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Patterns of Foreign Exchange Intervention under Inflation Targeting

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Abstract

The paper documents the use of foreign exchange intervention (FXI) across countries and monetary regimes, with special attention to its use under inflation targeting (IT). We find significant differences between advanced and emerging market economies, with the former group conducting FXI limitedly and broadly symmetrically, while the use of this policy instrument in emerging market countries is pervasive and mostly asymmetric (biased towards purchasing foreign currency, even after taking into account precautionary motives). Within emerging markets, the use of FXI is common both under IT and non-IT regimes. We find no evidence of FXI being used in response to inflation developments, while there is strong evidence that FXI responds to exchange rates, indicating that IT central banks in EMDEs have dual inflation/exchange rate objectives. We also find a higher propensity to overshoot inflation targets in emerging market economies where FXI is more pervasive.

JEL Classification Numbers: F31, E63

Keywords: inflation targeting, foreign exchange intervention, exchange rate

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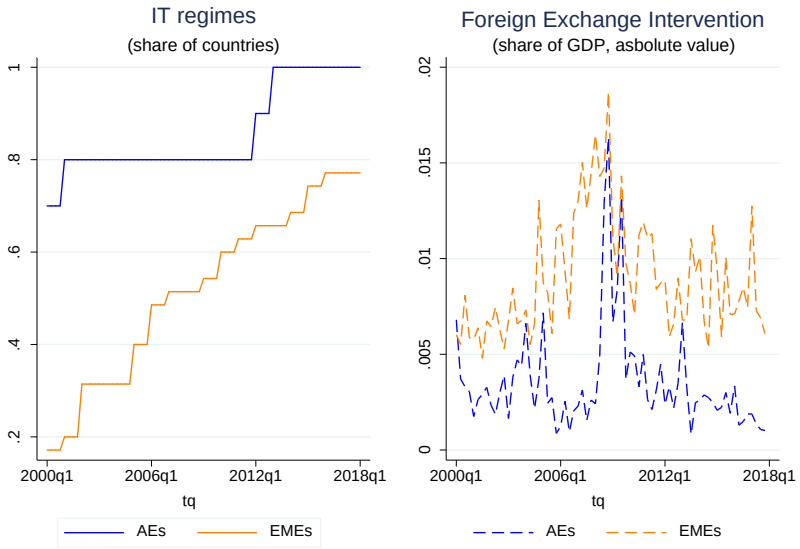
I. INTRODUCTION

Since the late 1990's a fast growing number of countries have adopted inflation targeting (IT) as monetary framework (Figure 1-left panel). The pace of adoption of IT regimes has been particularly striking among large emerging market and developing economies (EMDEs), where the share of countries with IT regimes has more than tripled over the last two decades. Consistent with the earlier implementation of IT in advanced economies (AEs), the conventional wisdom was, at first, that an essential element of a full-fledged IT regime was a free-floating exchange rate. With the increasing adoption of IT by EMDEs, however, such view came into question as many of these economies continued to manage their exchange rates through the deployment of foreign exchange intervention (FXI) after the adoption of IT (Figure 1-right panel). As a result, a debate about the consistency of FXI with IT, and its implications, emerged in recent years.

Figure 1. Inflation Targeting and Foreign Exchange Intervention 1/



Sources: AREAER, central banks, WEO, International Financial Statistics and authors' calculations.
1/ Based on a sample of 12 advanced and 36 emerging and developing market economies with independent monetary policy (see list in Appendix Table A1). Share of countries with IT regimes is depicted in left panel. Simple group average of proxy of FXI (discussed below) in absolute value is reported in the right panel.

Most of the new research that accompanied this debate focused on the role of FXI as an additional tool for macroeconomic stabilization, building on the notion that multiple policy objectives (for example, inflation and the exchange rate) required the use of multiple instruments, as studied by Ghosh et at (2016).[1] This line of research—including the work by Garcia et al (2011), Canzoneri and Cumby (2014), Benes et al (2015), Buffie et al (2018), Adler et at (2019), Cavallino (2019), Gomez et al (2019), etc.—studied the merits of the use of FXI as an additional policy instrument mostly from a theoretical perspective.[2]

[1] Other related studies with a focus on the use of FXI or equivalent policy instruments for capital flow management include Jeanne and Korinek (2010); Jeanne (2013), Qureshi et al (2011), Ostry et al (2011), and Ostry et al (2010). See also, Benes et al. (2015), Canzoneri and Cumby (2014), and Liu and Spiegel (2015).

[2] See Agénor and Pereira da Silva (2019) for a detailed discussion on the use of other policy instruments in the context of inflation targeting.

To date, however, there has been little empirical work on how FXI is conducted under IT regimes, whether the use of FXI under IT responds to inflation objectives or to dual exchange rate/inflation objectives, and whether exchange rate management is detrimental or instrumental to the achievement of inflation targets.

Foreign exchange intervention can have very different implications for inflation objectives depending on how it is conducted, especially in EMDEs where exchange rate pass-through tends to be high. As noted by Agénor and Pereira da Silva (2019), there is ample evidence on the effectiveness of FXI in reducing exchange rate volatility and, with high pass-through, stabilizing the exchange rate could be conducive to domestic price stability. This, however, would largely depend on the direction of FXI in connection to inflation developments. For example, selling foreign exchange to defend the value of the domestic currency, as often done in EMDEs, may be supportive of inflation objectives if done in the context of inflationary pressures. Similarly, purchasing foreign exchange could support inflation objectives if done in the context of deflationary pressures. This was part of the rationale for the large FX purchases conducted by the Swiss National Bank against a backdrop of deflationary pressures and sizable capital inflows in the aftermath of the global financial crisis (preceded by the lowering of interest rates to near zero and accompanied by the introduction of a floor on the value of the Swiss Franc against the Euro in September 2011 and negative interest rates in January 2015).[3]

On the other hand, the use of FXI to directly manage the exchange rate independently of inflationary developments would entail dual monetary objectives, arguably in detriment of a single inflation objective as FXI could move the exchange rate in a manner/direction inconsistent with inflation targets or de-anchor inflation expectations (see Adler et al, 2019).

Whether central banks conduct FXI in a manner consistent with IT or in pursue of dual objectives is an empirical question that have yet to be explored. Similarly, the consequences of the use of FXI when the latter reflects dual objectives remain to be understood. This paper aims at filling this gap in the literature by documenting the use of FXI under IT and non-IT regimes, both in advanced and emerging market economies, and exploring the implications of FXI for monetary policy outcomes.

Some clear patterns emerge from our analysis:

In advanced economies, the use of FXI is limited both in IT and non-IT regimes, and it is mostly symmetric. That is, FX purchases are as frequent as FX sales.

In emerging market economics, while IT regimes tend to allow for greater exchange rate flexibility, the use of FXI is pervasive under across monetary regimes, with only a marginally lower use in IT regimes. Moreover, FXI is largely one-sided under across regimes, with a bias towards buying foreign currency even after controlling for precautionary motives for reserve accumulation.

We find no evidence of FXI being used in response to inflation developments in IT regimes, while there is strong evidence that FXI responds to exchange rates, indicating that IT central banks in EMDEs have dual inflation/exchange rate objectives. Finally, we find a higher tendency to overshoot inflation targets in EMDEs and this outcome appears to be connected to the more extensive use of foreign exchange intervention.

The rest of the paper is organized as follows: Section II presents stylized facts on the use of FXI across country groups and monetary regimes. Section III explores the implications of the use of FXI in IT regimes, shedding light on whether the use of FXI is associated with different inflation outcomes. Section IV concludes with key takeaways and brief discussion of further areas of research.

[3] It was also the rationale for the introduction of the one-sided exchange rate floor by the Czech National Bank in November 2013 with the goal of fighting deflationary pressures (see Caselli, 2017).

II. Foreign Exchange Intervention across Monetary Regimes

Originally, conventional wisdom posed that a key element of a full-fledged IT regime was the free floating of the exchange rate. Under IT, the interest rate was meant to be the main instrument of monetary policy and the exchange rate let to float freely both to allow for the interest rate to affect inflation through its effect on the exchange rate and to ensure that inflation objectives were not subordinated to any exchange rate objective. Over time, however, and especially as EMDEs adopted IT, the use of FXI in conjunction with IT became common. In this section, we document the patterns of use of FXI for different groups of countries and across monetary regimes, focusing on a sample of 12 AEs and 36 EMDEs, composed of mid-to-large size economies with monetary policy autonomy (i.e., excluding currency pegs and countries within monetary unions). The sample encompasses quarterly data for the period 2000-17.[4]

A. FXI Proxy

In line with previous studies, and given the limited availability of public FXI data, the paper relies on a proxy based on quarterly balance-of-payments (BOP) statistics on changes in central bank reserves. Unlike other commonly-used measures in the literature based on changes in the stock of reserves—which are polluted by valuation changes—our proxy only reflects variations in the central bank reserves arising from FX transaction, as captured by BOP statistics. In additions, two adjustments along the lines of Adler et al (2019) are made in order to fully account for and reflect more accurately interventions in the FX market:

- *Income on reserves.* BOP reserve flows include changes arising from the accrual of income on the respective stock position. This component reflects automatic variations in reserves and not new FX operations and, thus, needs to be stripped in order to capture only new FX transactions. Accordingly, the estimated income on reserves (based on observed returns and existing stocks) are subtracted from BOP reserve changes.
- *Derivatives.* Some central banks have made increasing use of foreign currency derivatives (i.e., forwards, options and swap contracts) in recent years. In most respects, these operations are equivalent to operations in spot markets, as discussed by Nedeljkovic and Saborowski (2017). To encompass these operations, the FXI proxy includes changes in aggregate short and long positions in forwards and futures in foreign currencies vis-à-vis the domestic currency (including the forward leg of currency swaps) and financial instruments denominated in foreign currency but settled by other means (e.g., in domestic currency), as reported in the *IMF's International Reserves and Foreign Currency Liquidity Template.*

The computation of the FXI proxy, thus, takes the following form:

$$FXI_{it} = \Delta^{BOP} Res_{it} - Res\ Income_{it} + Derivatives_{it}$$

where $\Delta^{BOP} Res_{it}$ denotes changes in reserves as captured by BOP statistics; $Res\ Income_{it}$ refers to estimated income on reserves; and $Derivatives_{it}$ denotes foreign exchange transaction through derivatives. For comparability across time and countries, nominal US dollar values of FXI are normalized by GDP (FXI/GDP) using a trend measure of nominal GDP in US dollars (using trend values prevents variations in the ratio due to changes in the denominator unrelated to FXI).

