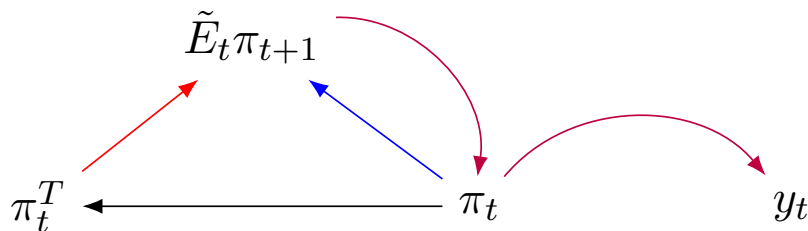# "Targeting Inflation Expectations?"

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Introduction
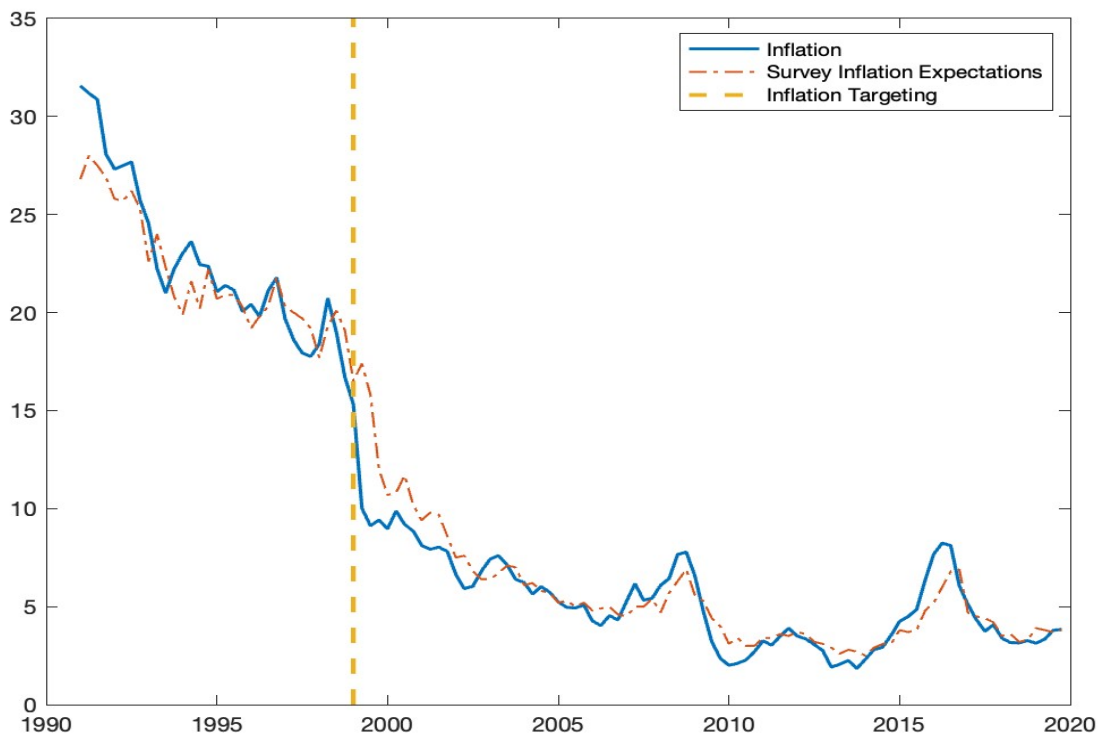
▶ Inflation expectations are central to monetary policy.

▶ Policy changes are introduced to anchor expectations and communicate with the public.

$$\tilde{E}_t \pi_{t+1}$$

$$\pi_t^T \qquad \pi_t \qquad y_t$$

▶ Limited information on the formation and updating of these expectations
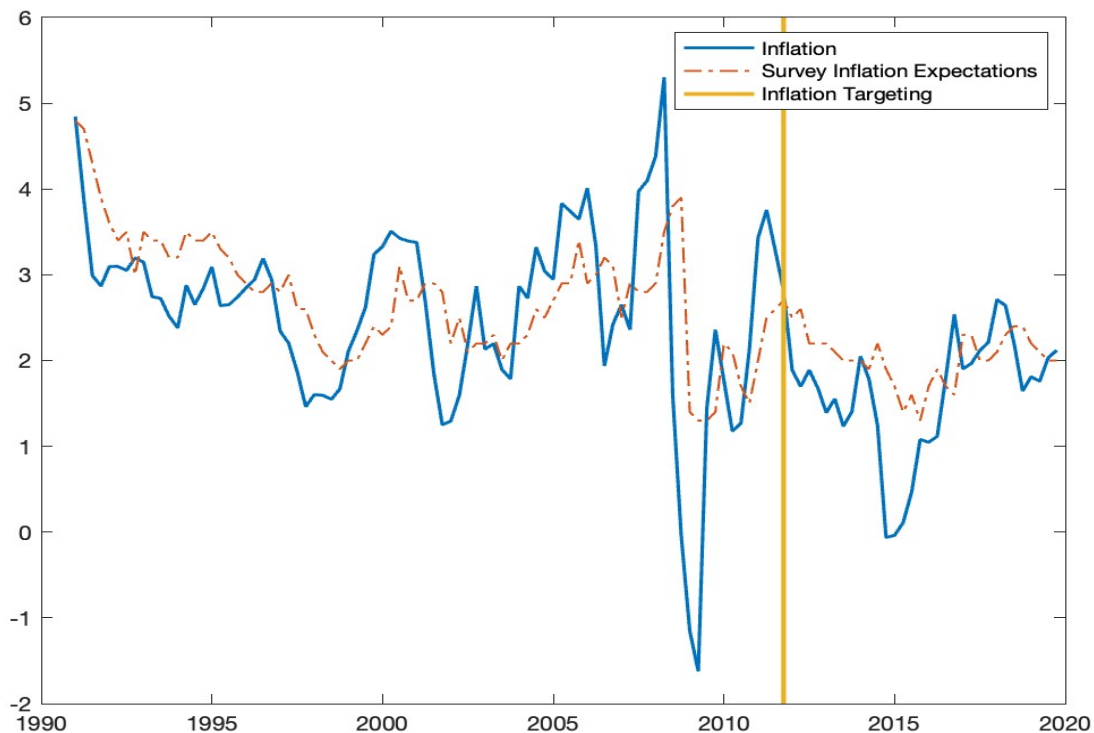
  1. Specifically, under regime changes.

