"Targeting Inflation Expectations?"

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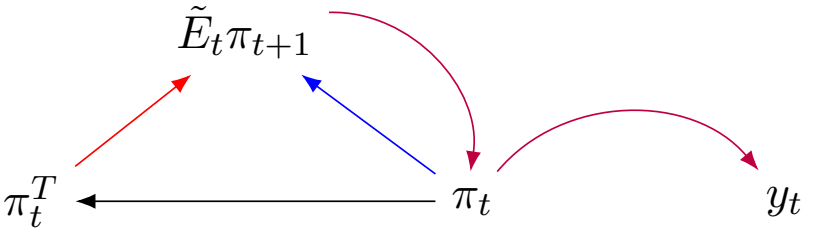
Introduction

- Inflation expectations are central to monetary policy.
- Policy changes are introduced to anchor expectations and communicate with the public.



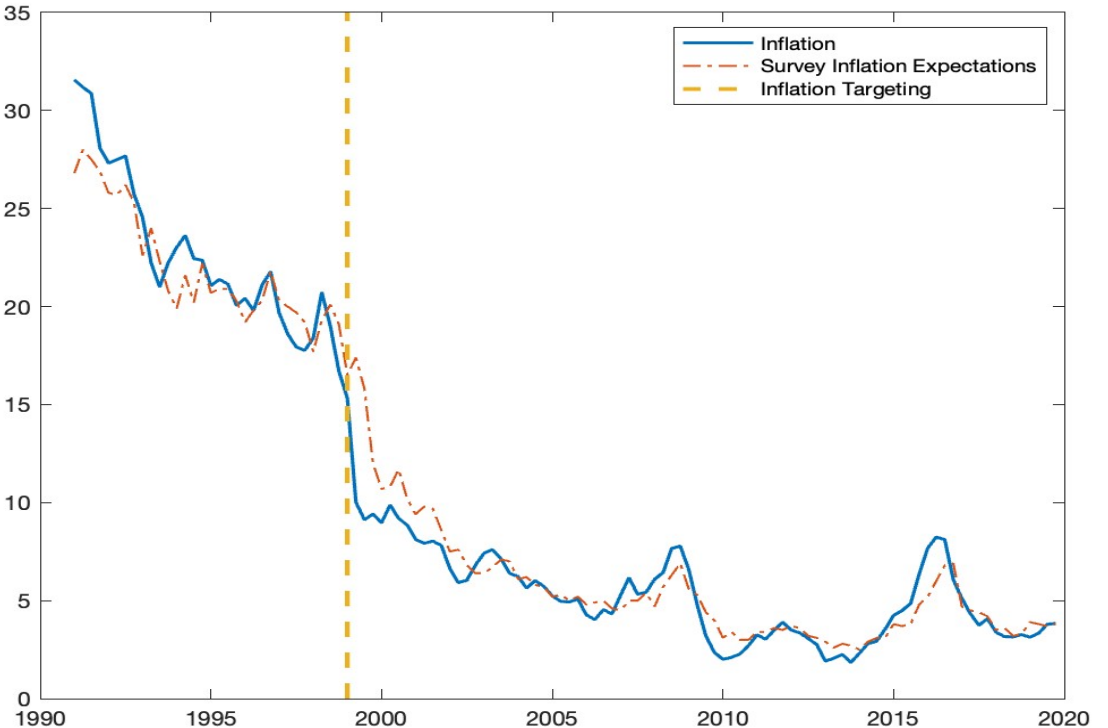
- Limited information on the formation and updating of these expectations
  1. Specifically, under regime changes.

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.