[4] See Appendix Table A1 for details on the sample of countries.

B. Patterns of Foreign Exchange Intervention

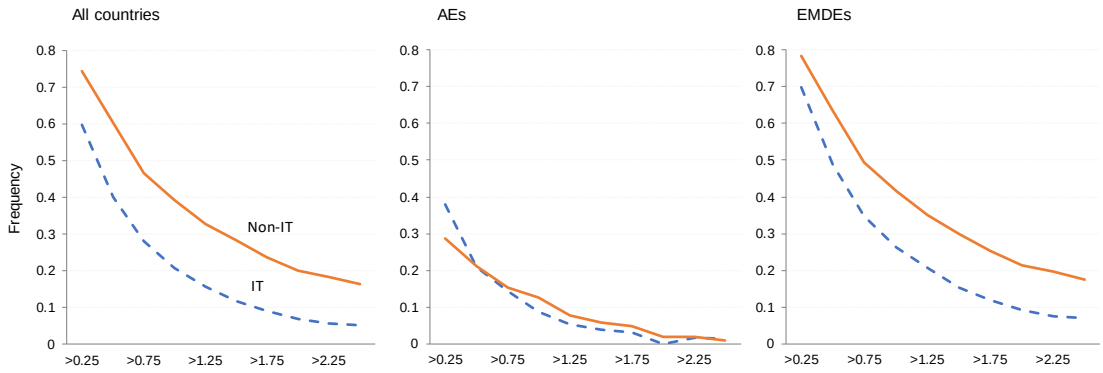
The conduct of FXI can be characterized along three key dimensions or metrics: (i) the *size* of interventions; (ii) their *symmetry*—i.e., whether interventions have a purchase or sale bias; and (iii) the *degree* of exchange rate management—i.e., degree of intervention relative to the volatility of the exchange rate. These characteristics are studied across monetary regimes, taking them as given.[5]

Size of foreign exchange intervention

Figure 2 presents key stylized facts on the average size and frequency of FXI under IT and non-IT regimes for the full sample as well as for AEs and EMDEs separately. To avoid including any residual measurement error related to the estimation of reserve income flows, (quarterly) values of the estimated FXI proxy that are smaller than 0.25 percent of GDP in absolute value are not reported. Given the size of reserve stock and normal returns, this threshold is likely to exclude most observations dominated by mismeasurement of the income on reserves.

For the full sample, the use of FXI is found to be common both under IT and non-IT regimes, being only marginally less frequent under IT. Specifically, interventions of 0.25 percent of GDP or more in absolute value (i.e., FX purchases or sales) took place 74 percent of the time in Non-IT regimes during the sample period, compared to 60 percent in IT regimes. This pattern mainly reflects the behavior of central banks in EMDEs, where interventions are frequent under both regimes, while in AEs interventions are markedly more limited under both regimes. For example, while interventions of 0.5 percent of GDP or larger took place about 20 percent of the time in advanced economies, they occur 60-70 percent of the time in EMDEs.

Figure 2. Foreign exchange intervention across groups and monetary regimes



Sources: IMF *Balance of Payment Statistics, World Economic Outlook* and authors' calculations.
Note: Foreign exchange intervention is measured in percent of GDP.

A formal test of differences is reported in Table 1 for both FXI and FXI in absolute value. As shown, there is a marked difference in the pace of net FX accumulation between AEs and EMEs as indicated by the mean value of FXI for each group, with the former accumulating less than 0.1 percent of GDP per quarter on average, in comparison to 0.3 percent of GDP in EMEs. Within each of these groups, however, there is no meaningful difference between IT and Non-IT regimes in terms of *net* FXI. On the other hand, IT and Non-IT regimes display a statistically significant difference in the absolute size of

[5] While the monetary regime is endogenous, the choice of IT would likely accentuate differences between IT and non-IT regimes with regards to the use of FXI, as countries with a preference or greater scope for exchange rate flexibility, and thus, less use of FXI, would be more prone to adopt IT.

FXI, indicating a greater degree of intervention in the latter group, in one direction of another, although the average size of FXI in IT regimes (0.8 percent of GDP is still economically sizable).

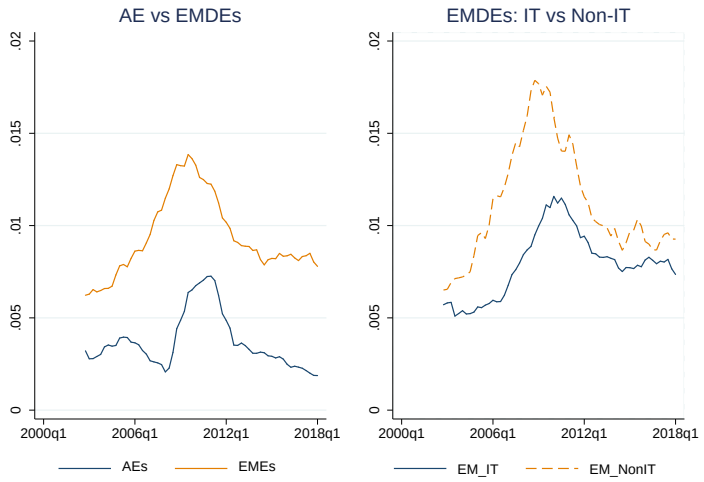
Table 1. FXI by country group and monetary regime

		FXI/GDP		Abs(FXI/GDP)	
		Mean	Var.	Mean	Var.
All countries					
AEs	μ1	0.088	0.658	0.354	0.562
EMDEs	μ2	0.301	1.414	0.898	1.133
Difference	μ1-μ2	-0.213 ***	-0.755 ***	-0.544 ***	-0.571 ***
Advanced Economies					
Non-IT	μ1	0.113	0.638	0.306	0.570
IT	μ2	0.084	0.662	0.362	0.561
Difference	μ1-μ2	0.029	-0.024	-0.056	0.010
Emerging Market and Developing Economies					
Non-IT	μ1	0.338	1.582	1.034	1.244
IT	μ2	0.270	1.254	0.783	1.015
Difference	μ1-μ2	0.067	0.329	0.251 ***	0.228 ***

Sources: IMF *Balance of Payment Statistics, WEO* and authors' calculations.
Note: Based on quarterly FXI, in percent of GDP. *** p<0.01, ** p<0.05, * p< 0.1.

A time-series perspective further indicates that these patterns hold throughout the last two decades, as shown in Figure 3. The figure also points to clear global waves in the use of FXI, pointing to the role of global factors in driving these policies. Specially striking is the increase in the use of FXI across groups in the run up to and the aftermath of the global financial crisis.

Figure 3. Foreign exchange intervention by country groups and over time
(3-year moving average)



Sources: IMF *Balance of Payment Statistics, World Economic Outlook* and authors' calculations.
Note: Simple moving average of the absolute value of FXI, in percent of GDP, is reported.

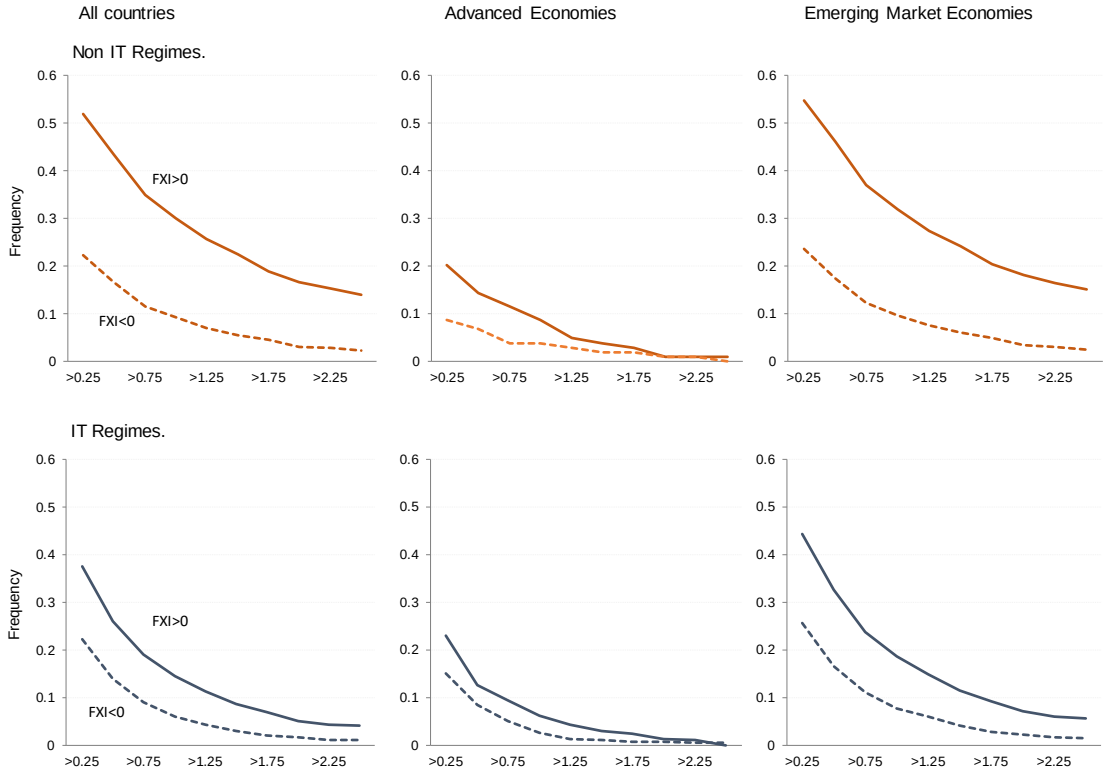
Symmetry of foreign exchange intervention

Another important aspect of the conduct of FXI is whether interventions are symmetric—aimed at dampening exchange rate volatility—or one-sided—leaning against appreciation or depreciation. The degree of symmetry is relevant not only for understanding the underlying motives for intervening in FX markets, as asymmetries may reflect different needs for accumulating reserves, or asymmetries

in shocks[6], but also because two-sided and one-sided interventions are likely to have different impact on exchange rates and inflation.