Motivation

Figure: Colombia Inflation and Inflation Expectations

Motivation

Figure: US Inflation and Inflation Expectations

Policy Change and Expectations

▶ Do agents respond to a change in monetary policy, specifically, the introduction of Inflation Targeting ?

  1. Do agents change their priors, at the time of implementation?

     ▶ The data suggests not.

  2. Does anticipation (announcement) of the policy play a role in the way priors are updated?

     ▶ In a negligible way

  3. Do agents incorporate the announced inflation target in their expectations?

     ▶ Yes, but the weight is small.

Literature and Contribution

▶ Inflation Targeting and Inflation Expectations (RE)

Ball and Sheridan (2004), Gürkaynak et al. (2010), Beechey et al. (2011)

▶ Inflation Expectations and Subjective Beliefs

Coibion and Gorodnichenko (2012, 2015), Coibion et al. (2018), Coibion et al. (2020), Carvalho et al. (2021), Gáti (2022).

▶ Credibility

Kostadinov and Roldán (2020), King et al. (2020), Duggal and Rojas (2022)

▶ Contribution

1. Only paper to explicitly address the impact of a change in policy on expectations under deviations from RE.
2. Using survey data from a variety of countries (32), whose experience with inflation has been different.
3. One of the only papers to study anticipation effects of the introduction of Inflation Targeting.

Agents' Expectations

Rational Expectations

1. Under RE, agents have perfect knowledge about the underlying process for inflation.

2. Are able to correctly predict future inflation.

3. Pre-inflation targeting: Inflation Bias à la Barro-Gordon

4. Post-Inflation Targeting: $E_t \pi_{t+h|t} = \bar{\pi}_t$ (Full Commitment)

Subejective Expectations

▶ **Adaptive Learning**

1. Agents use past information to forecast inflation.
2. Pre-Inflation Targeting: Assume agents use a constant gain model,

$$\tilde{\beta}_t = \tilde{\beta}_{t-1} + \kappa_t(y_t - \tilde{\beta}_{t-1}) \tag{1}$$

3. Post-Inflation Targeting $(t \geq IT)$: Two possibilities

   ▶ The process remains unchanged

   $$\tilde{\beta}_{t \geq IT} = \tilde{\beta}_{IT} + \kappa_{IT}(y_{IT} - \tilde{\beta}_{IT-1}) \tag{2}$$

   $$\tilde{\beta}_{IT} \sim N(\bar{\beta}_{IT}, \sigma^2_{\tilde{\beta},IT})$$

   ▶ Alternatively, the agents incorporate the inflation target in their PLMs and the rule changes to the following,

   $$\tilde{\beta}_{t \geq IT} = \tilde{\beta}_{IT} + \kappa_{IT}(y_{IT} - \alpha\bar{\pi}_t - (1-\alpha)\tilde{\beta}_{IT-1}) \tag{3}$$

Inflation

Inflation evloves according to a univariate unobserved component model, based on Stock and Watson (2007) and Stock and Watson (2016).

$$\pi_t = \tau_t + \varepsilon_t, \ \text{where,} \ \varepsilon_t = \sigma_{\varepsilon,t}\zeta_{\varepsilon,t} \tag{4}$$

$$\tau_t = \tau_{t-1} + \vartheta_t, \ \text{where,} \ \vartheta_t = \sigma_{\vartheta,t}\zeta_{\vartheta,t} \tag{5}$$
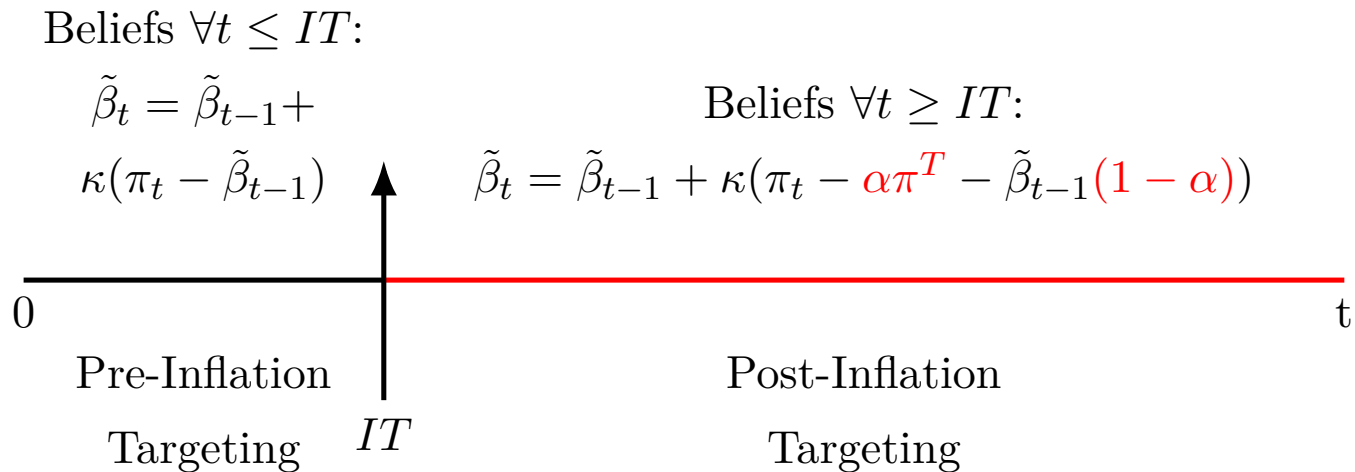
$$\ln \sigma_{\varepsilon,t}^2 = \ln \sigma_{\varepsilon,t-1}^2 + \nu_{\varepsilon,t} \tag{6}$$

$$\ln \sigma_{\vartheta,t}^2 = \ln \sigma_{\vartheta,t-1}^2 + \nu_{\vartheta,t} \tag{7}$$

