Further clarifications required on each variable are given in the text.

The average of both proxies is highest (lowest) in HICs (LICs). While one may argue that corruption measures are also relevant proxies for government accountability, our view is that institutional features such as constraints on politicians and citizens' political participation are the ones that are more relevant in relation to fiscal dominance, rather than corruption as an outcome of such features.[17]

[17]This view is in line with Keefer and Knack (2007), who find that the level of capital spending increases in the worsening of institutional quality. They argue that what is associated with the level of capital spending

Turning to control variables, exchange rate regime data and information on parity changes are dummy variables based on Bleaney and Tian (2017).[18] 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). For example, in LICs, the average of the hard peg dummy is 0.18, meaning that 18 percent of the observations (across all the LICs and years) are categorized as hard peg. Parity dummy takes the value of one in the case of parity changes in fixed exchange rate regimes. The currency crisis variable created by Bleaney et al. (2016) takes the value of one 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.[19] Across LICs (HICs) and years in our dataset, 29 (19) percent of all observations take the value of one. Measures for legal restrictions which limit a central bank's lending to the government, used above to consider the association between government accountability and fiscal dominance, are from Cukierman et al. (1992) and Crowe and Meade (2007).

6 Results

This section tests the two main hypotheses presented above. We first test if IT is significantly less effective in LICs than EMEs (Hypothesis 1), and then test if the difference in government accountability between the two country groups is a possible explaining factor for the different IT effects (Hypothesis 2).

is institutions that restrict government's rent seeking (e.g., competitive elections), rather than the level of corruption.

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

[19] Specifically, the authors define that this takes 1 when the EMPI is in the upper quartile of their dataset (spanning 1980-2012).

6.1 IT effects across different income levels

6.1.1 Using time-invariant income dummies

Table 4 shows estimation results of Eq.1 for an unconditional effect of IT on inflation, and also results of Eq.2 for conditional effects upon income levels. The conditional effects are estimated using time-invariant country group dummies (LIC_i, EME_i and HIC_i). Acknowledging the difficulty of defining IT adoption dates, we estimate equations using both strict and loose adoption dates. Also, given that using extra control variables ($z_{i,j,t}$) restricts the sample size greatly, results are shown with and without them. As noted, to take account of regression-to-the-mean, we include a country-specific linear trend as well as time dummies.

The first two columns estimate the equations without the 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 -0.04 is insignificant, implying that the adoption of IT is not associated with a change in inflation rates when using the entire observations. However, Column (2), estimating the IT effects conditional on income levels, shows that for EMEs, the adoption of IT is significantly associated with lower inflation by 4.78 percentage points. Meanwhile, the coefficients for IT*LIC and IT*HIC are positive (2.49 and 2.27), albeit insignificant for the former. Notice that the coefficient is significantly more negative (i.e., IT is more effective) in EMEs than in LICs and HICs. This is based on the observation that p-values from testing the equality of interaction coefficients between IT*LIC and IT*EME (see LIC_EME in the table) and IT*HIC and IT*EME (see HIC_EME) are 0.035 and 0.0040. The lagged inflation variable is highly significant, showing that inflation is persistent.

Column (3) and (4) add extra control variables, still using strict adoption dates. They confirm the heterogeneous effects of IT across income levels: only for EMEs, the IT dummy is negatively associated with inflation rates, and the coefficient is significantly more negative than in LICs or HICs. Turning to controls, a floating exchange rate is significantly associated

Table 4: IT effects across different income levels

Adopt dates	Strict				Loose			
Controls	Without		With		Without		With	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable: 100*△logcpi								
L.Infl	0.516***	0.515***	0.430***	0.428***	0.516***	0.515***	0.430***	0.429***
	(18.427)	(18.454)	(8.366)	(8.293)	(18.435)	(18.449)	(8.366)	(8.308)
IT	-0.037		-1.809		-1.405		-3.269**	
	(-0.032)		(-1.297)		(-1.087)		(-2.041)	
IT*LIC		2.486		-1.014		2.426		-0.359
		(0.944)		(-0.517)		(0.906)		(-0.171)
IT*EME		-4.782**		-7.551***		-5.512**		-7.598**
		(-2.207)		(-2.712)		(-2.115)		(-2.121)
IT*HIC		2.274**		2.879**		-0.320		-1.305
		(2.538)		(2.050)		(-0.287)		(-0.839)
Hard peg			-4.987	-5.005			-4.986	-5.032
			(-1.301)	(-1.319)			(-1.300)	(-1.312)
Float			3.130***	3.162***			3.160***	3.214***
			(3.469)	(3.549)			(3.492)	(3.600)
Parity chg			3.111***	3.139***			3.103***	3.140***
			(2.910)	(2.936)			(2.899)	(2.929)
L.Parity chg			-0.856	-0.837			-0.864	-0.855
			(-1.463)	(-1.445)			(-1.470)	(-1.463)
Cur crisis			3.332***	3.327***			3.317***	3.274***
			(5.404)	(5.437)			(5.413)	(5.418)
L.Cur crisis			2.406***	2.406***			2.404***	2.343***
			(4.754)	(4.809)			(4.743)	(4.731)
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Specific trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
LIC_EME		0.0353		0.0540		0.0364		0.0843
HIC_EME		0.00398		0.00172		0.0653		0.106
Observations	5,928	5,928	4,536	4,536	5,928	5,928	4,536	4,536
Countries	182	182	167	167	182	182	167	167
IT adopters	37	37	33	33	37	37	33	33
Adj. R2	0.540	0.541	0.462	0.463	0.541	0.541	0.462	0.463

Notes: Fixed-effect estimations. Constant, time dummies and country-specific linear trends 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 is calculated as a log difference of CPI. Countries with the average inflation of over 50 percent over the sample period are not included. t-statistics are in parentheses. Clustered standard errors are used to adjust for correlation of error terms within countries. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

with 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 previous year is always associated with significantly higher inflation, as is a current (but not lagged) parity change in a pegged regime. Columns (5) to (8) present results using loose IT adoption dates. Unlike Columns (2) and (4), coefficients on IT*HIC in Columns (6) and (8) are negative, albeit insignificant, and the difference between coefficients on IT*EME and IT*HIC is marginally insignificant in Column (8) (p-value is 0.106). Still, heterogeneous IT effects across income levels are observed with or without extra controls. Overall, in LICs IT is significantly less effective than in EMEs, and more broadly, the relation between the effectiveness of IT and income levels appears to be non-monotonic.

6.1.2 Interaction with per capita GDP

Table 5 estimates Eq.3, making use of within-country variations in income levels. Specifically, we interact IT dummy with log of real GDP per capita and its squared value. The idea is to shed further light on the possible non-monotonic relation between income and the effectiveness of IT suggested above. The table shows results on both strict and loose adoption dates, with and without extra control variables.