Figure 4 plots the frequency of FX purchases (FXI>0) and sales (FXI<0) separately, again reporting only interventions of absolute value equal or greater than 0.25 percent of GDP in any given quarter. A shown, there is a marked asymmetry in the deployment of FXI in EMDEs, with a bias towards buying foreign exchange. The asymmetry is marked in non-IT regimes (upper panels) but also visible in IT frameworks (lower panels), pointing to 'leaning against the wind' policies in both regimes. While this asymmetry is also visible in AEs, it is much less pronounced, reflecting and overall lower degree of intervention than in EMDEs, both for IT and non-IT frameworks.

Figure 4. Foreign exchange purchases and sales

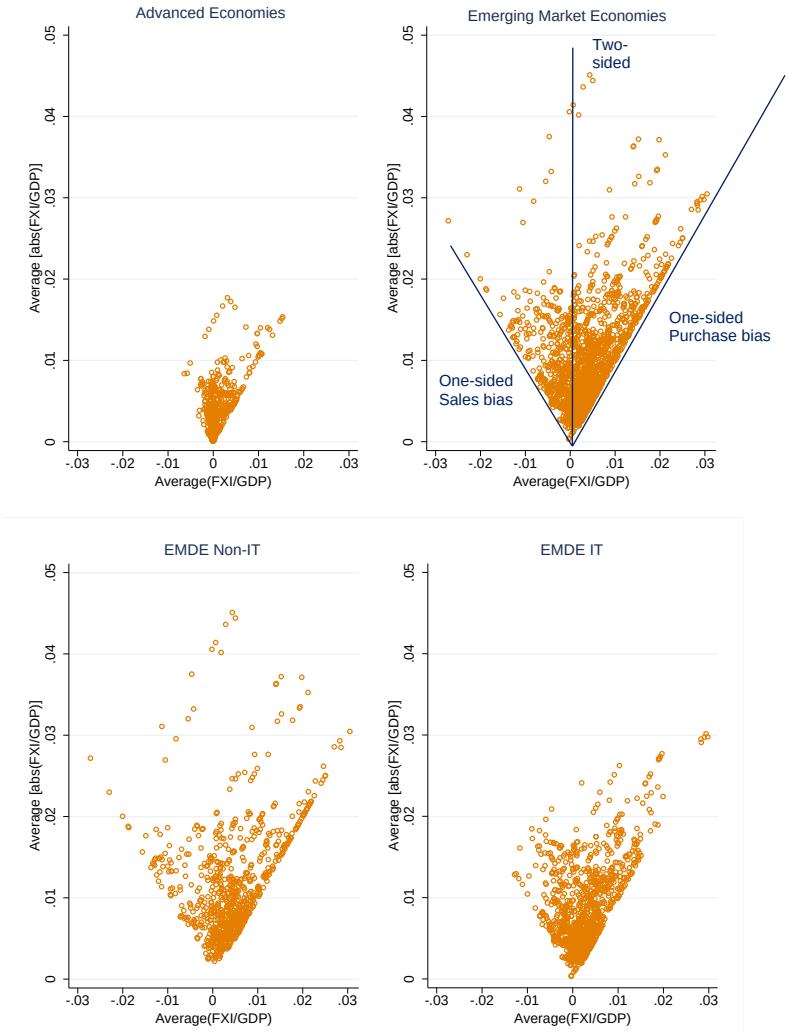


Sources: IMF *Balance of Payment Statistics, World Economic Outlook* and authors' calculations.
Note: FXI is measured in percent of GDP.

Figure 5 further illustrates the magnitude and degree of symmetry of FXI across key country groups by plotting the average FXI and average absolute value of FXI computed over 8-quarter windows (similar patterns are visible for longer windows). As shown, AEs tend to intervene in limited amounts in comparison to EMDEs where interventions are larger and tilted towards FX purchases. Within EMDEs, interventions do not appear to be fundamentally different between IT and non-IT regimes in terms of their size or direction, although cases of exceptionally high degree of intervention (for example, north of 3 percent of GDP per quarter) are only visible in non-IT regimes.

[6] For example, EMDEs may behave differently to AEs reflecting their tendency to receive capital flows in the first cases, in contrast to a tendency to export capital in the latter.

Figure 5. Size and symmetry of foreign exchange intervention



Sources: IMF *Balance of Payment Statistics, World Economic Outlook* and authors' calculations.
Notes: measures of FXI size and symmetry for 8-quarter windows are reported.

To formally test whether interventions are conducted in a two- or one-sided manner, we first construct an index of FXI symmetry (S_{it}^{L}), for country *i* at time *t*, as:

$$S_{it}^{L} = \sum_{l=1}^{L}\left[\frac{FXI_{i,t-l+1}}{GDP_{i,t-l+1}}\right] / \sum_{l=1}^{L} abs\left[\frac{FXI_{i,t-l+1}}{GDP_{i,t-l+1}}\right]$$

The index, calculated for alternative window lengths (L quarters), takes value 0 if interventions are fully symmetric and 1 (-1) if they are one-sided FX purchases (sales).[7]

Differences in the degree of symmetry across groups of countries are explored by estimating a simple equation of the form:

[7] The index capture symmetry at quarterly frequency, consistent with the frequency of the available data. While intra-quarter FX operations could display a different pattern, available data at higher frequency indicate that quarterly and higher frequency patterns are similar.

$$S_{it}^{L} = \alpha^{G} + \beta^{G} * IT_{it} + \varepsilon_{it}$$

where S_{it}^{L} is the index of symmetry as described above, and IT_{it} denotes a dummy of de jure inflation targeting. The coefficient α^{G} captures the average degree of symmetry of non-IT countries in income group G (AEs or EMDEs) and $\alpha^{G} + \beta^{G}$ the corresponding degree of symmetry for IT regimes within the income group.

Table 2 below display the results for 8- and 12-quarter windows. For the full sample (column 1), they confirm a bias towards FX purchases in non-IT regimes, as indicated by the positive and statistically significant value of α^{G} (0.33). This result is driven by EMDEs, as the corresponding value for AEs (column 2) is not statistically different from zero (case of symmetry), while the value for EMDEs (0.30) is economically and statistically significant (column 3). More importantly, while statistically significant, there is no evidence of an economically meaningful difference between IT and non-IT regimes for the EMDE group—as evidenced by the small value of β^{G}—indicating a similar degree of asymmetry in FX interventions both in IT and non-IT regimes.

As previously mentioned, this asymmetry in the conduct of FXI in EMDEs may reflect a need to accumulate reserves to maintain adequate foreign currency liquidity for precautionary reasons. To account for this, column (4) controls for the lagged level of reserves, measured as the stock of reserves in share of GDP. The estimated coefficient is negative and statistically significant, indicating that economies with lower reserves have a greater bias towards purchasing foreign currency. After controlling for precautionary motives, the observed asymmetry in the conduct of FXI in EMDEs becomes starker while the difference between IT and non-IT economies remains marginal. As shown, these patterns also hold for computations of the symmetry index over longer time windows (columns 5-8).[8]

Table 2. FXI symmetry across groups and regimes

Window:	L = 8 quarters				L = 12 quarters			
Smaple:	All	AEs	EMDEs	EMDEs	All	AEs	EMDEs	EMDEs
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
α^{G}	0.329***	0.0336	0.357***	0.624***	0.343***	0.0007	0.374***	0.649***
	(0.0182)	(0.0844)	(0.0180)	(0.0249)	(0.0173)	(0.0820)	(0.0169)	(0.0218)
β^{G}	-0.102***	0.0779	-0.0769***	-0.0937***	-0.0958***	0.144*	-0.0817***	-0.0996***
	(0.0223)	(0.0874)	(0.0239)	(0.0230)	(0.0208)	(0.0845)	(0.0217)	(0.0205)
Res/GDP (L-lagged)				-1.500***				-1.552***
				(0.136)				(0.123)
Observations	2,862	660	2,202	2,171	1,753	620	2,078	2,047
R-squared	0.007	0.002	0.005	0.074	0.029	0.009	0.007	0.105

Source: Authors' estimations.
Notes: Dependent variable is S_{it}^{L} for *L=8* and *L=12*. *** p<0.01, ** p<0.05, * p< 0.1.

Degree of Exchange Rate Management

The metrics of size and symmetry of FXI presented above provide a useful description of the extent of the use of this instrument across country and regime groups. However, they may not properly reflect the difference in the degree of exchange rate management across countries, as different economies may face shocks of different magnitudes and the use of FXI may reflect that. An alternative metric that takes this into account and attempts to measure the degree of exchange rate management can be constructed as:

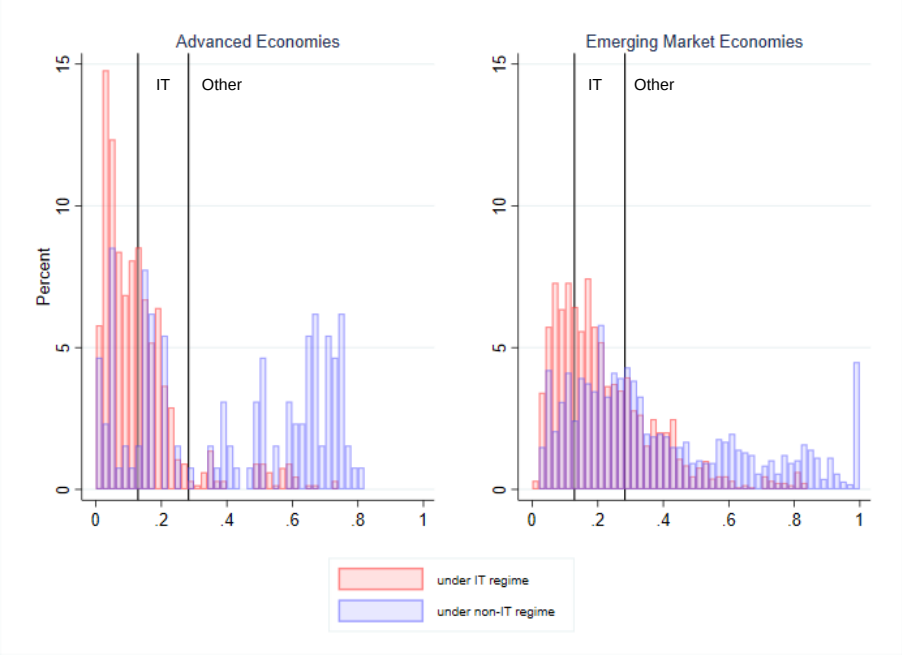
[8] Results also hold when reserves-to-M2 is used as control, and when non-linear effects for reserve holdings are allowed for.

$$\rho_t^L = \frac{\sigma_{L,t}^{fxi}}{\sigma_{L,t}^{\hat{s}} + \sigma_{L,t}^{fxi}}$$

where $\sigma_{L,t}^{\hat{s}}$ is the standard deviation of quarterly changes in the exchange rate (either nominal effective or vis-à-vis the US dollar) computed over a *L-quarter* window; and $\sigma_{L,t}^{fxi}$ is the standard deviation of the quarterly FXI/GDP ratio computed over the same time window. This index varies from 0 (free-floating) to 1 (fixed exchange rate), with the continuum between the two extremes reflecting the degree of exchange rate management. Since the metric captures only the variation in FXI within the L-quarter window, it is largely clean of (slow-moving) precautionary motives for accumulating reserves .