$\zeta_t = (\zeta_{\varepsilon,t}, \zeta_{\vartheta,t}) \sim iid(0, I_2)$ and $\nu_t = (\zeta_{\nu,t}, \zeta_{\nu,t}) \sim iid(0, \gamma I_2)$. Moreover, $Cov(\zeta_t, \nu_t) = 0$. Where, γ is a smoothing parameter for the stochastic volatility process.

Timing

Beliefs $\forall t \leq IT$:

$\tilde{\beta}_t = \tilde{\beta}_{t-1} +$

$\kappa(\pi_t - \tilde{\beta}_{t-1})$

Beliefs $\forall t \geq IT$:

$\tilde{\beta}_t = \tilde{\beta}_{t-1} + \kappa(\pi_t - \alpha\pi^T - \tilde{\beta}_{t-1}(1 - \alpha))$

0

Pre-Inflation

Targeting IT

Post-Inflation

Targeting

t

Pre-Inflation Targeting

1. Agents' beliefs about inflation are given by,

$$\pi_t = \beta_t + \epsilon_t \tag{8}$$

$$\beta_t = \beta_{t-1} + \eta_t \tag{9}$$

Moreover, $\epsilon_t \sim ii\mathcal{N}(0, \sigma_\epsilon^2)$ and $\eta_t \sim ii\mathcal{N}(0, \sigma_\eta^2)$ are independent of each other and jointly iid. Therefore, $E[(\epsilon_t, \eta_t)|I_{t-1}] = 0$.

Pre-Inflation Targeting

2 Assume that agents' priors are given by, $\tilde{\beta}_0 \sim N(\tilde{\beta}_{-1}, \tilde{\sigma}^2_{\tilde{\beta},0})$

3 Optimal updating then implies that $\tilde{\beta}_t$ evolves recursively according to,

$$\tilde{\beta}_t = \tilde{\beta}_{t-1} + \kappa(\pi_t - \tilde{\beta}_{t-1}) \tag{10}$$

4 $\kappa = \frac{\sigma^2_\beta}{\sigma^2_\beta + \sigma^2_\epsilon}$ is the gain and is defined as the strength with which agents update their beliefs.

5 $\tilde{\sigma}^2_\beta = \tilde{\sigma}^2_{\beta,0} - \kappa\tilde{\sigma}^2_{\beta,0} + \sigma^2_\eta$, which is the uncertainty about $\tilde{\beta}_t$.

Post-Inflation Targeting

At $t = IT$ inflation targeting is introduced.

1 Agents' beliefs about inflation are given by,

$$\pi_t = (1 - \alpha)\beta_t + \alpha\pi^T + \epsilon_t \tag{11}$$

$$\beta_t = \beta_{t-1} + \eta_t \tag{12}$$

Moreover, $\epsilon_t \sim ii\mathcal{N}(0, \sigma_\epsilon^2)$ and $\eta_t \sim ii\mathcal{N}(0, \sigma_\eta^2)$ are independent of each other and jointly *iid*. Therefore, $E[(\epsilon_t, \eta_t)|I_{t-1}] = 0$.

Post-Inflation Targeting

2 Optimal updating then implies that $\tilde{\beta}_t$ evolves recursively according to,

$$\tilde{\beta}_t = \tilde{\beta}_{t-1} + \kappa(\pi_t - \alpha\pi^T - \tilde{\beta}_{t-1}(1-\alpha)) \tag{13}$$
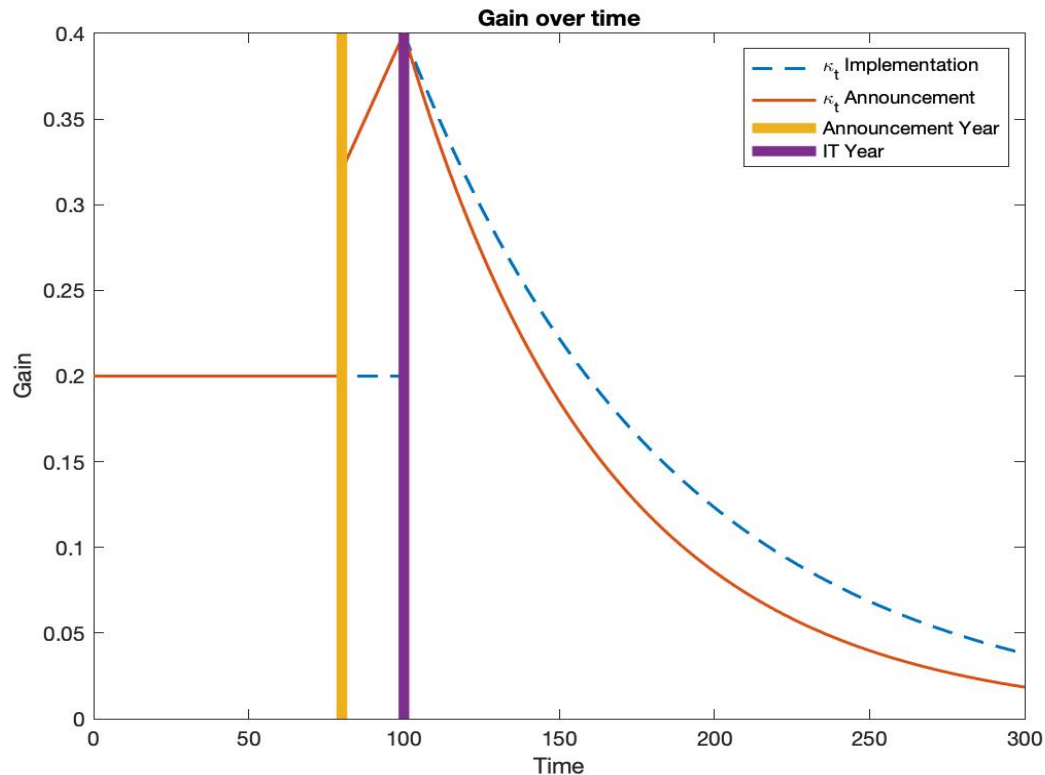
3 Kalman Gain is given by,