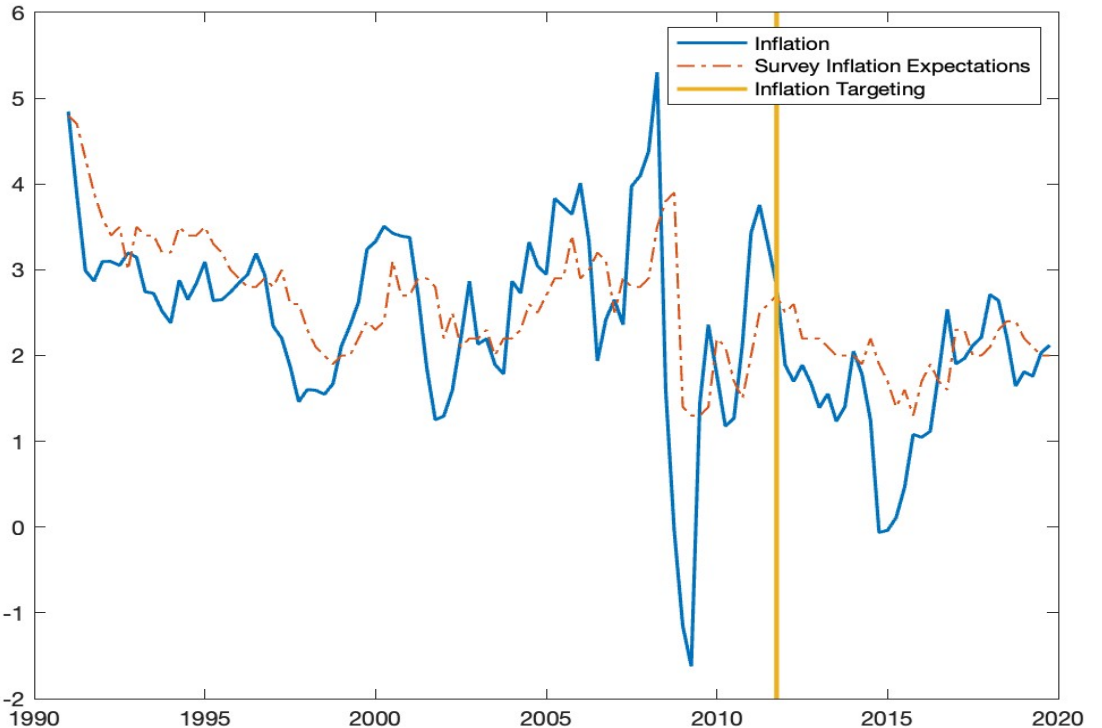
Motivation

Figure: Colombia Inflation and Inflation Expectations



Motivation

Figure: US Inflation and Inflation Expectations



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

Agents' Expectations

- **Rational Expectations (RE)**
  1. Under RE, agents have perfect knowledge about the underlying process for inflation.
  2. Are able to correctly predice 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)

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,

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

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 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)).

Empirical Strategy

$$\beta_{it} = \bar{\alpha} + \beta_{it-1} + \kappa(y_{it} - \beta_{it-1}) + \gamma_1 t + \gamma_2 \bar{\pi}_t + \epsilon_{it} \tag{4}$$

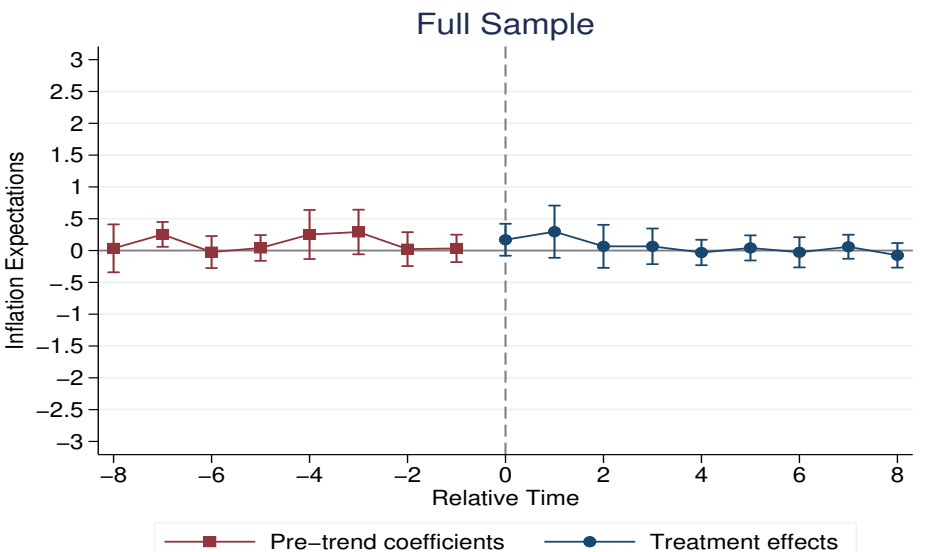
$$y_{it} = \bar{\alpha} + \beta_{it-1} + \kappa(y_{it} - \beta_{it-1}) + \gamma_1 t + \gamma_2 \bar{\pi}_t + \epsilon_{it} \tag{5}$$