Column (1) confirms a non-monotonic relation between income levels and the effectiveness of IT. Based on Eq.3, the marginal effect of the IT dummy on inflation is given by $\beta + \zeta * Income + \psi * Income^2 (= 112.90 - 25.39 * Income + 1.41 * Income^2)$. This indicates that the IT effect takes a U-shape with the maximum negative effect occurring at $Income = 9.00$, which corresponds to 8,103.1 US dollars in the level term. This is relatively close to the mean value of real GDP per capita among EMEs (7521.3 US dollars, see Table 3), implying that the relation is non-monotonic over the entire income range. Column (2) shows that with extra controls, the relation is again non-monotonic, with the maximum negative occurring at $6,185.7$ dollars.[20] Columns (3) and (4) indicate that the results are robust to the use of loose IT adoption dates. Therefore, together with the results from the analysis using time-invariant income dummies (Table 4), we argue that Hypothesis 1 has been supported.

[20]The maximum negative effects at $Income = 9.00$ and $Income = 8.73$ in Columns (1) and (2) are -1.4% and -3.1%.

Table 5: IT effects across different income levels: Alternative approach

Adopt dates	Strict		Loose	
	(1)	(2)	(3)	(4)
Dependent variable: 100*△logcpi				
L.Infl	0.506***	0.421***	0.506***	0.421***
	(15.872)	(7.426)	(15.865)	(7.418)
IT (β)	112.899**	145.578*	119.340**	165.636**
	(2.027)	(1.839)	(2.041)	(2.369)
IT*Income (ζ)	-25.388**	-34.048*	-26.559**	-37.266**
	(-2.051)	(-1.891)	(-2.052)	(-2.336)
IT*Income^2 (ψ)	1.412**	1.950*	1.447**	2.044**
	(2.088)	(1.941)	(2.064)	(2.312)
Income	-13.551	-14.681	-13.483	-14.612
	(-1.115)	(-0.937)	(-1.104)	(-0.931)
Income^2	1.004	0.764	1.006	0.768
	(1.519)	(0.872)	(1.514)	(0.875)
Hard peg		-5.390		-5.368
		(-1.385)		(-1.377)
Float		3.155***		3.228***
		(3.396)		(3.488)
Parity chg		3.190***		3.203***
		(2.877)		(2.880)
L.Parity chg		-0.869		-0.888
		(-1.417)		(-1.441)
Cur crisis		2.881***		2.858***
		(5.112)		(5.098)
L.Cur crisis		2.105***		2.076***
		(4.477)		(4.453)
Fixed effects	Yes	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes	Yes
Specific trends	Yes	Yes	Yes	Yes
Observations	5,649	4,330	5,649	4,330
Countries	180	165	180	165
IT adopters	37	33	37	33
Adj. R2	0.541	0.475	0.541	0.475

Notes: Fixed-effect estimations. Constant, time dummies and country-specific linear trends are not shown for brevity. Inflation rate is calculated as a log difference of CPI. Countries with the average inflation of over 50 percent over the sample period are not included. t-statistics are in parentheses. Clustered standard errors are used to adjust for correlation of error terms within countries. Real GDP per capita, US Dollar (Income) is log transformed. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

6.2 Role of government accountability

6.2.1 Without considering the role of exchange rate regimes

We showed above that IT is significantly less effective in reducing inflation in LICs than in EMEs. We now test the hypothesis that the degree of government accountability is a possible driving force behind this result (Hypothesis 2). We first consider the role of government accountability in the IT effect on inflation rates without taking account of the possible relevance of exchange rate regimes as a prerequisite for successful IT performance. Specifically, using the sub-sample of LICs and EMEs, Table 6 estimates the association between IT and inflation rates conditional on government accountability (Eq.4), proxied by "executive constraints" and "democracy/autocracy". As mentioned, because these institutional variables do not show frequent time variations, we show results without country fixed effects as well, which exploit cross-country variations of accountability. For brevity, the table only shows results based on strict IT adoption dates (Results using loose adoption dates are in Table 10 in Appendix A).

Columns (1) to (4) are using executive constraints as a proxy for government accountability. The former (latter) two columns are without (with) extra controls, and Columns (1) and (3) include fixed effects, while Column (2) and (4) do not. In all these four columns, coefficients on the interaction between IT dummy and executive constraints, which reflects the role of accountability in the marginal effect of IT, are significantly negative. A rise in executive constraints (which ranges between 1 and 7) by the value of one corresponds to a fall in the marginal effect of IT by 1.15 to 3.03 percentage points. In Columns (5) to (8), democracy/autocracy is used as an accountability proxy. Again, the signs of interaction coefficients are all negative, although the coefficient is significant only in Column (5). Notice, however, that the coefficients being insignificant do not necessary indicate that the role of accountability in the effect of IT is not robust, because the relevance of exchange rate regimes is not taken into account yet.

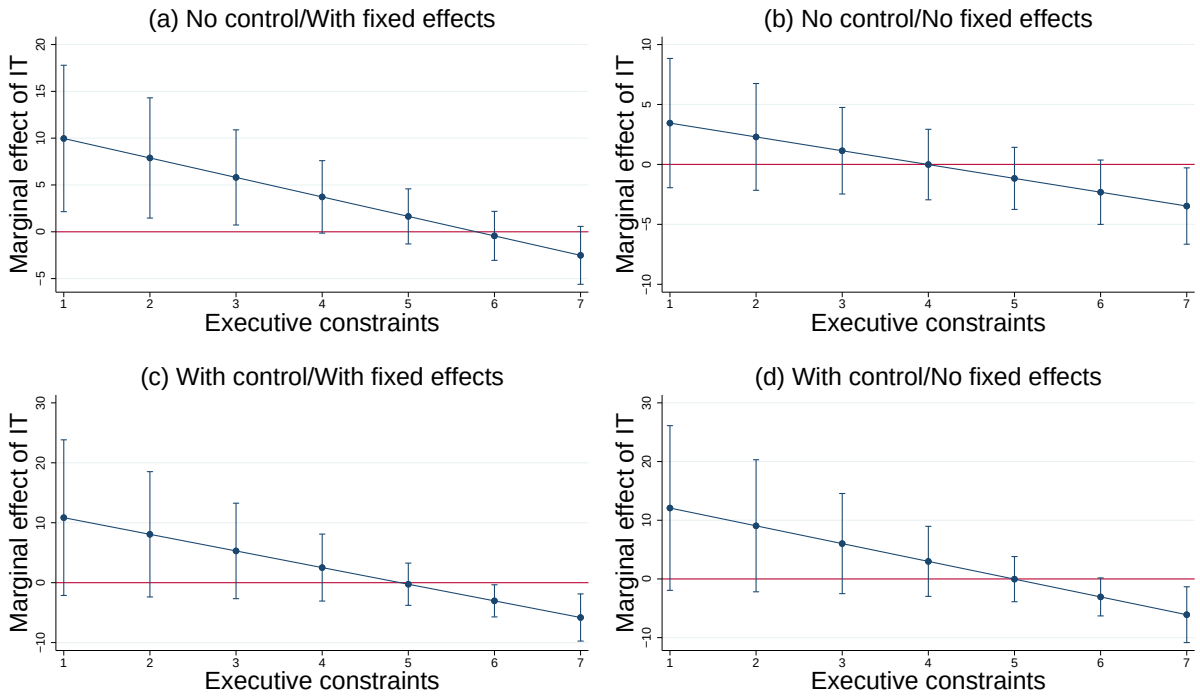
Table 6: Role of government accountability in IT effects within LICs and EMEs (Strict IT dates)