$$\kappa = \frac{\tilde{\sigma}_\beta^2(1-\alpha)}{(1-\alpha)^2\tilde{\sigma}_\beta^2 + \sigma_\epsilon^2} \tag{14}$$

4 Variance of the prior is updated according to,

$$\tilde{\sigma}_\beta^2 = \tilde{\sigma}_{\beta,0}^2 - \kappa(1-\alpha)\tilde{\sigma}_{\beta,0}^2 + \sigma_\eta^2 \tag{15}$$

Speed of Adjustment

Figure: Change in weight to information

Gain over time

Moments

	Pre-IT		Post-IT	
Moment	Model	Data	Model	Data
$\widehat{E(\pi_t^e)}$	22.67	22.03	5.78	5.636
$\widehat{\sigma_{\pi_t^e}}$	1.92	2.87	4.64	3.041
$\widehat{\rho_{\pi_t^e}}$	0.938	0.447	0.82	0.780
$\widehat{E(\pi_t - \pi_t^e)}$	0.570	0.684	-0.35	-0.366
$\widehat{\sigma_{\pi_t - \pi_t^e}}$	0.871	1.65	0.049	1.395
$\widehat{\rho_{\pi_t - \pi_t^e}}$	0.216	0.217	0.417	1.017

Parameters

Table: Parameters

Parameters	Pre-IT	Post-IT		
		2 years	5 years	Full Sample
κ	0.0553	0.057	0.110	0.639
α	-	0.10	0.109	0.113

Empirical Framework

Methods

The paper performs the analysis in two stages,

1. **Assumption**: Unobserved Heterogeniety is common for all countries $(\alpha_i = \bar{\alpha})$.

2. Event study approach by Borusyak et al. (2021) to assess any change in the levels and volatility of inflation expectations, forecast errors and inflation.

3. **Assumption is relaxed**

4. Dynamic Panel Data models are used based on Anderson and Hsiao (1981) and Arellano and Bond (1991) to estimate the response to inflation surprises (gain (κ)).

Ifo World Economic Survey

- ▶ Respondents are professional forecasters.

- ▶ Expectations about Inflation

    1. Expected inflation rate by the end of the next 6 Months.

- ▶ 1991Q1 - 2019Q4

- ▶ Data for 32 Inflation Targeting countries including the United States and some Eurozone countries.

Motivation   REH   Structural Break   IT Countries   Short-Run

Empirical Strategy

$$\beta_{it} = \bar{\alpha} + \beta_{it-1} + \kappa(y_{it} - \beta_{it-1}) + \gamma_1 t + \gamma_2 \bar{\pi}_t + \epsilon_{it} \qquad (16)$$
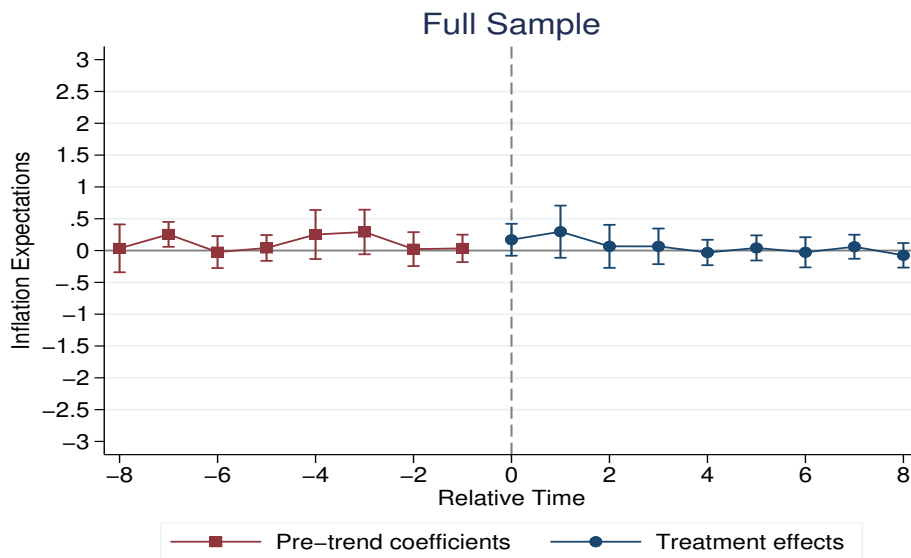
$$y_{it} = \bar{\alpha} + \beta_{it-1} + \kappa(y_{it} - \beta_{it-1}) + \gamma_1 t + \gamma_2 \bar{\pi}_t + \epsilon_{it} \qquad (17)$$

β_{it} are the inflation expectations from the survey, y_{it} is the realised inflation, κ is the Kalman gain and $\bar{\pi}_t$ is the world inflation.