Figure 6 depicts the distribution of ρ for different groups of economies, focusing on variations of the exchange rate vis-à-vis the US dollar. As shown, similar patterns across regimes and income groups to the ones discussed above arise when using this measure. Exchange rates are more tightly managed under non-IT regimes, as indicated by a distribution skewed to the right for this group of countries, in comparison to IT regimes. This difference is particularly stark for the AE group (left panel), for which the distribution of the indicator ρ is markedly skewed to the left for IT and to the right for non-IT regimes. The difference between IT and non-IT regimes within EMDEs is less clear (right panel). Similar patterns are visible when using variations in the nominal effective exchange rate (NEER) as opposed to the bilateral exchange rate vis-à-vis the US dollar, as shown in Appendix Figure A1.

Figure 6. Distribution of exchange rate management Index, by group and regime



Sources: IRFCL, BOP, IFS and authors' calculations.
Notes: Figures report the distribution of $\rho_t = \sigma_t^{fxi}/(\sigma_t^{\hat{s}} + \sigma_t^{fxi})$, computed over 12-quarter windows and focusing on the nominal exchange rate vis-à-vis the US dollar. Vertical lines correspond to IT and non-IT group averages.

As before, to formally test the difference in the degree of exchange rate management between monetary regimes, a simple equation of the following form is estimated:

$$\rho_{it}^L = \alpha^G + \beta^G * IT_{it} + \varepsilon_{it}$$

where ρ_{it}^{L} is the metric of degree of exchange rate management, and IT_{it} is a dummy of inflation targeting regime. The coefficient α^{G} captures the average degree of exchange rate management for non-IT economies in the income group G, and $\alpha^{G} + \beta^{G}$ the corresponding metric for IT regimes within the same income group. These simple equations are estimated also controlling for the level of the reserves-to-GDP ratio to account for precautionary motives for reserve accumulation. Table 3 displays the main results.

Table 3. Degree of exchange rate management across groups and regimes

Window:	L=8 quarters				L=12 quarters			
Country Sample:	All	AEs	EMDEs	EMDEs	All	AEs	EMDEs	EMDEs
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
α^{G}	0.401***	0.124***	0.416***	0.369***	0.383***	0.130***	0.397***	0.362***
	(0.00857)	(0.0142)	(0.00877)	(0.0126)	(0.00832)	(0.0127)	(0.00854)	(0.0126)
β^{G}	-0.212***	-0.0166	-0.189***	-0.214***	-0.198***	-0.0208	-0.176***	-0.214***
	(0.00931)	(0.0146)	(0.00997)	(0.0107)	(0.00898)	(0.0131)	(0.00959)	(0.0107)
Res/GDP (L-lagged)				0.453***				0.466***
				(0.0459)				(0.0437)
Observations	2,961	650	2,311	2,094	2,938	646	2,292	1,971
R square	0.189	0.003	0.148	0.212	0.183	0.006	0.142	0.233

Source: Authors' estimations.
Notes: Dependent variable is ρ_{i}^{L} for *L=8* and *L=12*. *** p<0.01, ** p<0.05, * p< 0.1.

As shown, for the full sample, there is a statistically and economically significant different in the degree of exchange rate management between IT and non-IT regimes (column 1), although EMDEs (column 3) display a significantly higher degree of exchange rate management than AEs (column 2) both for IT and non-IT regimes. Within EMDEs, there is a non-negligible difference between IT and non-IT regimes, with the degree of exchange rate management being considerably lower in IT regimes. Controlling for the level of reserves (columns 4) does not alter the results.[9]

C. Age of IT regime

It is possible that the conduct of FXI under IT changes with the age of the IT regime, as central banks transition away from targeting the exchange rate and towards targeting inflation and as the framework gains credibility and inflation expectations become better anchored around the announced targets. To shed light on this, the relationship between the previously discussed metrics of FXI (size, symmetry and degree of exchange rate management) and the age of the IT regime is explored extending the specification to:

$$y_{it}^{L} = \alpha^{G} + \beta^{G} * IT_{it} + \gamma * IT_{it}^{Age} + \varepsilon_{it}$$

where y_{it}^{L} denotes the metric of FXI use, IT_{it} is the dummy of inflation targeting, as before, and IT_{it}^{Age} denotes the age of the IT regimes in years. Our interest is on the coefficient γ.

Results are presented in Table 4 below. As shown, there is evidence of a statistically-significant reduction in the use of FXI over time in the three metrics, both for AEs and EMDEs, although the effects are relatively small from an economic viewpoint, indicating that the use of FXI remains pervasive even after years of IT regimes.

[9] A time-series perspective highlights the persistence of these patterns throughout the last two decades (see Appendix Figure A2).

Table 4. Age of IT regime and FXI.

	All economies			Emerging and Developing Economies			Advanced Economies		
	Size	Symmetry	Degree of ER mgmt	Size	Symmetry	Degree of ER mgmt	Size	Symmetry	Degree of ER mgmt
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Constant	0.0095***	0.3170***	0.4158***	0.0102***	0.3466***	0.4336***	0.0031***	0.0336	0.1237***
	(30.305)	(16.900)	(62.896)	(28.456)	(18.019)	(59.184)	(5.584)	(0.554)	(11.617)
IT_dummy	-0.0003	-0.0215	-0.1466***	-0.0007	0.0580*	-0.1569***	0.0020***	-0.2126***	0.0347***
	(-0.661)	(-0.716)	(-13.687)	(-1.097)	(1.760)	(-12.225)	(2.776)	(-2.606)	(2.650)
Years of IT	-0.0003***	-0.0059***	-0.0080***	-0.0002***	-0.0143***	-0.0060***	-0.0001***	0.0213***	-0.0038***
	(-6.957)	(-2.871)	(-10.797)	(-3.028)	(-5.050)	(-5.355)	(-3.378)	(5.903)	(-7.471)
Observations	3,145	2,862	2,961	2,415	2,202	2,311	730	660	650
R-squared	0.030	0.007	0.228	0.011	0.014	0.176	0.017	0.052	0.082

Source: Authors' estimations.
Notes: t-statistics reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1, + p<0.15

Taken together, the evidence from the various metrics indicate that, while FXI is limited in AEs, it is pervasive in EMDEs. Moreover, in the latter group, both IT and Non-IT central banks make extensive use of FXI and largely in an asymmetric manner, although IT regimes tend to allow for greater exchange rate flexibility. These patterns appear to hold throughout the last two decades and irrespective of the age of the IT regime.

As mentioned above, these stylized facts take the monetary regime as given. Thus, it is possible that they suffer from endogeneity bias as monetary regimes are a choice for central banks. The choice of IT over other regimes, however, is likely to accentuate differences between IT and non-IT regimes with regard to the use of FXI, as countries with a preference or greater scope for exchange rate flexibility and, thus, less use of FXI, would be more prone to adopt IT. Evidence of small differences in the use of FXI between IT and non-IT regimes speaks of the significant use of FXI even under IT.

D. Single or Dual Objectives?

This section explores the underlying objectives of the central bank associated with the conduct of foreign exchange intervention.

As discussed above, the use of FXI in the context of IT can reflect the use of multiple policy instruments to achieve inflation objectives or dual inflation/exchange rate objectives. In the former case, FXI can support inflation objectives through its impact on the exchange rate if conducted in a direction consistent with pass-through effects that contribute to moving inflation towards the target.[10] The relevance of this mechanism depends on the effectiveness of FXI in moving the exchange rate and the extent of pass-through of exchange rate changes to inflation. Both aspects are particularly relevant for EMDEs as FXI tends to be more powerful in influencing the exchange rate[11] and pass-through tends to be higher than in AEs. Thus, we explore whether central banks actively attempt to affect the exchange rate to facilitate the achievement of inflation targets with the associated pass-through effects. A central bank operating

[10] Agénor and Pereira da Silva (2019) point to the evidence on the role of FXI in reducing exchange rate volatility as an indication that FXI likely contributed to price stability in EMDEs although they do not explicitly explore the latter link.

[11] See empirical work on the impact of FXI on exchange rates by Adler et al (2019), Blanchard et al (2015), Daude et al (2016), Fratzcher et al (2019); and a comprehensive survey of the literature by Menkhoff (2013).

in this manner would buy foreign exchange—to depreciate the domestic currency—in the context of low inflation or expected inflation. Conversely, it would sell foreign exchange in the context of high inflation or expected inflation.[12]

To study the link between FXI and inflation developments, measures of both actual inflation (from the *International Financial Statistics*) and inflation expectations from Consensus Forecast are considered. The latter encompass survey-based measures that reflect inflation expectations for end of the current year as well as end of the following year. Because none of these have a uniform time horizon over time, a synthetic 12-month horizon inflation expectation measure ($E\pi_{it}^{12m}$) is constructed. This combines the survey-based expectations for the current and the following calendar year as well as up-to-date realized inflation in the current year, as follows:

$$E\pi_{it}^{12m}(M) = \left(E\pi_{it}^{CY} - \pi_{it}^{TD}\right) + E\pi_{it}^{NY}\left(\frac{12-M}{12}\right)$$

where the first right-hand side term captures the expected inflation between time t and the end of the current year, that is, the difference between inflation expectation for the end of the current year ($E\pi_{it}^{CY}$) and the accumulated inflation to date, (π_{it}^{TD}). The second term captures the expected inflation in the first months of the following year up to the 12-month horizon (assuming constant inflation within the following year).