Account proxy	Executive constraints				Democracy/autocracy			
Controls	Without		With		Without		With	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable: 100*△logcpi								
L.Infl	0.506***	0.591***	0.413***	0.494***	0.504***	0.594***	0.414***	0.497***
	(16.108)	(25.159)	(7.091)	(9.809)	(16.516)	(25.917)	(7.379)	(10.274)
IT	12.046**	4.601	13.622	15.113	4.073	-0.285	1.129	1.522
	(2.142)	(1.195)	(1.442)	(1.490)	(1.201)	(-0.115)	(0.267)	(0.422)
Account	0.920**	0.456	0.565	0.399	0.433***	0.141	0.286**	0.147
	(2.226)	(1.316)	(1.477)	(0.918)	(2.973)	(1.329)	(2.291)	(1.168)
IT*Account	-2.080**	-1.153*	-2.776*	-3.030*	-0.643*	-0.272	-0.621	-0.661
	(-2.274)	(-1.733)	(-1.756)	(-1.752)	(-1.793)	(-1.076)	(-1.283)	(-1.491)
Hard peg			1.041	-5.291***			-1.174	-5.425***
			(0.610)	(-4.754)			(-0.513)	(-5.431)
Float			3.687***	3.885***			3.500***	4.065***
			(3.197)	(4.039)			(3.169)	(4.331)
Parity chg			4.497***	4.996***			4.409***	4.936***
			(3.102)	(3.335)			(3.130)	(3.385)
L.Parity chg			-0.790	-0.161			-0.763	-0.367
			(-1.042)	(-0.220)			(-1.043)	(-0.515)
Cur crisis			3.832***	4.435***			3.944***	4.624***
			(5.067)	(5.527)			(5.102)	(5.613)
L.Cur crisis			3.076***	3.227***			3.051***	3.261***
			(4.530)	(5.397)			(4.671)	(5.479)
Fixed effects	Yes	No	Yes	No	Yes	No	Yes	No
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Specific trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,555	3,555	2,871	2,871	3,662	3,662	2,978	2,978
Countries	114	114	107	107	114	114	109	109
IT adopters	23	23	20	20	23	23	20	20
Adj. R2	0.536	0.559	0.453	0.496	0.537	0.557	0.454	0.497

Notes: Based on the sub-sample of LICs and EMEs. Strict IT adoption dates are used. Constant, time dummies and country-specific linear trends are not shown for brevity. Executive constraints (democracy/autocracy) ranges from 1 to 7 (-10 to 10). Inflation rate is calculated as a log difference of CPI. Countries with the average inflation of over 50 percent over the sample period are not included. t-statistics are in parentheses. Clustered standard errors are used to adjust for correlation of error terms within countries. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

To illustrate the implication of the negative interaction coefficients, Figure 3 plots marginal effects of IT together with 90 percent confidence interval for different levels of executive constraints. Sub-figures (a) to (d) correspond to Columns (1) to (4) of Table 6. They show that apart from sub-figure (a), IT is associated with significantly negative marginal effect of IT

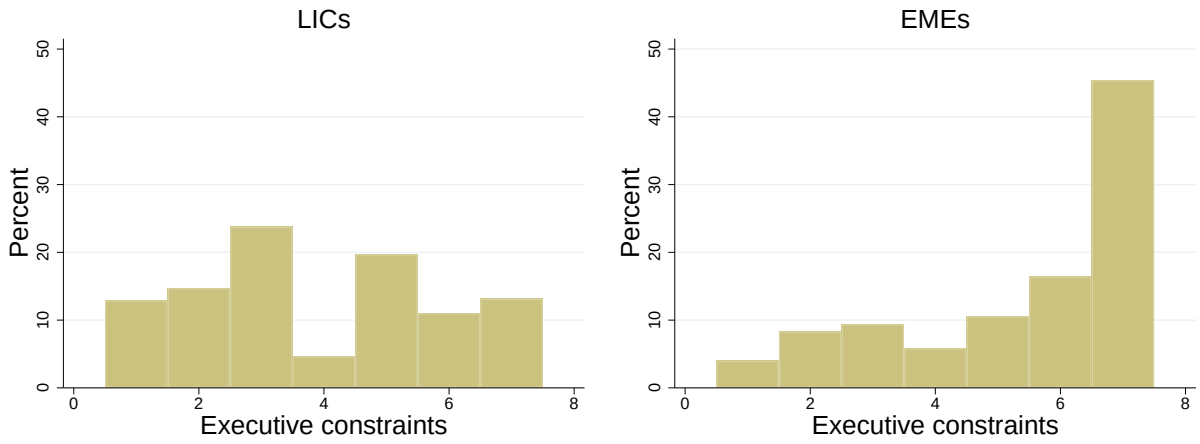
Figure 3: Marginal IT effects and government accountability within LICs and EMEs



Note: A marginal effect with 90% confidence interval is shown.

Source: Authors' calculations

Figure 4: Distribution of government accountability in LICs and EMEs



Notes: Executive constraints are used as a proxy for government accountability.
Executive constraints range from 1 to 7. The higher the value is, the more government is constrained.

Source: Authors' calculations

when the proxy takes the value of 7. Now, notice from Figure 4 (the histograms of executive constraints for LICs and EMEs) that about 45 percent of observations from EMEs take the values of 7, whereas only about 10 percent of observations from LICs do.[21] Therefore, even when the relevance of exchange rates is not considered, there is some indication that government accountability works as a driving factor behind the different IT effects across income levels. A similar observation can be made for the case when democracy/autocracy is used as a proxy for government accountability (see Figure 6 and Figure 7 in Appendix A).[22]

6.2.2 Relevance of exchange rate regimes

Next, to take account of the possible relevance of exchange rate regimes as a pre-requisite for successful IT performance, Table 7 estimates Eq.5 which entails three-way interactions among IT dummy, accountability proxy, and floating dummy. Using the notation of Eq.5, the marginal effect of IT on inflation is given as:

$$\frac{\partial \pi_{i,t}}{\partial IT_{i,t}} = \beta + \lambda * Account_{i,t} + \rho * Float_{i,t} + \upsilon * Account_{i,t} * Float_{i,t}. \tag{6}$$

Thus, the effects under different exchange rate regimes are:

$$\frac{\partial \pi_{i,t}}{\partial IT_{i,t}} = \begin{cases} \beta + \rho + (\lambda + \upsilon) * Account_{i,t} & \text{if } Float_{i,t} = 1 \\ \beta + \lambda * Account_{i,t} & \text{if } Float_{i,t} = 0. \end{cases} \tag{7}$$

In Eq.7, $\lambda + \upsilon$ represents the role of accountability in the marginal effect of IT on inflation rates under a floating regime, and λ indicates the role of accountability under a fixed regime. Table 7 has the same structure as Table 6, considering the alternative accountability proxies and regression equations with and without extra control variables. The key message of the table is simple: as shown in the rows on the size and p-value of $\lambda+\upsilon$, it is significantly negative

[21] These histograms are based on the observations used to create sub-figures (a) and (b).