Event Study Details

Fact 1: *Inflation expectations do not respond to the implementation of the policy.*

Figure: Inflation Expectations Around Implementation
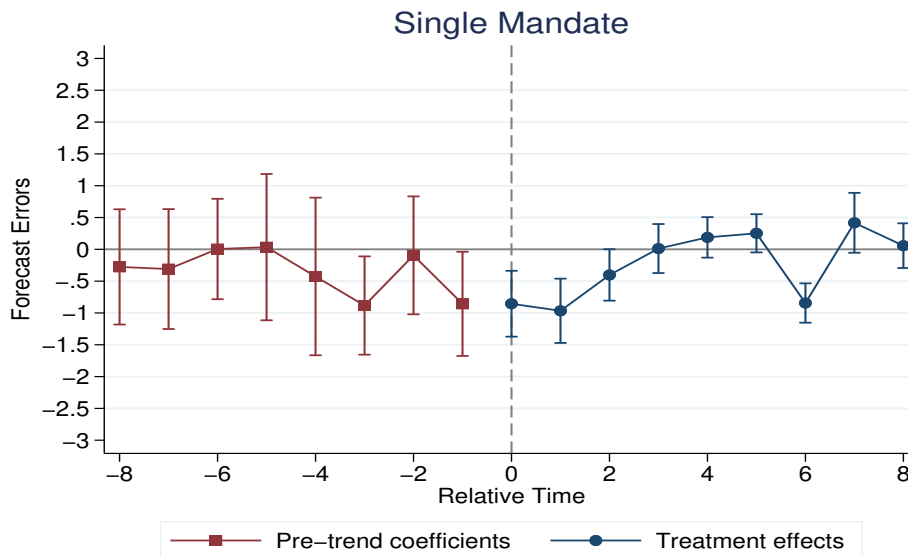

Up to five years Advanced Economies Developing Economies New Targeters

Old Targeters

Fact 2: *Forecast errors for those countries whose central banks have single mandates are close to zero a few quarters after implementation.*
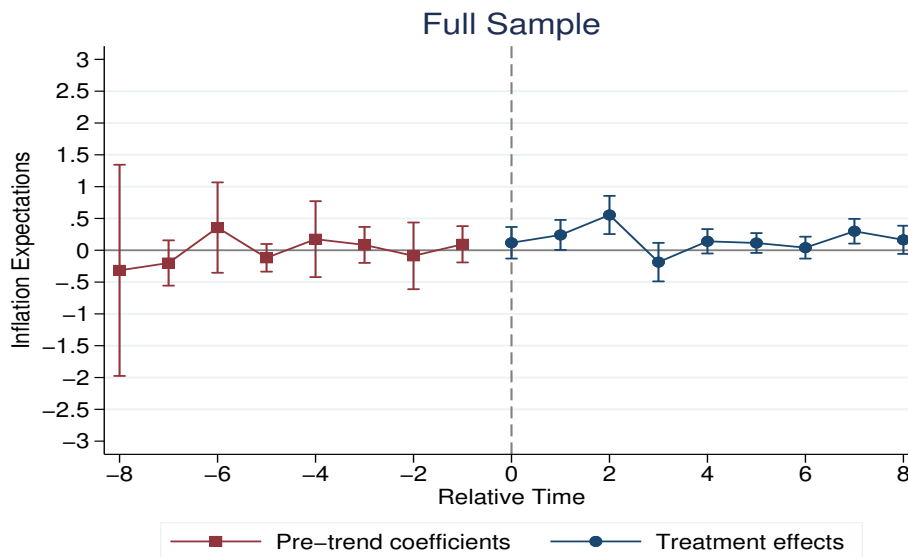

Figure: Forecast Errors Around Implementation

Dual Mandates

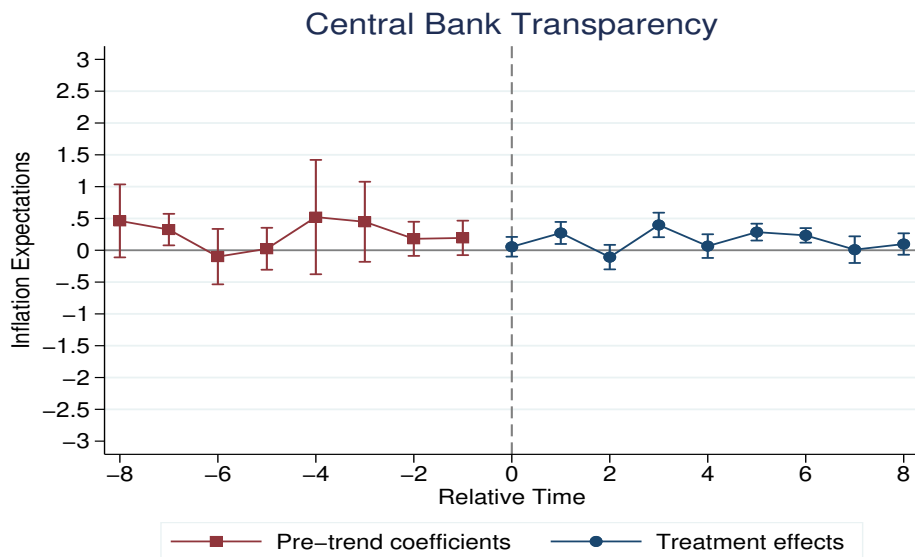# Fact 3: *There is minimal change in inflation expectations upon announcement.*

Figure: Inflation Expectations Around Announcement

Full Sample

Fact 4: *Controlling for Central Bank Independence and Transparency does not change the result.*

Figure: Inflation Expectations After controlling for Transparency

Fact 5: Response to Inflation Surprises has a minimal change.

VARIABLES	Pre-IT	Post-IT		
	(1)	(2)	(3)	(4)
	π_t^e	π_t^e (1 year)	π_t^e (2 years)	π_t^e (Full Sample)
π_{t-1}^e	0.903***	0.954***	0.996***	0.935***
	(0.0616)	(0.198)	(0.097)	(0.045)
$\pi_{t,fe}$	0.402**	0.156	0.226	0.316***
	(0.160)	(0.210)	(0.079)	(0.044)
Constant	0.491	0.152	0.079	0.221
	(0.496)	(0.155)	(0.227)	(0.129)

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Conclusions/Extensions

▶ There is no significant change in expectations when Inflation Targeting is introduced.