First, we compare joint probabilities of FXI and contemporaneous inflation outcomes, focusing on EMDEs given the greater prevalence of FXI in this country group. As shown in Table 5, there is no apparent link between the conduct of FXI and contemporaneous inflation developments in term of deviations from the target. For example, focusing on FX purchases or sales that are greater than 0.25 percent of GDP, we find that less than ½ of the FX operations were conducted in a manner that would have helped achieve inflation targets (either selling FX when inflation was above the target, or buying FX when inflation was below the target). This holds also for any of the measures of inflation expectations as well as for larger observations of FXI operations (e.g., greater than 0.5 or 1.0 percent of GDP).

The propensity to intervene in a manner supportive of the inflation objective was, however, depends on whether inflation was over- or under-shooting the target. Specifically, FXI was more likely to be deployed in a direction consistent with inflation objectives when inflation was running below target (in these cases, central banks purchased foreign exchange 63 percent of the time) than when inflation was running above target (in these cases, central banks sold foreign exchange 35 percent of the time). This pattern indicates a greater propensity to attempt to depreciate the domestic currency than to appreciate it. The pattern holds for actual inflation as well as for the different measures of inflation expectations, and for small and large interventions.

[12] This could happen in isolation (active exchange rate management) or in response to shocks that would exacerbate inflation developments (passive management). An example of the later would be selling reserves to contain depreciation pressures in the context of capital outflows and inflation pressures (inflation or inflation expectations above the target).

Table 5. FXI and inflation target deviations—EMDEs

		Inflation $\pi-\pi^T$			12-month ahead Inflation Exp. $E(\pi^{12m}-\pi^T)$			Next-year Inflation Expect. $E(\pi^{NY}-\pi^T)$		
FXI size (%GDP)	FXI Direction	Above target	Below target	Both	Above target	Below target	Both	Above target	Below target	Both
>0.25	Purchase	0.25	0.18	0.43	0.27	0.17	0.44	0.29	0.15	0.44
	Sale	0.15	0.11	0.26	0.15	0.12	0.26	0.17	0.09	0.26
	Freq (IT-cons. FXI / π)	0.37	0.62	0.47	0.35	0.59	0.45	0.37	0.62	0.46
>0.5	Purchase	0.17	0.14	0.31	0.19	0.12	0.31	0.20	0.11	0.31
	Sale	0.09	0.08	0.17	0.09	0.09	0.18	0.11	0.07	0.18
	Freq (IT-cons. FXI / π)	0.35	0.64	0.48	0.32	0.58	0.43	0.36	0.62	0.45
>1.0	Purchase	0.10	0.07	0.17	0.10	0.07	0.17	0.11	0.06	0.17
	Sale	0.04	0.03	0.08	0.04	0.04	0.08	0.05	0.03	0.08
	Freq (IT-cons. FXI / π)	0.30	0.69	0.47	0.30	0.63	0.44	0.32	0.66	0.44

Source: Authors' calculations.
Note: The table reports the frequency of FXI of different magnitudes (greater than 0.25, 0.50 or 1.0 percent of GDP) under different inflation backdrops.

As shown in Table 6, however, the difference in the prevalence of FXI between periods of inflation under- and over-shooting disappears when deviations are measured relative to the target range (that is, overshooting the upper band or undershooting the lower band), although the propensity to conduct FXI in a manner supportive of the inflation objective remains low (30-40 percent).

Table 6. FXI and inflation deviations from target bands—EMDEs

		Inflation $\pi-\pi^T$				12-month ahead Inflation Exp. $E(\pi^{12m}-\pi^T)$				Next-year Inflation Expect. $E(\pi^{NY}-\pi^T)$			
FXI size (%GDP)	FXI Direction	Above range	Within range	Below range	All	Above range	Within range	Below range	All	Above range	Within range	Below range	All
>0.25	Purchase	0.15	0.19	0.09	0.43	0.10	0.25	0.09	0.43	0.10	0.25	0.08	0.43
	Sale	0.09	0.10	0.05	0.25	0.07	0.13	0.05	0.25	0.07	0.13	0.05	0.25
	Freq (IT-cons. FXI / π)	0.38	0.35	0.36	0.48	0.41	0.35	0.37	0.51	0.41	0.35	0.37	0.51
>0.5	Purchase	0.11	0.14	0.07	0.31	0.07	0.18	0.06	0.31	0.08	0.18	0.06	0.31
	Sale	0.06	0.07	0.03	0.16	0.04	0.08	0.04	0.16	0.05	0.08	0.03	0.16
	Freq (IT-cons. FXI / π)	0.34	0.33	0.34	0.46	0.37	0.32	0.36	0.50	0.39	0.32	0.33	0.50
>1.0	Purchase	0.07	0.06	0.04	0.17	0.04	0.08	0.05	0.17	0.05	0.08	0.04	0.17
	Sale	0.02	0.03	0.02	0.07	0.02	0.03	0.02	0.07	0.03	0.03	0.01	0.07
	Freq (IT-cons. FXI / π)	0.26	0.32	0.28	0.43	0.32	0.27	0.33	0.51	0.37	0.27	0.25	0.52

Source: Authors' calculations.
Notes: The table reports the frequency of FXI of different magnitudes (greater than 0.25, 0.50 or 1.0 percent of GDP) under different inflation backdrops.

To shed further light on the underlying objectives of FXI and, specifically whether FXI responds to inflation or the exchange rate, we explore a reaction function for FXI of the following form:

$$FXI_{it} = \psi^{\pi}\left(E\pi_{it}^{h} - \pi_{it}^{T}\right) + \sum_{l=1}^{L} \psi_{l}^{e} \Delta lne_{it-l+1} + \alpha_{it} + \varepsilon_{it}$$

where FXI_{it} denotes period *t* foreign exchange intervention, as share of GDP; $\left(\mathrm{E}\pi_{\mathrm{it}}^{\mathrm{h}} - \pi_{\mathrm{it}}^{\mathrm{T}}\right)$ denotes the deviation of (*horizon-h)* inflation expectation from the target[13]; Δlne_{it-l+1}denotes the *l*-lagged quarterly change in the exchange rate vis-à-vis the US dollar (with positive values corresponding to a depreciation of the domestic currency); and α_{it} is a country fixed effect that captures other, time-variant, determinants of foreign exchange intervention. Contemporaneous and 7 lags are considered for the exchange rate variables.

The coefficients ψ^{π} and ψ^{e}, which reflect how FXI responds to inflation and exchange rate developments, respectively, are of particular interest. As shown in Table 7, results across different specifications display consistently sizable and statistically-significant coefficients for ψ^{e} (particularly for the contemporaneous effects and the first two lags) while insignificant values for ψ^{π}. These indicate that the use of FXI in IT regimes responds to exchange rates—leaning against the wind[14]—rather than inflation developments. Similar results hold when using NEER instead of USD exchange rate, as well as lagged values of inflation deviations from target (actual or inflation expectations).

Table 7. FXI reaction function—EMDEs 1/

	Response to:								
	Actual Inflation			Next-year Inflation Expect.			12-month Inflation Expect.		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
π-π^{T}	0.010	0.015	0.015						
	(0.686)	(1.067)	(1.062)						
$E(\pi^{NY}$-$\pi^{T})$				0.019	0.004	0.004			
				(0.364)	(0.054)	(0.062)			
$E(\pi^{12m}$-$\pi^{T})$							0.035	0.032	0.031
							(0.955)	(0.751)	(0.750)
∑Δln(ER)	-0.0740***	-0.0638**	-0.0606**	-0.0868***	-0.0872***	-0.0808***	-0.0906**	-0.0889***	-0.0825***
	(-2.957)	(-2.072)	(-2.127)	(-3.422)	(-4.061)	(-3.592)	(-3.791)	(-4.202)	(-3.717)
Δln(ER)	-0.050***	-0.047***	-0.046***	-0.051***	-0.049**	-0.046**	-0.050***	-0.049**	-0.046**
	(-2.974)	(-2.908)	(-2.895)	(-2.747)	(-2.806)	(-2.663)	(-2.781)	(-2.805)	(-2.671)
L.Δln(ER)	-0.011+	-0.010	-0.009	-0.017***	-0.016***	-0.015***	-0.016***	-0.015***	-0.015***
	(-1.612)	(-1.247)	(-1.257)	(-3.031)	(-2.896)	(-2.823)	(-3.115)	(-3.004)	(-2.937)
L2.Δln(ER)	-0.008	-0.006	-0.006	-0.010*	-0.009+	-0.009	-0.010*	-0.010+	-0.009+
	(-1.387)	(-1.014)	(-1.012)	(-1.673)	(-1.536)	(-1.476)	(-1.710)	(-1.575)	(-1.511)
Reserves/GDP (l1)			-0.010			-0.022**			-0.022**
			(-0.887)			(-2.302)			(-2.315)
Constant	0.003***	0.003***	0.005**	0.003***	0.003***	0.007***	0.003***	0.003***	0.006***
	(5.155)	(16.360)	(2.280)	(4.730)	(10.079)	(4.285)	(4.251)	(12.740)	(4.131)
Country FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Reserves	No	No	Yes	No	No	Yes	No	No	Yes
Observations	1,084	1,084	1,084	997	997	997	997	997	997
Countries	25	25	25	24	24	24	24	24	24

Sources: Authors' estimations.
1/ Robust t-statistics reported in parentheses. *** p<0.01, ** p<0.05, *p< 0.1, + p<0.15. ∑Δln(ER) denotes the lags 0 to 7 cumulative effect. Contemporaneous and first two lags are also reported separately.

[13] As before, the model is estimated for different measures of inflation expectations.

[14] The results indicate that central banks purchase foreign exchange when the domestic currency is appreciating and sell foreign exchange when it is depreciating.