[22] The marginal effect plots are based on Columns (5) to (8) of Table 6. To be compatible with *margins* Stata command, democracy/autocracy is re-scaled to 0 to 20 (from -10 to 10).

in most of the cases considered (except for Column (8), where the p-value is 0.104), whereas λ is insignificant for all the cases. This means that particularly under floating exchange rates, an increase in government accountability is associated with significantly more effective IT in terms of reducing inflation rates. For example, $\lambda + \upsilon$ in Columns (1) to (4) indicates that under floating rates a rise in executive constraints by one is associated with a fall in the marginal effect by 2.25 to 3.82 percentage points. Under fixed exchange rates, however, government accountability plays virtually no role. Table 11 in Appendix A shows that the results are robust to the use of loose IT adoption dates.

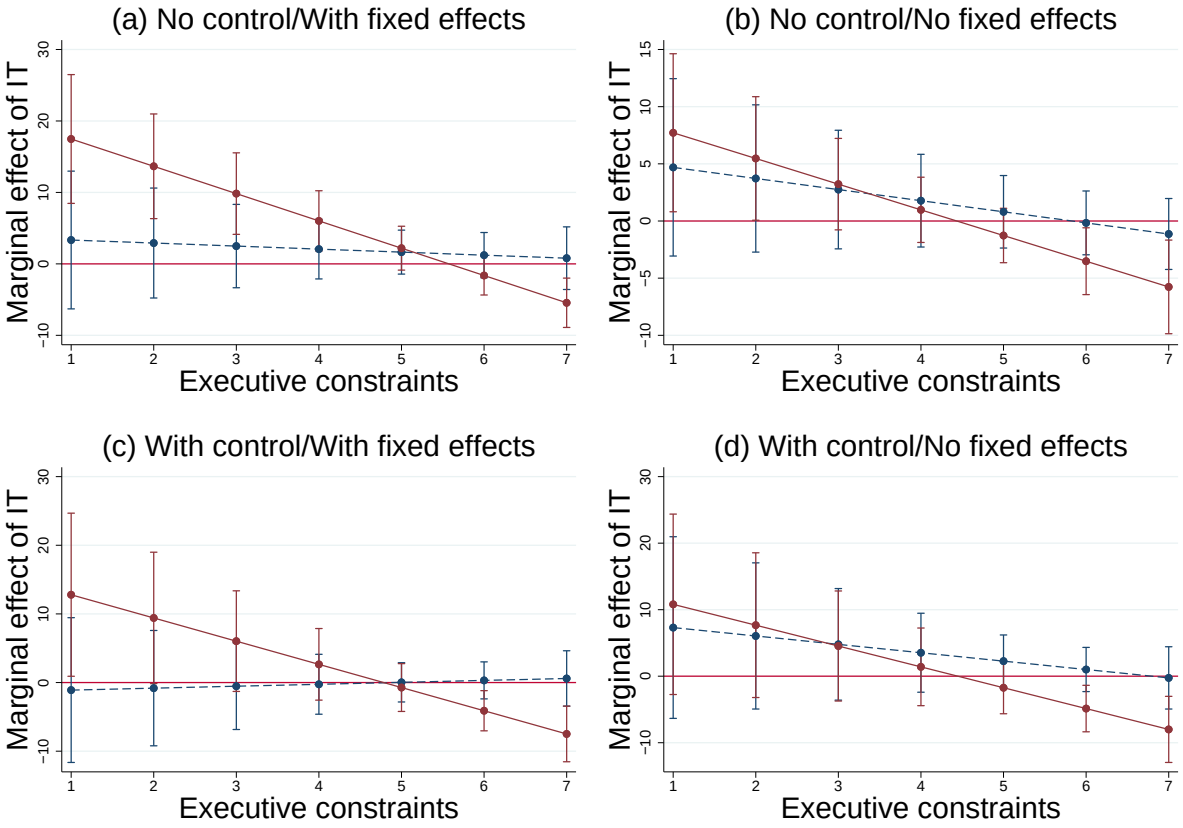
To complete the analysis, Figure 5 illustrates how the marginal effects of IT on inflation rates change across government accountability, proxied by executive constraints. Sub-figures (a) to (d) corresponds to the first four columns of Table 7. Solid lines connect the point estimates of marginal effects under floating exchange rates, while dashed lines connect effects under fixed exchange rates. The key message is that only under floating exchange rates, a rise in government accountability is associated with a significantly negative effect of IT on inflation rates. Under floating exchange rates, except for sub-figure (a), the marginal effect is significantly negative when executive constraints take the value of 6 or 7, which correspond to about 60% (20%) of observations from EMEs (LICs) (see Figure 4). This observation supports our hypothesis that particularly under floating rates, government accountability works as a driving factor behind the different IT effects across income levels. Meanwhile, under fixed exchange rates, a difference in accountability matters little. The results using democracy/autocracy as an alternative accountability proxy conveys the same message (see Figure 8 in Appendix A).

Table 7: Role of government accountability across exchange rate regimes (Strict IT dates)

Account proxy	Executive constraints				Democracy/autocracy			
Controls	Without		With		Without		With	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable: 100*△logcpi								
L.Infl	0.496***	0.578***	0.413***	0.497***	0.496***	0.580***	0.413***	0.500***
	(13.864)	(22.469)	(7.151)	(10.048)	(14.372)	(23.261)	(7.435)	(10.515)
IT (β)	3.761	5.664	-1.379	8.573	3.341	2.181	-1.488	2.615
	(0.532)	(1.031)	(-0.178)	(0.870)	(1.268)	(0.774)	(-0.458)	(0.742)
Account	0.397	0.296	0.193	0.344	0.248**	0.089	0.171	0.135
	(1.060)	(0.822)	(0.525)	(0.855)	(2.034)	(0.837)	(1.491)	(1.165)
Float	-2.338	0.880	-1.769	1.048	1.725	3.312***	2.836***	4.267***
	(-0.878)	(0.371)	(-0.828)	(0.495)	(1.535)	(3.245)	(2.654)	(4.680)
IT*Account(λ)	-0.423	-0.971	0.282	-1.261	-0.306	-0.262	0.197	-0.206
	(-0.336)	(-1.125)	(0.208)	(-0.756)	(-1.010)	(-0.980)	(0.584)	(-0.563)
IT*Float (ρ)	17.535***	4.301	17.554**	5.368	3.324	-1.370	3.374	-2.392
	(2.687)	(0.762)	(2.162)	(0.625)	(1.409)	(-0.548)	(0.825)	(-0.968)
Float*Account	1.052**	0.517	1.226**	0.755	0.344*	0.168	0.358**	0.194
	(1.989)	(1.077)	(2.440)	(1.443)	(1.956)	(1.071)	(2.385)	(1.259)
IT*Float*	-3.397***	-1.276	-3.663**	-1.873	-0.895**	-0.367	-1.077*	-0.539
Account (υ)	(-2.870)	(-1.289)	(-2.541)	(-1.202)	(-2.598)	(-1.037)	(-1.928)	(-1.288)
Parity chg			4.264***	5.373***			4.229***	5.358***
			(3.036)	(3.644)			(3.083)	(3.717)
L.Parity chg			-0.649	0.227			-0.660	-0.021
			(-0.872)	(0.312)			(-0.914)	(-0.029)
Cur crisis			3.905***	4.496***			4.011***	4.680***
			(5.067)	(5.465)			(5.129)	(5.581)
L.Cur crisis			3.065***	3.258***			3.064***	3.315***
			(4.478)	(5.466)			(4.655)	(5.576)
Fixed effects	Yes	No	Yes	No	Yes	No	Yes	No
Time dummies	Yes	Ye	Yes	Yes	Yes	Yes	Yes	Yes
Specific trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
$\lambda + \upsilon$	-3.820	-2.247	-3.380	-3.134	-1.201	-0.629	-0.879	-0.745
$\lambda + \upsilon$, p-value	0.000643	0.0247	0.0222	0.0654	0.00674	0.0585	0.0787	0.104
λ	-0.423	-0.971	0.282	-1.261	-0.306	-0.262	0.197	-0.206
λ, p-value	0.737	0.263	0.835	0.451	0.315	0.329	0.560	0.575
Observations	3,240	3,240	2,871	2,871	3,341	3,341	2,978	2,978
Countries	110	110	107	107	110	110	109	109
IT adopters	22	22	20	20	22	22	20	20
Adj. R2	0.533	0.558	0.455	0.496	0.535	0.557	0.456	0.496