▶ Forecast errors adjust because of a change in inflation.

▶ Agents rely on past inflation to make forecasts.

▶ Limited credibility of the central bank announcement or target ($\kappa \approx 0.4$).

1. Successful anchoring requires: $\kappa \approx 0$.

▶ Policy should focus on a single objective even though the adjustment is not based on the anticipated channel.

Thank You!

Appendix

Inflation Targeting

A country is called an Inflation Targeter (Hammond et al. (2012)) when the following conditions are met.

1. Price stability is recognised as the explicit goal of monetary policy.

2. There is a public announcement of a quantitative target for inflation.

3. Monetary policy is based on a wide set of information, including an inflation forecast.

4. Transparency

5. Accountability mechanisms.

Short-Run Expectations

Consider the Euler equation,

$$u'(c_t) = \beta \mathbb{E}_t \left[u'(c_{t+1}) \frac{(1 + i_t)}{1 + \pi_{t+1}} \right] \tag{18}$$

▶ Equation (18) explains how consumption today, adjusts to inflation expectations one-period ahead. Thus, adjustment to short run expectations leads to stimulation of consumption which further contributes to a rise in inflation.

▶ The objective of Inflation Targeting is respond to deviations in target irrespective of the length of time of deviations.

Agents' Expectations

Barro-Gordon

Let's assume the following simple model of the central bank with the loss function given by,

$$\mathcal{L}^{CB} = \max_{\pi_t} \frac{1}{2}\left[(y_t - y^*)^2 + a(\pi_t - \pi_t^*)^2\right] \tag{19}$$

Where, y_t and π_t are the current output and inflation levels. y^*, π^* are the potential output and inflation target. $\mathcal{L}^{CB}$ represents the loss function of the central bank subject to the following constraint,

$$y_t = b(\pi_t - \pi_t^e) \tag{20}$$

(20) is the Phillips Curve, $a, b > 0$ and there is perfect foresight. Given there are rational expectations this would imply that $\pi_t^e = \pi_t$. That is, agents always know the optimal level of inflation from the central bank's loss function. Let us now consider the switch in regimes.

Agents' Expectations

Pre-Inflation Targeting

Take first order conditions and solve for optimal inflation with given inflation expectations and $\pi^* = 0$,

$$\pi_t = \frac{b(\pi_t^e + y^*)}{a + b} \tag{21}$$

$$\pi_t^e = \frac{(a + b)\pi_t - by^*}{b} \tag{22}$$

Given the central bank does not have commitment and agents have rational expectations, the inflation will follow (22) which is often referred to as the inflation bias level.

Agents' Expectations

Post-Inflation Targeting

Assume that the bank now has full commitment to bring reduce inflation to the target and let $\pi_t^* \geq 0$.

Then, following the same procedure as above we find the following,

$$\pi_t = \pi_t^* = \pi_t^e \tag{23}$$

Therefore, with rational expectations and full commitment by the central bank, inflation expectations will always be equal to the inflation target.

Agents' Expectations

IT Countries

Name of Country	Development Status	Mandate	Hyper Inflation
Argentina	Developing	No-mandate	Yes
Austria	Advanced	Dual	No
Belgium	Advanced	Dual	No
Brazil	Developing	Single	Yes
Chile	Developing	Single	No
Colombia	Developing	Single	No
Czech Republic	Developing	Single	Yes
Finland	Advanced	Dual	No
Germany	Advanced	Dual	No
Hungary	Advanced	Single	No
India	Developing	Single	No
Ireland	Advanced	Dual	No
Israel	Developing	Single	No
Italy	Advanced	Dual	No
Japan	Advanced	Single	No
Korea	Developing	Single	No

Name of Country	Development Status	Mandate	Hyper Inflation
Mexico	Developing	Single	No
Netherlands	Advanced	Dual	No
Norway	Advanced	Single	No
Paraguay	Developing	Single	No
Peru	Developing	Single	Yes
Philippines	Developing	Single	No
Poland	Advanced	Single	Yes
Russia	Developing	Single	Yes
South Africa	Developing	Single	No
Spain	Advanced	Dual	No
Switzerland	Advanced	Dual	No
Thailand	Developing	Single	No
Turkey	Developing	Single	Yes
Ukraine	Developing	Single	Yes
United States	Advanced	Dual	No
Uruguay	Developing	Single	Yes

Survey

REH Test

Country	Pre-IT	Post-IT
Argentina	.431***	.529***
	(.099)	(0.069)
Austria	.296***	.659***
	(.048)	(0.059)
Belgium	.202	.611***
	(.128)	(0.511)
Brazil	.410***	.455***
	(.046)	(0.077)
Chile	.167***	.650***
	(.041)	(0.055)
Colombia	.355***	-.162
	(.062)	(0.221)

Newey West SE in parentheses

Country	Pre-IT	Post-IT
Czech Republic	.654***	.269**
	(.134)	(.142)
Finland	.401**	.521***
	(.147)	(.057)
Germany	.448***	.470***
	(.038)	(0.070)
Hungary	.054	.290***
	(.072)	(0.080)
India	.592***	1.139***
	(.150)	(0.042)
Ireland	.695***	.449***
	(.095)	(0.082)

Newey West SE in parentheses

Country	Pre-IT	Post-IT
Israel	2.22**	0.693***
	(.0672)	(0.207)
Italy	.038	0.411***
	(.089)	(0.054)
Japan	.288**	.598***
	(.094)	(.081)
Korea	.526**	.539***
	(.211)	(.114)
Mexico	.041	.396**
	(.058)	(.135)
Netherlands	.467***	.343***
	(.130)	(.083)