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.*

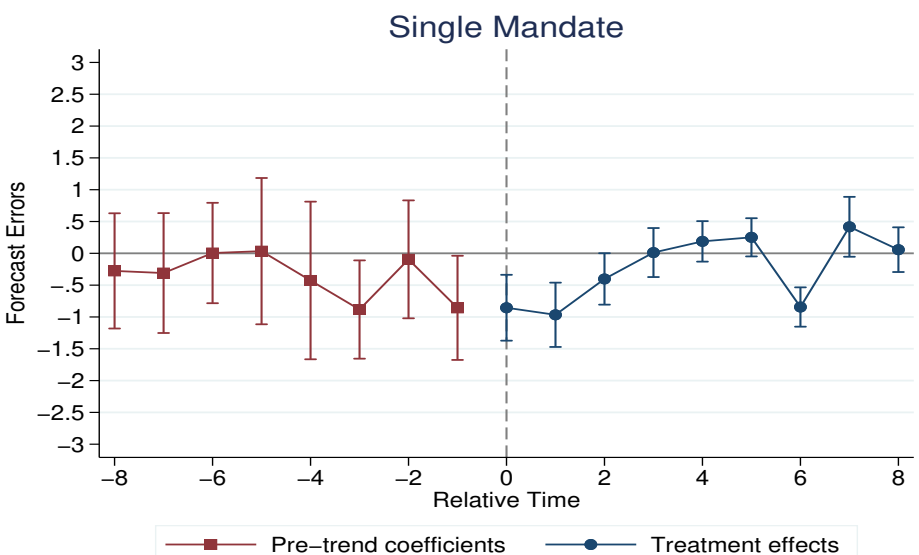
Figure: Inflation Expectations Around Implementation



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.*

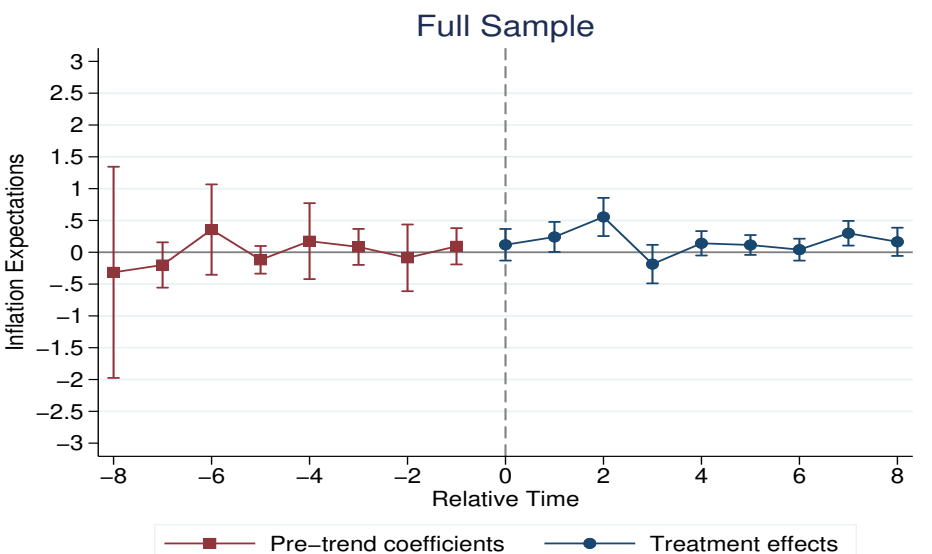
Figure: Forecast Errors Around Implementation