III. FXI AND INFLATION OUTCOMES

The evidence presented above indicates that the pervasive use of FXI in EMDEs responds to exchange rate rather than inflation objectives. This multiplicity of objectives under IT may come at expense of lower success rates in achieving any single objective. Thus, a central question is whether the deployment of FXI affects inflation outcomes under IT regimes. This section sheds light on this issue.

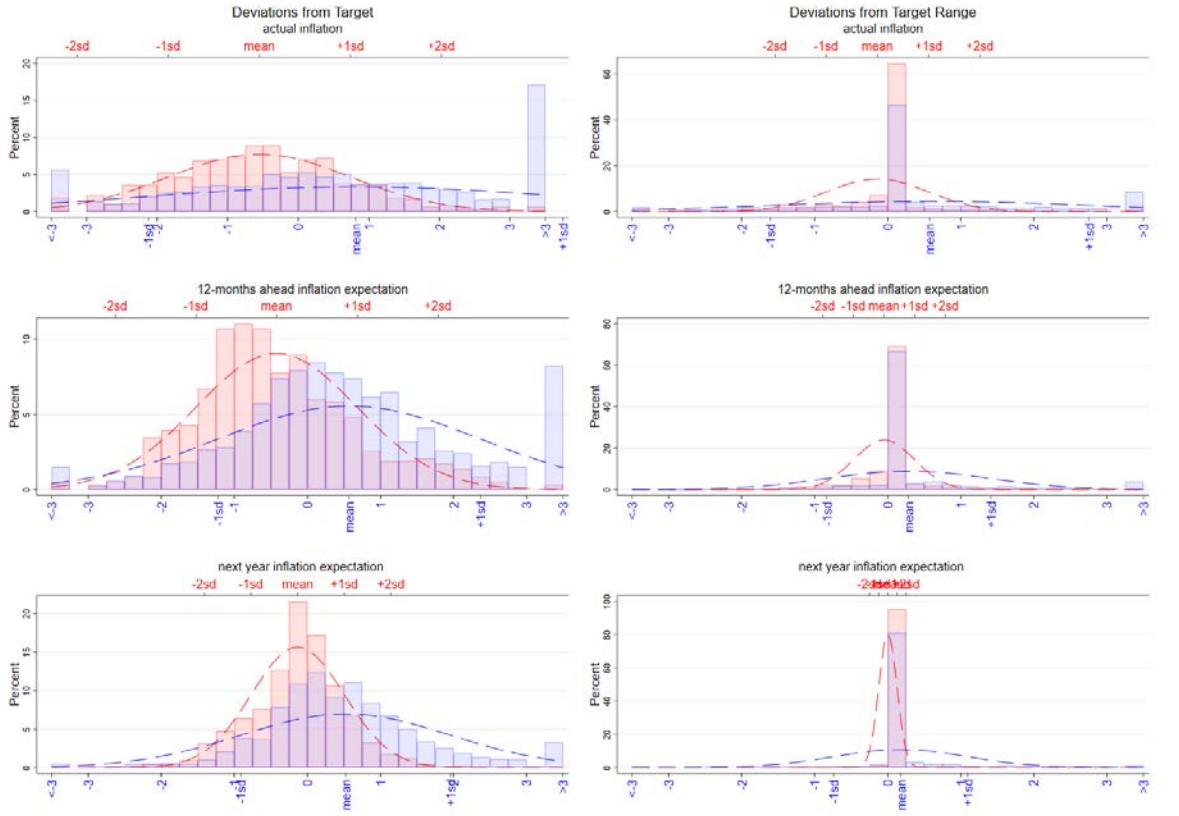
A. Stylized facts

Inflation outcomes are evaluated in terms of deviations from the inflation target ($\pi_{it}^{h} - \pi_{it}^{T}$), as well as deviations from the target range or inflation bands, defined as:

$$\Delta E\pi_{it}^{h} = \begin{cases} \mathrm{E}\pi_{it}^{h} - \overline{\pi}_{it} & if \quad \mathrm{E}\pi_{it}^{h} > \overline{\pi}_{it} \\ 0 & if \quad \underline{\pi}_{it} < \mathrm{E}\pi_{it}^{h} < \overline{\pi}_{it} \\ \pi_{it}^{h} - \underline{\pi}_{it} & if \quad \mathrm{E}\pi_{it}^{h} < \underline{\pi}_{it} \end{cases}$$

where $\underline{\pi}_{it}$ and $\overline{\pi}_{it}$ denote lower and upper bands, respectively. Figure 7 documents the distribution of inflation and inflation expectation outcomes for different groups of countries. As shown, there is a visible difference between AEs and EMDEs in terms of inflation outcomes, measured as deviations from target (left column) or deviations from target bands (right column).

Figure 7. Distribution of deviations from target—AEs vs EMDEs



Sources: AREAER, Consensus Forecasts, Haver Analytics, IFS, Authors' calculations.
Notes: Figures display the distribution of deviation of inflation and inflation expectation from target (left column) and from target bands (right column), based on quarterly observations. Blue (orange) corresponds to emerging market (advanced) economies.

During the sample period, on average, EMDEs overshot their inflation targets by about 82 basis points, while AEs undershot their targets by 43 basis points. While the latter partly reflects the deflationary context in AEs in the years following the global financial crisis (GFC), as shown in Appendix Figures A3 & A4, the EMDEs' greater propensity to overshoot targets is also visible in the years preceding the GFC. Inflation outcomes also display greater dispersion for EMDEs, including a mass of 15 (5) percent of observations with deviations of more than 300 basis points above (below) target, as oppose to a density function with thinner tails for AEs. Differences between the two groups are also visible, although less stark, in terms of success rates of inflation outcomes falling within the target bands, with inflation in EMDEs falling within bands about 45 percent of the time, compared to 65 percent in AEs. Both deviations from targets and from target bands display significantly higher volatility in EMDEs.

Differences between AEs and EMDEs are also apparent in inflation expectations, as indicated by the deviation of current-year inflation expectations (Figure 6, middle row panels) and next-year inflation expectations (Figure 6, last row) from inflation targets. For example, while next-year inflation expectations were anchored within the target range about 95 percent of the time in AEs, this ratio was less than 80 percent for EMDEs. This pattern holds throughout the sample period as shown Appendix Figure A4.

Table 8 formally tests differences between groups and the results corroborate the contrast in outcomes. Particularly striking is the difference in the variance of inflation and inflation expectation outcomes, with EMDEs displaying 2-3 times higher variance than AEs.

Table 8. Inflation outcome. AEs vs EMDEs

	Mean					Variance				
	AEs	*EMDEs*		P-val		AEs	EMDEs		P-val	
	μ^1	μ^2	$\mu^1-\mu^2$	H_0: $\mu^1<\mu^2$	H_0: $\mu^1>\mu^2$	σ^1	σ^2	$\sigma^1-\sigma^2$	H_0: $\sigma^1<\sigma^2$	H_0: $\sigma^1>\sigma^2$
Deviation from target										
$\pi-\pi^T$	-0.427	0.765	-1.191	0.000	1.000	1.229	2.902	-1.673	0.000	1.000
$E(\pi^{CY}-\pi^T)$	-0.126	0.756	-0.882	0.000	1.000	1.042	2.148	-1.106	0.000	1.000
$E(\pi^{NY}-\pi^T)$	-0.007	0.457	-0.464	0.000	1.000	0.550	1.264	-0.715	0.000	1.000
$E(\pi^{12m}-\pi^T)$	-0.283	0.516	-0.799	0.000	1.000	1.058	1.769	-0.712	0.000	1.000
Deviation from target range (bands)										
$\Delta\pi$	-0.213	0.507	-0.721	0.000	1.000	0.882	1.805	-0.923	0.000	1.000
$\Delta E\pi^{CY}$	-0.040	0.403	-0.442	0.000	1.000	0.532	1.248	-0.717	0.000	1.000
$\Delta E\pi^{NY}$	0.045	0.079	-0.034	0.119	0.881	0.357	0.762	-0.405	0.185	0.815
$\Delta E\pi^{12m}$	-0.081	0.144	-0.225	0.000	1.000	0.456	1.108	-0.652	0.000	1.000

Sources: Authors' calculations.
Notes: Inflation statistics expressed in percent. Inflation expectations reported for end-of current year (π^{CY}), end of next year (π^{NY}) and 12-month ahead (π^{12m}).

Linking FXI to Inflation Outcomes

The evidence presented above indicates that EMDEs with IT regimes tend to intervene more heavily and asymmetrically than AEs with the same monetary regimes, and to overshoot inflation targets, in contrast to the evidence of undershooting in AEs. But, is there a connection between the degree of FX intervention and the observed inflation outcomes? Our interest lies on a causal effect of FXI on inflation outcomes, in particular beyond the mechanic channel of exchange rate pass-through. To shed light on this, we estimate a probit model that links the degree of foreign exchange intervention to the probability of missing the inflation target or target range, either by over- or under-shooting it. Specifically, the following specification is estimated:

$$\Pr(Dev_{it}) = \Phi\left[\beta FXI_{it}^{L} + \sum_{l=1}^{L}\delta_l \Delta lne_{it-l+1} + \sum_{l=1}^{L}\rho i_{it-l+1}^{r} + \varphi\left(y_{it} - \bar{y}_{it}\right) + \boldsymbol{\gamma}^{'}\boldsymbol{G}_t + \alpha_i\right]$$

where $\Pr(Dev_{it})$ is a binary variable that takes value 0 or 1 if Dev_{it}, which denotes a deviation from target, meets certain criterion. These deviations from target are defined as:

$$Dev_{it} = \begin{cases} \pi_{it} - \pi_{it}^{T} > 0 & \text{if overshooting the target} \\ \pi_{it} - \pi_{it}^{T} < 0 & \text{if undeshooting the target} \end{cases}$$

where π_{it}^{T} is the inflation target.[15] Φ denotes a cumulative normal distribution; FXI_{it}^{L} is a metric of FXI capturing the extent of FXI during the current and L-1 previous quarters, computed as:

$$FXI_{it}^{Abs,L} = \sum_{l=1}^{L} abs\left[\frac{FXI_{i,t-l+1}}{GDP_{i,t-l+1}}\right]/L$$

In addition, e_{it-l} is the exchange rate vis-à-vis the US dollar or the nominal effective exchange rate (NEER); i_{it}^{r} is the real short term interest rate; and $\left(y_{it} - \bar{y}_{it}\right)$ is a measure of the output gap; and $\boldsymbol{G}_t$ is a vector of global factors including the VIX index, World GDP growth, World CPI inflation, and the US 10-year Treasury yield. Country fixed effects are included to capture time invariant credibility aspects. Our interest lies in the coefficient β—which would capture the impact of FXI intervention, above and beyond the impact through exchange rates, on inflation outcomes—and the associated marginal effect on the probability of missing the inflation target.