Notes: Based on the sub-sample of LICs and EMEs. Strict IT adopt dates are used. Constant, time dummies and country-specific linear trends are not shown for brevity. Executive constraints (democracy/autocracy) ranges from 1 to 7 (-10 to 10). $\lambda + \upsilon$ reflects how the marginal effect of IT on inflation changes as government accountability rises under floating exchange rates; λ reflects how the effect changes under fixed exchange rates. Inflation rate is calculated as a log difference of CPI. Countries with the average inflation of over 50 percent over the sample period are not included. t-statistics are in parentheses. Clustered standard errors are used to adjust for correlation of error terms within countries. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Figure 5: Marginal IT effects, government accountability and exchange rate regimes



Notes: A solid (dashed) line connects point estimates under floating (fixed) exchange rate regime. A marginal effect with 90% confidence interval is shown.

Source: Authors' calculations

6.3 Alternative explanation: the role of initial inflation

Having shown that government accountability helps explain why IT may not be effective in LICs unlike in EMEs, we here examine an alternative possible explanation. That is, one may argue that IT has reduced inflation more in EMEs than in LICs (and HICs), simply because the pre-IT inflation rate in EMEs was higher than other countries. Indeed, Table 8 shows that the initial inflation, calculated as a 5-year average before the adoption of IT, is particularly higher in EMEs on average (18.19%, 13.69% without Brazil) than in LICs and HICs (7.32% and 4.44%), whereas the 5-year average after IT adoption in EMEs (5.53%, 5.31% without Brazil) is rather close to the corresponding figure in LICs and HICs (5.31% and 2.17%).

Notice that the fact that we always include a country-specific linear trend (to control for regression-to-the-mean) does take account of the effects of initial inflation to some degree. Still, however, there is an explicit way to address this issue (though not entirely satisfactory, as explained below), which is simply to interact the IT dummy with initial inflation rates. This is feasible despite the fact that initial inflation rates themselves, being time-invariant, are absorbed into country fixed effects. This is because for IT adopters, the interaction between the IT dummy and initial inflation shows time variations. What is unsatisfactory with this approach, however, is that for non-IT adopters, initial inflation (inflation before IT adoption) does not exist by definition.[23] Nonetheless, since the IT dummy is always zero for these countries, the level of initial inflation would not matter at least for an estimation purpose.[24]

With this caveat, Table 9 estimates Eq.5 with the additional interaction term, "IT*Initial Infl", where "Initial Infl" is the 5-year average inflation prior to the IT adoption. The table has the same structure as Table 7, except that only the regressions with country fixed effects are shown. This is because as emphasized, the initial inflation is not defined for countries that have never adopted IT. The results show that the coefficient of the new interaction variable is always negative, as expected, and significant (at the 1 percent level). However, the institutional variables also retain similar coefficients and significance levels to those in Table 7 under floating exchange rates (see the odd-numbered columns of Table 7 with fixed effects).[25] This suggests that, although the initial-inflation effect is significant and thus there is some truth in the alternative explanation, our institutional story is robust to its inclusion.

[23]This is directly related to the debatable feature of a differences-in-differences approach mentioned above, which is that the dividing line for non-IT-targeters has to be determined in an ad-hoc manner.

[24]For non-IT adopters, we simply set initial inflation to be zero.

[25]In Column (3) of Table 9, λ, which reflects how the marginal effect changes under fixed exchange rates, is also negative and significant (though only marginally, with the p-value of 0.09). However, the effect is much smaller (less negative) than $\lambda + \upsilon$, which captures the effect under floating exchange rates.

Table 8: Initial inflation rates across income levels

			5 year averages		
Country	Income group	Adopt year	Before	After	Change
Albania	LIC	2009	2.63	2.49	.14
Armenia	LIC	2006	3.23	6.29	-3.07
Georgia	LIC	2009	8.11	3.33	4.79
Ghana	LIC	2007	14.76	12.04	2.72
Guatemala	LIC	2005	6.68	5.87	.82
Indonesia	LIC	2006	8.9	6.09	2.8
Moldova	LIC	2009	11.72	5.69	6.02
Paraguay	LIC	2013	5.66	4	1.67
Peru	LIC	2002	4.85	2.24	2.62
Philippines	LIC	2002	5.83	4.3	1.53
Uganda	LIC	2011	8.11	6.07	2.04
Average			**7.32**	**5.31**	**2.01**
Brazil	EME	1999	76.63	8.33	68.3
Chile	EME	2001	5.01	2.53	2.49
Colombia	EME	1999	18.5	7.05	11.45
Dominican Republic	EME	2012	6.35	2.53	3.83
Hungary	EME	2001	14	4.71	9.3
Mexico	EME	2001	17.5	4.28	13.22
Poland	EME	1999	19.33	4.22	15.11
Romania	EME	2005	22.6	6	16.6
Russian Federation	EME	2014	7.45	10.62	-3.17
Serbia	EME	2006	23.88	8.44	15.44
Slovak Republic	EME	2005	7.44	3.87	3.57
South Africa	EME	2001	6.45	4.74	1.71
Thailand	EME	2000	4.95	2.25	2.7
Turkey	EME	2006	24.57	7.78	16.79
Average			**18.19**	**5.53**	**12.67**
Average (without Brazil)			**13.69**	**5.31**	**8.39**
Australia	HIC	1994	4.05	1.93	2.12
Canada	HIC	1995	2.72	1.71	1.01
Czech Republic	HIC	1998	8.73	2.48	6.24
Finland	HIC	1994	4.21	1.04	3.16
Iceland	HIC	2003	4.22	6.07	-1.85
Israel	HIC	1997	10.71	3.62	7.09
Japan	HIC	2013	-.21	1.13	-1.34
Korea, Rep.	HIC	2001	3.89	2.93	.96
New Zealand	HIC	1993	4.25	2.01	2.24
Norway	HIC	2001	2.28	1.6	.67
Spain	HIC	1995	5.42	2.42	3
Sweden	HIC	1995	5.57	.47	5.1
Switzerland	HIC	2000	.79	.85	-.05
United Kingdom	HIC	1993	5.56	2.07	3.48
Average			**4.44**	**2.17**	**2.27**

Notes: Initial inflation is the 5-year average of inflation rates just before the adoption of IT. "Change" is obtained as the average of inflation just before IT adoption minus the (5-year) average just after the adoption. IT adoption year is based on the strict definition (cf. Table 1). When inflation data is not available for 5 years after IT adoption (e.g., Japan), the average is calculated using as many observations as available.