Dual Mandates

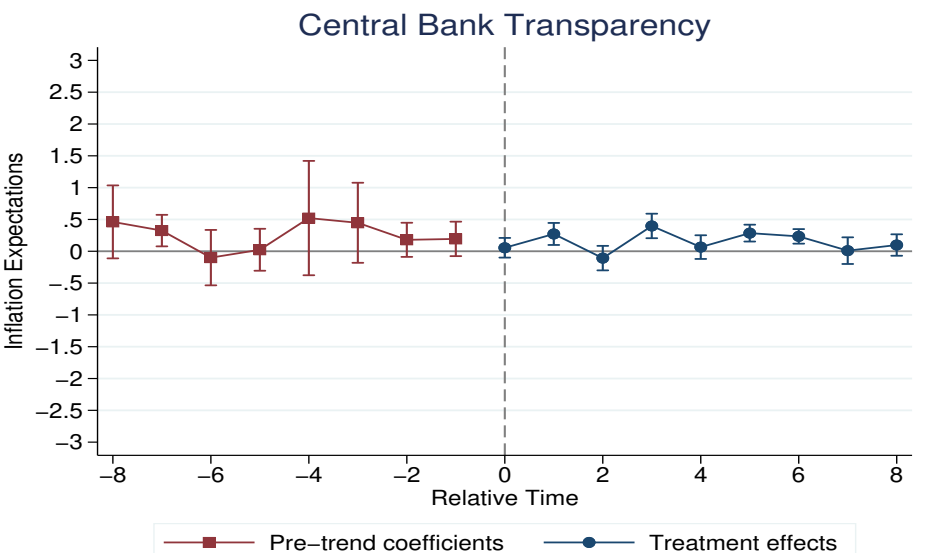
Fact 3: *There is minimal change in inflation expectations upon announcement.*

Figure: Inflation Expectations Around Announcement



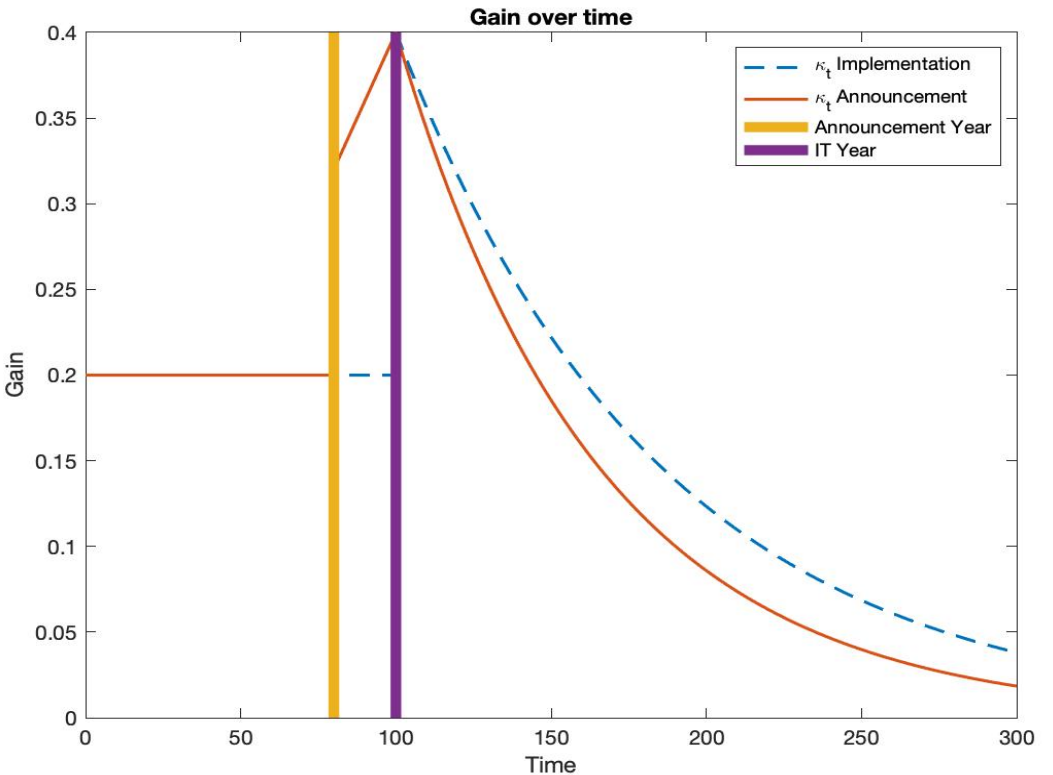
Fact 4: *Controlling for Central Bank Independence and Transparency does not change the result.*