Table 9 below reports the estimated marginal effects of FXI on deviations from the target *point*. Consistent with the stylized fact presented before, greater FXI appears to be associated with a higher probability of overshooting the target. Specifically, a 1 percent of GDP of quarterly FXI is associated with 16-22 percent higher probability of overshooting the target after controlling for key country-specific variables (columns 1-3). Controlling for global factors (column 4) reduces somewhat the estimated effect of FXI on inflation outcomes and, the effect becomes statistically insignificant when time fixed effects are included (column 5), indicating that the link between FXI on inflation outcomes partly arises from the use of FXI in response to global factors.[16] Controlling for exchange rate movements (columns 6-9) does not change the results materially. Results for the probability of undershooting mirror those of the overshooting regressions, reflecting the fact that the probability of exactly hitting the target is virtually zero (see Appendix Table A2).

[15] Deviations from the target range, defined as:

$$Dev_{it} = \begin{cases} \pi_{it} - \overline{\pi}_{it} > 0 & \text{if overshooting the upper band} \\ \pi_{it} - \underline{\pi}_{it} < 0 & \text{if undeshooting the lower band} \end{cases}$$

are also explored and reported in the appendix.

[16] This result is consistent with the 'leaning against the wind' patterns documented in the first section of the paper.

Table 9. Probability of overshooting inflation targets—Marginal effects.

	Overshooting Inflation Target								
	Without controlling for Exchange Rate					Controlling for Exchange Rate			
	No controls	Country Fixed Effects	Output Gap & Int Rate	Global Factors	Time Fixed Effects	Country Fixed Effects	Output Gap & Int Rate	Global Factors	Time Fixed Effects
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
FXI	8.39+	16.74***	22.70***	16.36***	6.67	16.94***	23.09***	16.83***	7.93
	(5.23)	(4.60)	(6.75)	(6.35)	(8.40)	(4.65)	(6.71)	(6.24)	(8.62)
Output gap			4.92***	3.96***	4.53**		5.31***	4.08***	4.05**
			(1.31)	(1.30)	(1.88)		(1.34)	(1.37)	(1.84)
Country Fixed Effects	--	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Output gap	--	--	Yes	Yes	Yes	--	Yes	Yes	Yes
Real Interest Rate	--	--	Yes	Yes	Yes	--	Yes	Yes	Yes
Exchange Rate	--	--	--	--	--	Yes	Yes	Yes	Yes
Global variables	--	--	--	Yes	--	--	--	Yes	--
Time Fixed Effects	--	--	--	--	Yes	--	--	--	Yes
Observations	1,541	1,523	1,089	1,089	1,041	1,498	1,067	1,067	1,019

Source: Authors' estimations.
1/ Standard errors are reported in parentheses. *** p<0.01, ** p<0.05, *p< 0.1, + p<0.15.

In addition, results for deviations from the target *range* (that is, overshooting the upper band or undershooting the lower band) point in the same direction as those presented in Table 9, although the effects are somewhat smaller and, in general, statistically weaker, possibly indicating that central banks are more cautious in the use of FXI when it comes to missing the target range than to missing the target point by small magnitudes (Table 10).

Table 10. Probability of overshooting inflation target *range*—Marginal effects.

	Overshooting Upper Band								
	Without controlling for Exchange Rate					Controlling for Exchange Rate			
	No controls	Country Fixed Effects	Output Gap & Int Rate	Global Factors	Time Fixed Effects	Country Fixed Effects	Output Gap & Int Rate	Global Factors	Time Fixed Effects
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
FXI	7.49	6.90	14.90***	9.63+	11.04+	7.54	18.05***	13.16**	12.47*
	(6.37)	(5.77)	(5.49)	(6.07)	(6.83)	(5.78)	(4.69)	(5.30)	(6.58)
Output gap			2.37*	1.73	2.88*		3.85***	2.56**	2.69*
			(1.25)	(1.27)	(1.65)		(1.33)	(1.25)	(1.53)
Exchange Rate	--	--	--	--	--	Yes	Yes	Yes	Yes
Country Fixed Effects	--	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Output gap	--	--	Yes	Yes	Yes	--	Yes	Yes	Yes
Real Interest Rate	--	--	Yes	Yes	Yes	--	Yes	Yes	Yes
Global variables	--	--	--	Yes	--	--	--	Yes	--
Time Fixed Effects	--	--	--	--	Yes	--	--	--	Yes
Observations	1,349	1,348	1,026	1,026	1,026	1,331	1,026	1,026	1,026

Source: Authors' estimations.
1/ Standard errors are reported in parentheses. *** p<0.01, ** p<0.05, *p< 0.1, + p<0.15.

Do weaker inflation outcomes in the context of FXI reflect a de-anchoring of inflation expectations? To shed light on this, the model is re-estimated focusing on inflation expectations, specifically on the probability that expected inflation overshoots the target. Table 10 reports the results for deviations of inflation expectations from the target point and target range (upper band) both using current calendar year and next-year inflation expectations. Most specifications (columns 1-4 and 6-8) show a positive and statistically significant effect of FXI on deviations of expectations from the target point, suggesting that interventions contribute to a de-anchoring of inflation expectations. This is also visible in deviations from the target range for the current year, although not for next-year expectations, suggesting that FXI has a greater impact (weakening) inflation expectations at short horizons. As before, controlling for time fixed effects reduces the significance of the estimates, indicating that the link between FXI and inflation expectations relates to the use of FXI in response to global factors..

Overall, the results suggest that a greater use of FXI is associated with a de-anchoring of inflation expectations, especially at short horizons, and a higher probability of overshooting inflation targets. These results partly reflect the response of FXI and inflation to global factors, possibly indicating that 'leaning against the wind' policies may be detrimental of inflation outcomes.

Table 10. Probability of inflation expectation overshooting the target—Marginal effects.

	Without controlling for Exchange Rate					Controlling for Exchange Rate			
	No controls	Country Fixed Effects	Output Gap & Int Rate	Global Factors	Time Fixed Effects	Country Fixed Effects	Output Gap & Int Rate	Global Factors	Time Fixed Effects
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Target									
Current Year Exectations	8.32+	17.30***	17.73**	13.28*	4.98	17.71***	17.67***	13.68**	6.32
	(5.38)	(5.32)	(6.90)	(7.05)	(9.62)	(5.52)	(6.81)	(6.87)	(9.83)
Next Year Expectations	7.51	19.91***	24.64***	21.17***	11.42	20.13***	25.11***	21.44***	11.16
	(6.25)	(5.46)	(6.29)	(7.16)	(10.06)	(5.59)	(6.09)	(6.96)	(9.88)
Target Range (upper band)									
Current Year Exectations	11.05*	7.98+	15.14***	10.29**	12.88**	8.61*	17.56***	13.05***	12.44**
	(5.97)	(5.10)	(3.92)	(4.42)	(5.89)	(5.11)	(3.66)	(4.11)	(5.67)
Next Year Expectations	9.37*	0.56	3.82	4.09	5.53	1.86	4.70	4.51	6.06
	(5.37)	(6.60)	(5.96)	(5.40)	(5.58)	(6.71)	(5.87)	(5.29)	(5.63)
Exchange Rate	--	--	--	--	--	Yes	Yes	Yes	Yes
Country Fixed Effects	--	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Output gap	--	--	Yes	Yes	Yes	--	Yes	Yes	Yes
Real Interest Rate	--	--	Yes	Yes	Yes	--	Yes	Yes	Yes
Global variables	--	--	--	Yes	--	--	--	Yes	--
Time Fixed Effects	--	--	--	--	Yes	--	--	--	Yes

Source: Authors' estimations.
1/ Standard errors are reported in parentheses. *** p<0.01, ** p<0.05, *p< 0.1, + p<0.15.

IV. CONCLUSIONS

There is an ongoing debate about the contours of inflation targeting and, in particular, the use of foreign exchange intervention under these monetary regimes, either as an additional instrument to help achieve inflation objectives or as an instrument aimed at a second objective (the exchange rate). Despite the extensive debate, however, there has been little empirical work on the patterns of intervention in the context of IT, its underlying objectives and its implications for inflation outcomes. This paper is a first attempt at filling this gap and unveils some interesting insights.

We find that, in advanced economies, FXI is limited both in IT and other monetary regimes. In emerging and developing economies, however, the use of FXI is pervasive and one-sided, with a bias towards

buying reserves even after taking into account precautionary motives for reserve accumulation. This pattern holds both in IT and non-IT regimes. While we find no evidence connecting the conduct of FXI to contemporaneous inflation developments, there is strong evidence that FXI responds to exchange rate movements, suggesting that inflation targeting central banks in emerging markets have dual inflation/exchange rate objectives. We also find weaker anchoring of inflation expectations and higher propensity to overshoot inflation targets in emerging market countries, in contrast to advanced economies. A more extensive use of FXI is associated with both a more frequent de-anchoring of inflation expectations and a lower success rate of inflation targeting—partly reflecting the response to global factors, thus, pointing to possible side effects of ‘leaning against the wind’ policies under IT.