Newey West SE in parentheses

Country	Pre-IT	Post-IT
Norway	.612**	.881***
	(.221)	(.059)
Paraguay	.343***	.535**
	(.086)	(.224)
Peru	.572***	.669***
	(.074)	(.067)
Philippines	.430***	.547***
	(.064)	(.107)
Poland	.034	.262***
	(.122)	(.059)
Russia	-.367***	.385***
	(.019)	(.102)

Newey West SE in parentheses

Country	Pre-IT	Post-IT
South Africa	.355***	.652***
	(.070)	(.098)
Spain	.025	.487***
	(.141)	(.052)
Switzerland	.225***	.401***
	(.049)	(.077)
Thailand	.673***	.592***
	(.145)	(.081)
Turkey	.187	-.082
	(.130)	(.080)
Ukraine	.564***	.968***
	(.089)	(.171)

Newey West SE in parentheses

Country	Pre-IT	Post-IT
United States	.689***	.791***
	(.094)	(.070)
Uruguay	.130**	.588***
	(.041)	(.105)

Newey West SE in parentheses

Survey

Structural Break Test

	π_t^e		π_t	
	(1)	(2)	(1)	(2)
Lagged Var	0.939***	0.957***	0.944***	0.881***
	(0.005)	(0.008)	(0.004)	(0.007)
Lag*$\mathbb{1}_{\{t \geq t^*\}}$		-0.042***		0.108***
		(0.011)		(0.009)
Constant	0.194***	0.285***	0.136***	0.718***
	(0.032)	(0.093)	(0.028)	(0.079)
Constant$\mathbb{1}_{\{t \geq t^*\}}$		-0.042		-0.739***
		(0.100)		(0.085)

Note: HAC Robust standard errors in parenthesis.

$*p < 0.10, **p < 0.05, ***p < 0.01$.

Survey

Event Study

1. For all untreated observations in Ω_0, compute β_{it} by OLS. Thus, for this paper the regression is given by equation 16 to estimate $\hat{\kappa}, \hat{\gamma}_1, \hat{\gamma}_2$.

2. For all the treated observations in Ω_1 and $w_{it} \neq 0$ compute
   $$\beta_{it}(0) = \bar{\alpha} + \beta_{it-1} + \hat{\kappa}(y_{it} - \beta_{it-1}) + \hat{\gamma}_1 t + \hat{\gamma}_2 \bar{\pi}_t + \epsilon_{it}.$$

3. Compute, $\beta_{it} - \beta_{it}(0) = \tau_{it}$ which gives us the treatment effect.

4. Finally, the effect for each period after the treatment is computed as per $w_{it} = \frac{1}{\Omega_{1,h}}$ where $\Omega_{1,h} = \{it : K_{it} = h\}$ and $K_{it} = t - E_i$ which is the relative time since the adoption of the policy.
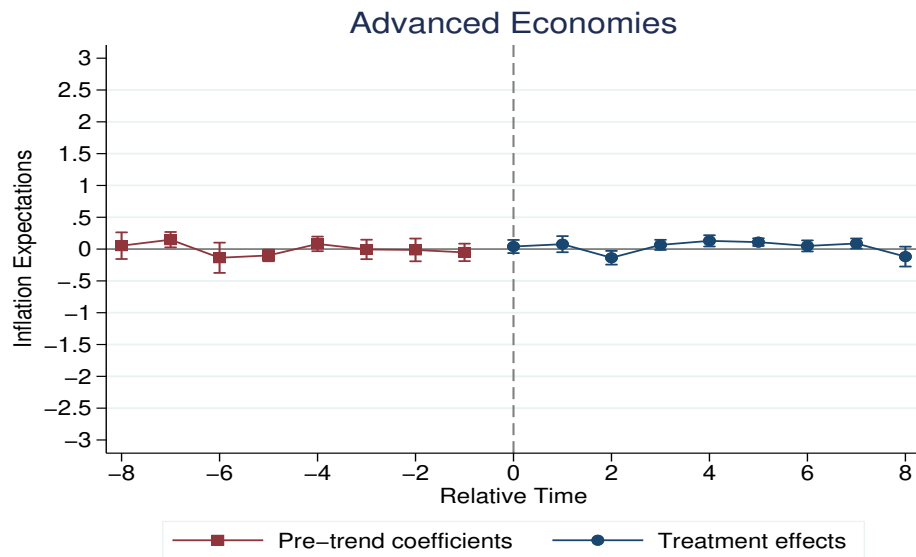
Methods

Fact A1: *Inflation expectations do not respond to the implementation of the policy.*
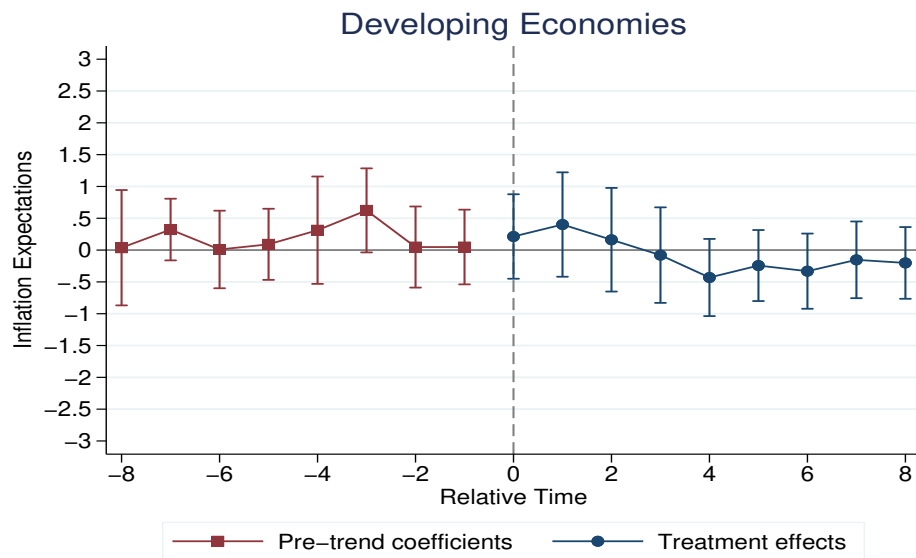
Figure: Inflation Expectations Around Implementation