Table 9: Role of initial inflation within LICs and EMEs

Account proxy	Executive constraints		Democracy/autocracy	
Controls	Without	With	Without	With
	(1)	(2)	(3)	(4)
Dependent variable: 100*△logcpi				
L.Infl	0.493***	0.410***	0.492***	0.410***
	(13.745)	(7.018)	(14.258)	(7.280)
IT (β)	12.132**	3.279	13.186***	6.472
	(2.095)	(0.452)	(4.206)	(1.484)
Account	0.405	0.205	0.248**	0.173
	(1.082)	(0.555)	(2.055)	(1.519)
Float	-2.170	-1.680	1.773	2.866***
	(-0.819)	(-0.791)	(1.584)	(2.706)
IT*Account(λ)	-0.346	0.688	-0.381*	0.162
	(-0.369)	(0.694)	(-1.709)	(0.473)
IT*Float (ρ)	14.915***	15.882**	3.028	3.016
	(2.649)	(2.195)	(1.308)	(0.815)
Float*Account	1.019*	1.209**	0.334*	0.354**
	(1.936)	(2.409)	(1.915)	(2.366)
IT*Float*	-2.744***	-3.235**	-0.658**	-0.887*
Account (υ)	(-2.906)	(-2.606)	(-2.278)	(-1.835)
IT*Initial Infl	-0.914***	-0.690***	-0.956***	-0.736***
	(-4.499)	(-2.971)	(-4.550)	(-3.004)
Parity chg		4.254***		4.215***
		(3.022)		(3.066)
L.Parity chg		-0.664		-0.679
		(-0.897)		(-0.948)
Cur crisis		3.877***		3.977***
		(5.083)		(5.152)
L.Cur crisis		3.038***		3.031***
		(4.506)		(4.686)
Fixed effects	Yes	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes	Yes
Specific trends	Yes	Yes	Yes	Yes
$\lambda + \upsilon$	-3.090	-2.547	-1.039	-0.726
$\lambda + \upsilon$, p-value	0.000123	0.0298	0.00187	0.0790
λ	-0.346	0.688	-0.381	0.162
λ, p-value	0.713	0.489	0.0903	0.637
Observations	3,240	2,871	3,341	2,978
Countries	110	107	110	109
IT adopters	22	20	22	20
Adj. R2	0.534	0.455	0.536	0.457

Notes: Initial inflation is the 5-year average of inflation prior to the adoption of IT. For further relevant information, see Notes for Table 7. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

7 Discussion and 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 (as indicated by Table 2). Because LICs have been slower to adopt inflation targeting than EMEs (Table 1), 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. By using panel regression methods rather than differences-in-differences or propensity score matching, our results are able to control for unobserved country characteristics (through country fixed effects), for unexplained fluctuations in inflation that affect all countries equally (through time fixed effects), and for variation in the speed of disinflation in different countries (through country-specific time trends).

We gave a story as to why this should be the case. Specifically, we examined the role of institutions which affect the degree of government accountability in the effectiveness of IT in a sample of LICs and EMEs. Measures of institutional quality based on political arrangements are more structural and less subjective, and also less likely to be endogenous to outcomes, than those based on survey data such as perceptions of corruption. The results indicate that IT was more effective with stronger institutions. Various authors (e.g. Masson et al. (1997); Thornton (2016)) have pointed out that in lower-income countries pegging the exchange rate can also be an effective nominal anchor. If that is the case, the benefits from IT should be greater when the exchange rate is floating than when it is pegged. Allowing for this, we found that the institutional effect is particularly marked under floating rates, and not significant when the exchange rate is pegged. This is still true even when we control for the significant effect of the pre-IT inflation rate, which has tended to be particularly high in EMEs, on the reduction in inflation achieved under IT. Overall, given that institutions are generally

weaker in LICs than in EMEs (Figure 1), we believe that government accountability does help us grasp why IT may be less effective in LICs.

We argued that the reason why government accountability matters in the IT effect is that fiscal dominance under an unaccountable government creates inflationary pressures of a fiscal origin, and impairs the ability of central banks to align private sector's inflation expectation to their target rate. However, we admit that this is merely a conjecture, where a formal model of institutional quality and inflation would be desirable. For example, Acemoglu et al. (2008) present such a model, showing that policy reforms aimed at increasing central bank independence do not necessarily help control inflation rates. Specifically, the model shows that the reform has a maximum impact when the quality of institutions is intermediate, because when institutions are strong, existing policies are less distorted so that reforms are unnecessary, while when institutions are weak, unconstrained policymakers who pursue personal rents may not implement reforms properly. Building a formal model of this kind and incorporating the interaction between monetary and fiscal policies may shed further light on our empirical results on the role of institutions in IT.

Acknowledgements

We thank Michael Ehrmann and Assaf Razin for their comments. Any remaining errors are our own responsibility.

Appendix

Please see the following.