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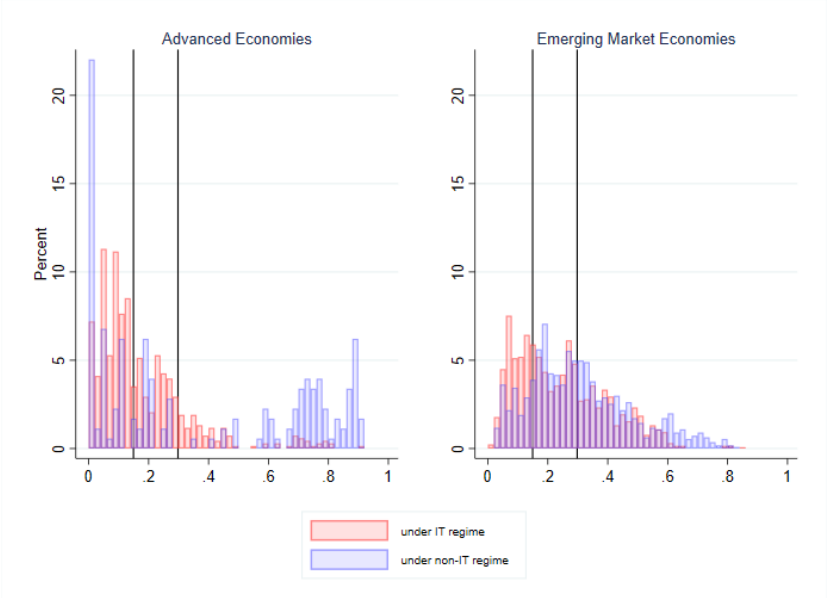
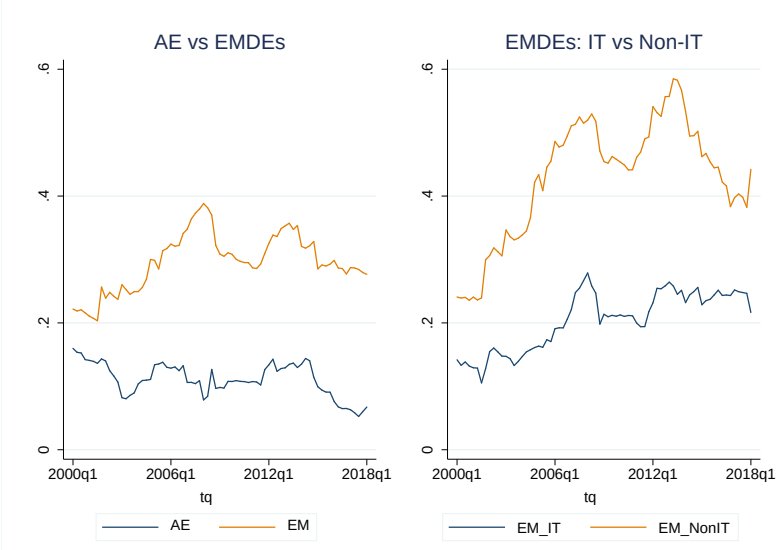
Appendix Figure A1. Index of exchange rate management, 2000-18



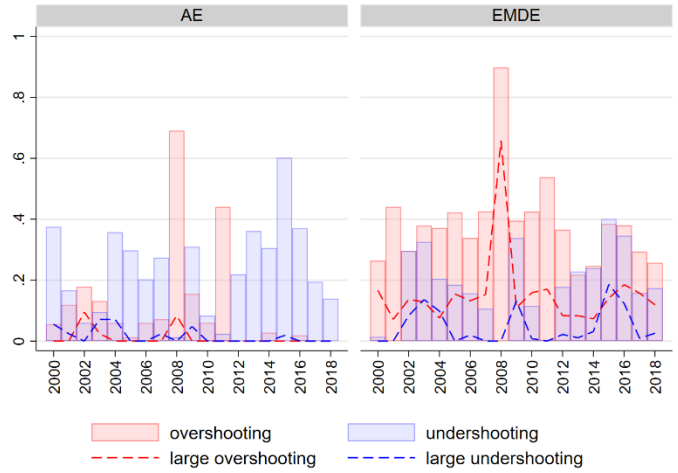
Sources: IRFCL, BOP, INS and Authors' calculations
Notes: Reports the distribution of indexes $\rho_t = \sigma_t^{fxi}/(\sigma_t^{\hat{s}} + \sigma_t^{fxi})$, computed over 12-quarter windows using nominal effective exchange rate. Includes all available observations for 2000Q1 through 2018Q1. Vertical lines indicate IT and non-IT group averages.

Appendix Figure A2. Exchange rate management by group and regime
(3-year moving window)



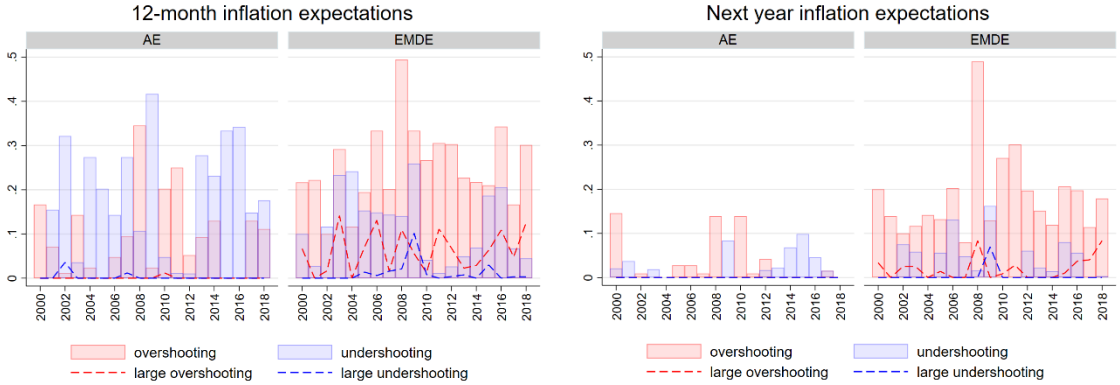
Sources: IMF *Balance of Payment Statistics, World Economic Outlook,* and authors' calculations.

Appendix Figure A3. Frequency of IT misses.



Sources: AREAER, Haver Analytics, International Financial Statistics, and authors' calculations.
Notes: Figures display the frequency of actual inflation missing the targets, based on monthly observations. Large over- and under-shooting refer to deviations of 2 percentage points or more.

Appendix Figure A4. Frequency of unanchored expectations.



Sources: AREAER, Consensus Forecasts, Haver Analytics, International Financial Statistics, and authors' calculations.
Notes: Figures display the frequency of unanchored inflation expectations, based on monthly observations. Large over- and under-shooting refer to deviations of 2 percentage points or more.

Appendix Table A1. Sample of countries.

Country	Inflation Targeting Adoption Date	Target Change	Point Target (in percent)	Target Range (in percent)
Advanced Economies				
Australia	04/1993	No	None	2.0-3.0
Canada	02/1991	Yes	Various	+/-1.0
Czech Republic	01/1998	Yes	Various	+/-1.0
Israel	06/1997	Yes	Various	Various
Japan	01/2013	No	2	None
Korea	01/1998	Yes	Various	Various
New Zealand	01/1991	Yes	Various	Various
Norway	03/2001	Yes	Various	None
Singapore	…	…	…	…
Sweden	01/1995	No	2	+/-1.0
Switzerland	01/2000	No	None	<2.0
United Kingdom	01/1993	Yes	Various	None
United States	01/2012	No	2	None
Emerging Markets and Developing Economies				
Argentina	01/2016	Yes	Various	Various
Armenia	01/2006	Yes	4	Various
Bolivia	…	…	…	…
Brazil	06/1999	Yes	Various	Various
Chile	09/1999	No	3	+/-1.0
China	…	…	…	…
Colombia	10/1999	Yes	Various	Various
Costa Rica	…	…	…	…
Croatia	…	…	…	…
Egypt	05/2017	No	13	+/-3.0
Guatemala	01/2005	Yes	Various	+/-1.0
Honduras	…	…	…	…
Hungary	06/2001	Yes	Various	+/-1.0
India	01/2014	Yes	Various	Various
Indonesia	07/2005	Yes	Various	+/-1.0
Kazakhstan	08/2015	Yes	Various	Various
Malaysia	…	…	…	…
Mexico	01/2001	No	3	+/-1.0
Moldova	01/2010	No	5	+/-1.5
Nicaragua	…	…	…	…
Nigeria	01/2010	Yes	None	Various
Pakistan	01/2006	Yes	Various	None
Paraguay	05/2011	Yes	Various	Various
Peru	01/2002	Yes	Various	+/-1.0
Philippines	01/2002	Yes	Various	Various
Poland	10/1998	Yes	Various	Various
Romania	08/2005	Yes	Various	+/-1.0
Russia	01/2015	Yes	Various	None
South Africa	02/2000	No	None	3.0-6.0
Sri Lanka	01/2015	Yes	None	Various
Thailand	05/2000	Yes	Various	Various
Turkey	01/2006	Yes	Various	+/-2.0
Ukraine	12/2016	Yes	Various	Various
Uruguay	09/2007	No	None	4.0-6.0
Vietnam	01/2009	Yes	Various	None

Sources: AREAER database; central banks' websites; Roger (2009); Ebeke and Azangue (2015).

Appendix Table A2. Probability of undershooting inflation target—Marginal effects.

	Undershooting Inflation Target								
	Without controlling for Exchange Rate					Controlling for Exchange Rate			
	No controls	Country Fixed Effects	Output Gap & Int Rate	Global Factors	Time Fixed Effects	Country Fixed Effects	Output Gap & Int Rate	Global Factors	Time Fixed Effects
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
FXI	-8.39+	-16.74***	-22.70***	-16.36***	-6.67	-16.94***	-23.09***	-16.83***	-7.93
	(5.23)	(4.60)	(6.75)	(6.35)	(8.40)	(4.65)	(6.71)	(6.24)	(8.62)
Output gap			-4.92***	-3.96***	-4.53**		-5.31***	-4.08***	-4.05**
			(1.31)	(1.30)	(1.88)		(1.34)	(1.37)	(1.84)
Country Fixed Effects	--	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Output gap	--	--	Yes	Yes	Yes	--	Yes	Yes	Yes
Real Interest Rate	--	--	Yes	Yes	Yes	--	Yes	Yes	Yes
Exchange Rate	--	--	--	--	--	Yes	Yes	Yes	Yes
Global variables	--	--	--	Yes	--	--	--	Yes	--
Time Fixed Effects	--	--	--	--	Yes	--	--	--	Yes
Observations	1,541	1,523	1,089	1,089	1,041	1,498	1,067	1,067	1,019

Source: Authors' estimations.
1/ Standard errors are reported in parentheses. *** p<0.01, ** p<0.05, *p< 0.1, + p<0.15.