Figure: Inflation Expectations After controlling for Transparency



Speed of Adjustment

Figure: Change in weight to information



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

Simulations

Inflation

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

$$\pi_t = \tau_t + \varepsilon_t, \text{ where, } \varepsilon_t = \sigma_{\varepsilon,t}\zeta_{\varepsilon,t} \tag{6}$$

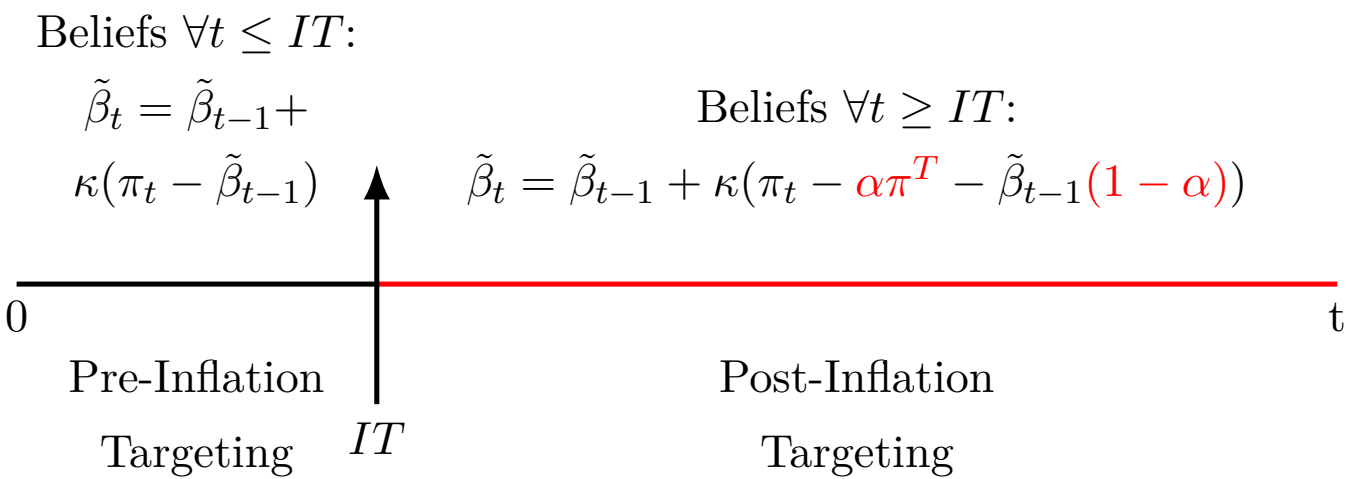
$$\tau_t = \tau_{t-1} + \vartheta_t, \text{ where, } \vartheta_t = \sigma_{\vartheta,t}\zeta_{\vartheta,t} \tag{7}$$

$$\ln \sigma^2_{\varepsilon,t} = \ln \sigma^2_{\varepsilon,t-1} + \nu_{\varepsilon,t} \tag{8}$$

$$\ln \sigma^2_{\vartheta,t} = \ln \sigma^2_{\vartheta,t-1} + \nu_{\vartheta,t} \tag{9}$$