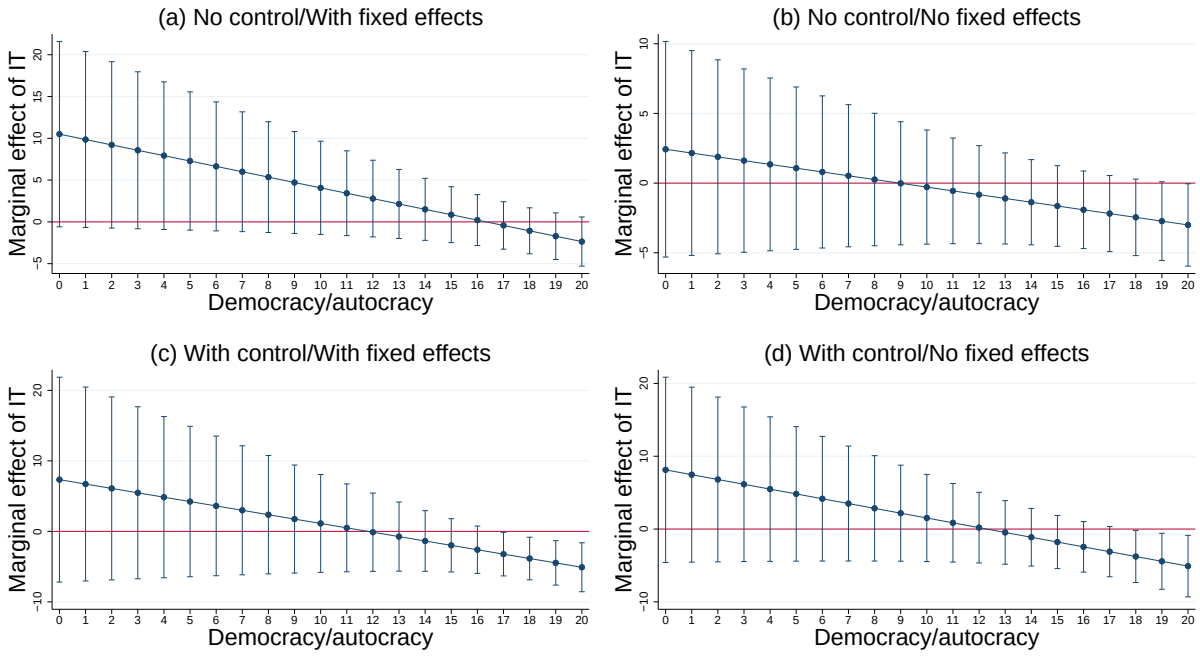
A Supplementary results

Table 10: Role of government accountability in IT effects within LICs and EMEs (Loose IT dates)

Account proxy	Executive constraints				Democracy/autocracy			
Controls	Without		With		Without		With	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable: 100*△logcpi								
L.Infl	0.506***	0.591***	0.413***	0.494***	0.504***	0.593***	0.414***	0.497***
	(16.095)	(25.140)	(7.092)	(9.819)	(16.513)	(25.895)	(7.378)	(10.278)
IT	12.960**	5.463	15.193	16.251	3.416	-0.625	1.621	1.992
	(2.183)	(1.366)	(1.554)	(1.542)	(0.904)	(-0.226)	(0.377)	(0.538)
Account	0.947**	0.478	0.615	0.428	0.434***	0.144	0.292**	0.152
	(2.276)	(1.378)	(1.583)	(0.992)	(2.981)	(1.362)	(2.322)	(1.215)
IT*Account	-2.385**	-1.415**	-3.014*	-3.197*	-0.678*	-0.318	-0.687	-0.717
	(-2.536)	(-2.188)	(-1.799)	(-1.753)	(-1.769)	(-1.227)	(-1.431)	(-1.563)
Hard peg			1.024	-5.299***			-1.199	-5.439***
			(0.581)	(-4.720)			(-0.510)	(-5.409)
Float			3.676***	3.867***			3.493***	4.051***
			(3.181)	(4.003)			(3.154)	(4.300)
Parity chg			4.506***	4.997***			4.415***	4.934***
			(3.106)	(3.334)			(3.132)	(3.382)
L.Parity chg			-0.787	-0.163			-0.760	-0.369
			(-1.036)	(-0.223)			(-1.037)	(-0.516)
Cur crisis			3.777***	4.392***			3.907***	4.598***
			(5.060)	(5.503)			(5.102)	(5.596)
L.Cur crisis			3.009***	3.169***			3.003***	3.222***
			(4.470)	(5.333)			(4.616)	(5.428)
Fixed effects	Yes	No	Yes	No	Yes	No	Yes	No
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Specific trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,555	3,555	2,871	2,871	3,662	3,662	2,978	2,978
Countries	114	114	107	107	114	114	109	109
IT adopters	23	23	20	20	23	23	20	20
Adj. R2	0.536	0.559	0.453	0.497	0.538	0.557	0.454	0.497

Notes: Based on the sub-sample of LICs and EMEs. Loose IT adoption dates are used. Constant, time dummies and country-specific linear trends are not shown for brevity. Executive constraints (democracy/autocracy) ranges from 1 to 7 (-10 to 10). Inflation rate is calculated as a log difference of CPI. Countries with the average inflation of over 50 percent over the sample period are not included. t-statistics are in parentheses. Clustered standard errors are used to adjust for correlation of error terms within countries. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

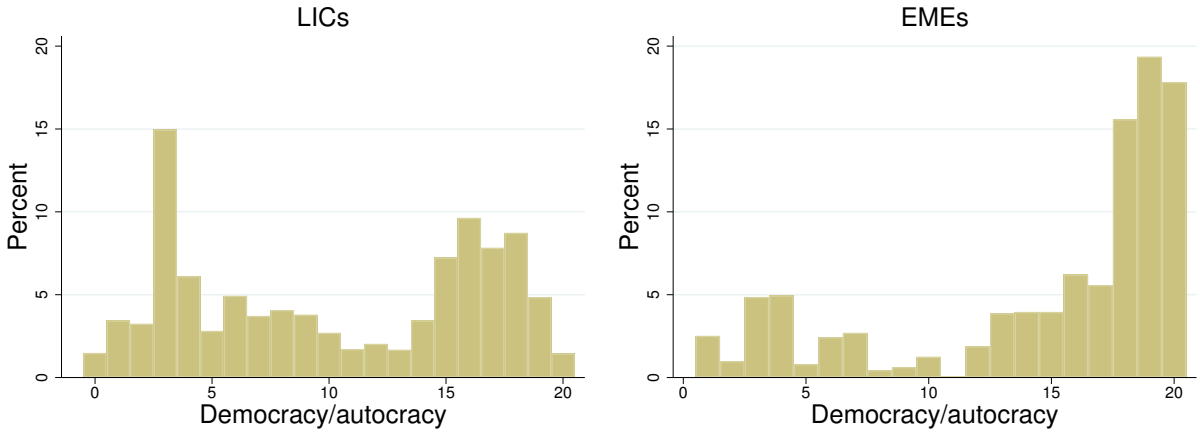
Figure 6: Marginal IT effects and democracy/autocracy within LICs and EMEs



Notes: A marginal effect with 90% confidence interval is shown.
Democracy/autocracy initially ranges from −10 to 10. The higher the value is, the more government is constrained.
It is rescaled to 0 to 20 to be compatible with "Margins" Stata command.

Source: Authors' calculations

Figure 7: Distribution of democracy/autocracy in LICs and EMEs



Notes: Democracy/autocracy initially ranges from −10 to 10. The higher the value is, the more government is constrained.
It is rescaled to 0 to 20 to be compatible with "Margins" Stata command.