Fact 1
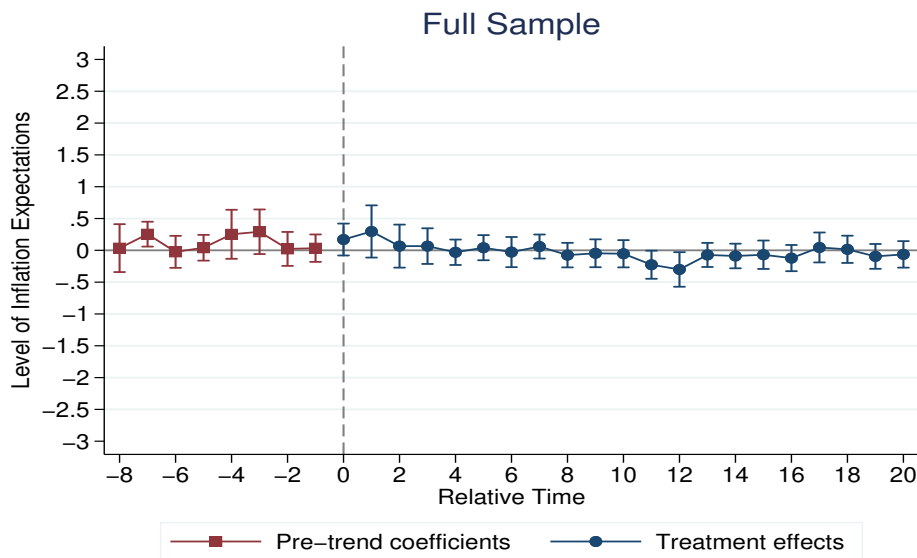
Fact A2:
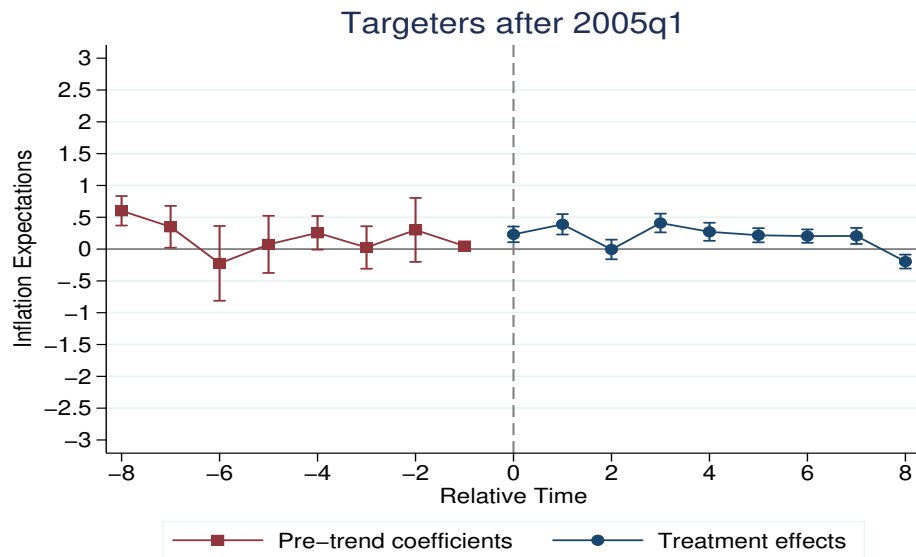
Figure: Forecast Errors Around Implementation

Advanced Economies

Legend: Pre-trend coefficients, Treatment effects

Fact 1

Fact A3:

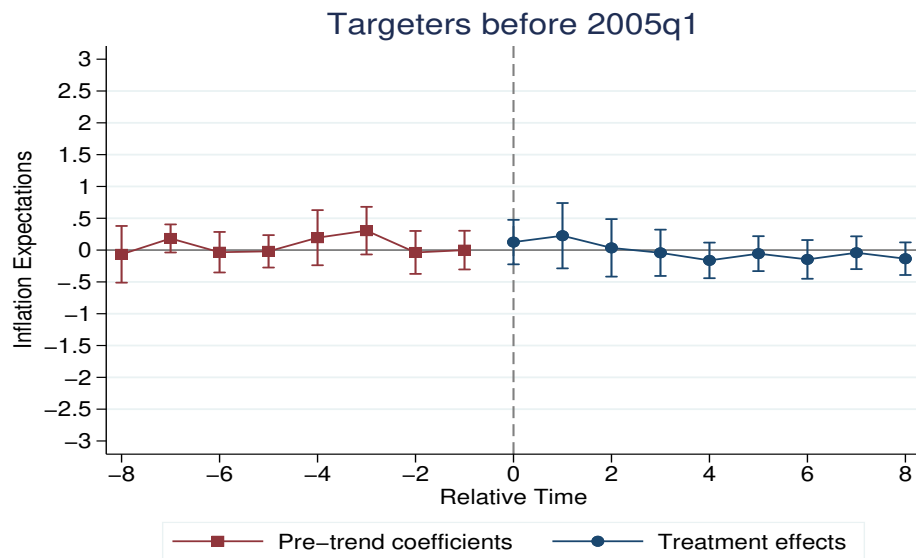## Figure: Inflation Expectations Around Implementation

Developing Economies

Fact A4:

Figure: Forecast Errors Around Implementation

Fact A5:

Figure: Inflation Expectations Around Implementation

Targeters before 2005q1

Pre-trend coefficients   Treatment effects

Fact 1

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