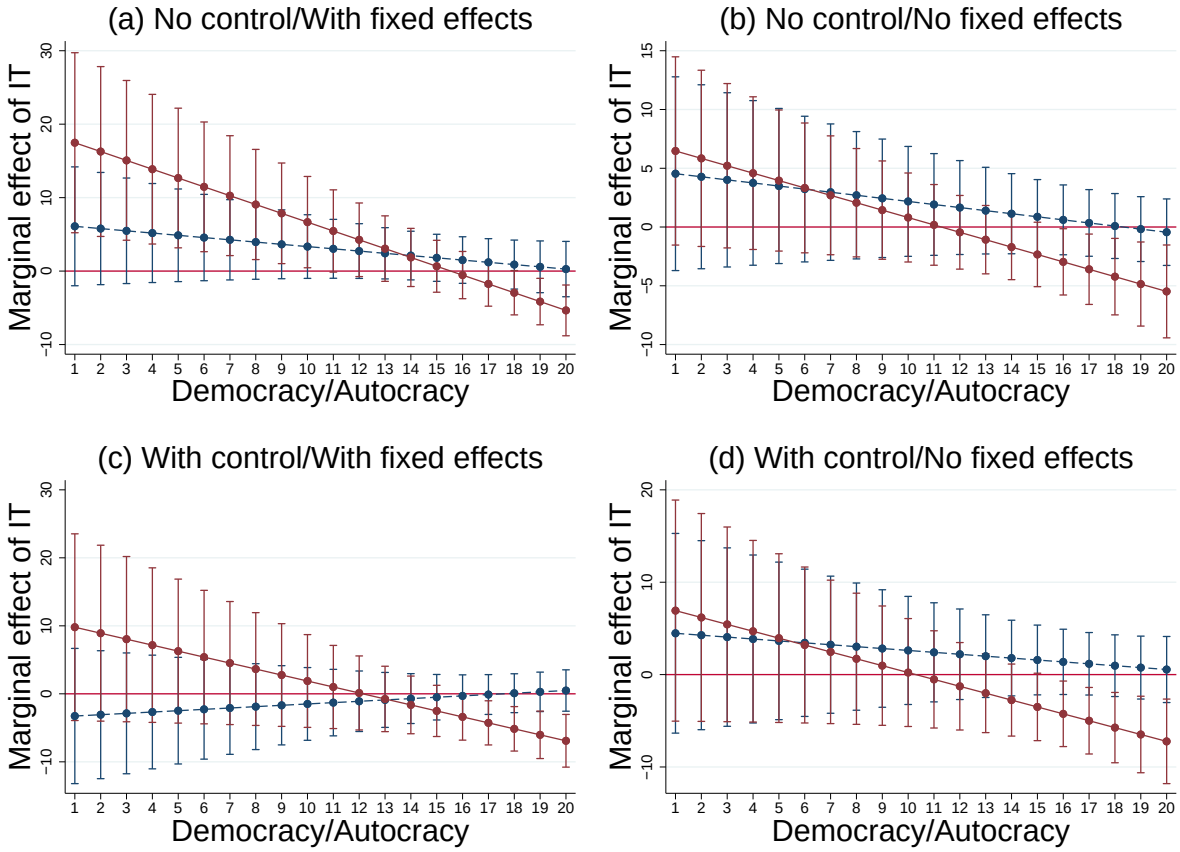
Source: Authors' calculations

Table 11: Role of government accountability across exchange rate regimes (Loose IT dates)

Account proxy	Executive constraints				Democracy/autocracy			
Controls	Without		With		Without		With	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable: 100*△logcpi								
L.Infl	0.496***	0.578***	0.412***	0.497***	0.496***	0.580***	0.413***	0.500***
	(13.857)	(22.424)	(7.146)	(10.032)	(14.365)	(23.222)	(7.433)	(10.498)
IT (β)	4.852	5.258	0.612	8.322	2.560	1.684	-0.846	3.077
	(0.723)	(0.928)	(0.079)	(0.901)	(0.890)	(0.606)	(-0.238)	(0.848)
Account	0.406	0.297	0.199	0.338	0.245**	0.088	0.167	0.133
	(1.084)	(0.829)	(0.541)	(0.842)	(2.013)	(0.828)	(1.463)	(1.150)
Float	-2.554	0.678	-2.048	0.827	1.768	3.355***	2.935***	4.361***
	(-0.951)	(0.283)	(-0.945)	(0.385)	(1.564)	(3.266)	(2.721)	(4.742)
IT*Account(λ)	-0.780	-1.007	-0.042	-1.205	-0.334	-0.284	0.131	-0.266
	(-0.688)	(-1.178)	(-0.031)	(-0.795)	(-1.095)	(-1.091)	(0.392)	(-0.697)
IT*Float (ρ)	18.780***	7.277	19.442***	9.179	3.310	-1.295	2.932	-2.424
	(3.274)	(1.352)	(2.637)	(1.209)	(1.359)	(-0.491)	(0.723)	(-0.904)
Float*Account	1.117**	0.577	1.325**	0.837	0.355**	0.180	0.379**	0.211
	(2.065)	(1.174)	(2.553)	(1.563)	(1.995)	(1.129)	(2.460)	(1.341)
IT*Float*	-3.617***	-1.825*	-4.119***	-2.609*	-0.925***	-0.423	-1.154**	-0.612
Account (υ)	(-3.596)	(-1.944)	(-3.162)	(-1.940)	(-2.785)	(-1.162)	(-2.091)	(-1.425)
Parity chg			4.265***	5.378***			4.235***	5.365***
			(3.033)	(3.642)			(3.085)	(3.718)
L.Parity chg			-0.664	0.214			-0.671	-0.033
			(-0.890)	(0.294)			(-0.927)	(-0.046)
Cur crisis			3.861***	4.453***			3.988***	4.658***
			(5.072)	(5.441)			(5.138)	(5.565)
L.Cur crisis			3.017***	3.211***			3.038***	3.291***
			(4.454)	(5.423)			(4.642)	(5.551)
Fixed effects	Yes	No	Yes	No	Yes	No	Yes	No
Time dummies	Yes	Ye	Yes	Yes	Yes	Yes	Yes	Yes
Specific trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
$\lambda + \upsilon$	-4.397	-2.832	-4.161	-3.814	-1.259	-0.706	-1.023	-0.878
$\lambda + \upsilon$, p-value	0.000199	0.00735	0.0104	0.0437	0.00768	0.0449	0.0453	0.0724
λ	-0.780	-1.007	-0.0422	-1.205	-0.334	-0.284	0.131	-0.266
λ, p-value	0.493	0.241	0.975	0.428	0.276	0.278	0.696	0.487
Observations	3,240	3,240	2,871	2,871	3,341	3,341	2,978	2,978
Countries	110	110	107	107	110	110	109	109
IT adopters	22	22	20	20	22	22	20	20
Adj. R2	0.533	0.558	0.455	0.496	0.535	0.557	0.456	0.496

Notes: Based on the sub-sample of LICs and EMEs. Loose IT adopt dates are used. Constant, time dummies and country-specific linear trends are not shown for brevity. Executive constraints (democracy/autocracy) ranges from 1 to 7 (-10 to 10). $\lambda+\upsilon$ reflects how the marginal effect of IT on inflation changes as government accountability rises under floating exchange rates; λ reflects how the effect changes under fixed exchange rates. Inflation rate is calculated as a log difference of CPI. Countries with the average inflation of over 50 percent over the sample period are not included. t-statistics are in parentheses. Clustered standard errors are used to adjust for correlation of error terms within countries. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Figure 8: Marginal IT effects, democracy/autocracy and exchange rate regimes (Strict IT dates)



Notes: A solid (dashed) line connects point estimates under floating (fixed) exchange rate regime.
A marginal effect with 90% confidence interval is shown.
Democracy/autocracy initially ranges from −10 to 10.
It is rescaled to 0 to 20 to be compatible with "Margins" Stata command.

Source: Authors' calculations

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