$\zeta_t = (\zeta_{\varepsilon,t}, \zeta_{\vartheta,t}) \sim iid(0, I_2)$ 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
t
Pre-Inflation
Targeting
IT
Post-Inflation
Targeting

Pre-Inflation Targeting

1 Agents' beliefs about inflation are given by,

$$\pi_t = \beta_t + \epsilon_t \tag{10}$$

$$\beta_t = \beta_{t-1} + \eta_t \tag{11}$$

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,

$$\tilde{\beta}_t = \tilde{\beta}_{t-1} + \kappa(\pi_t - \tilde{\beta}_{t-1}) \tag{12}$$

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,

$$\pi_t = (1 - \alpha)\beta_t + \alpha\pi^T + \epsilon_t \tag{13}$$

$$\beta_t = \beta_{t-1} + \eta_t \tag{14}$$

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,

$$\tilde{\beta}_t = \tilde{\beta}_{t-1} + \kappa(\pi_t - \alpha\pi^T - \tilde{\beta}_{t-1}(1-\alpha)) \tag{15}$$

3 Kalman Gain is given by,

$$\kappa = \frac{\tilde{\sigma}_\beta^2(1-\alpha)}{(1-\alpha)^2\tilde{\sigma}_\beta^2 + \sigma_\epsilon^2} \tag{16}$$

4 Variance of the prior is updated according to,

$$\tilde{\sigma}_\beta^2 = \tilde{\sigma}_{\beta,0}^2 - \kappa(1-\alpha)\tilde{\sigma}_{\beta,0}^2 + \sigma_\eta^2 \tag{17}$$

Moments

Table: 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

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.

Research Question

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,

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

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

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.

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

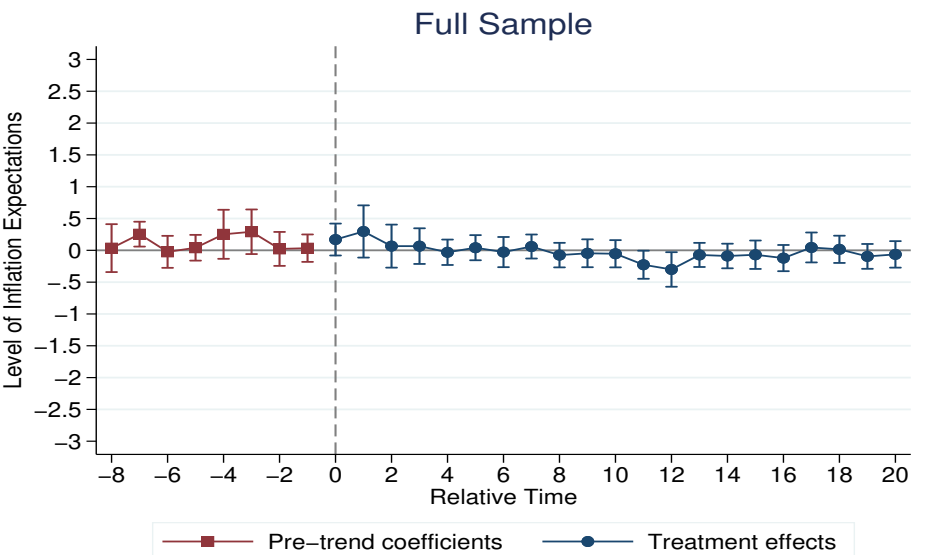
Event Study

1. For all untreated observations in Ω_0, compute β_{it} by OLS. Thus, for this paper the regression is given by equation 4 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

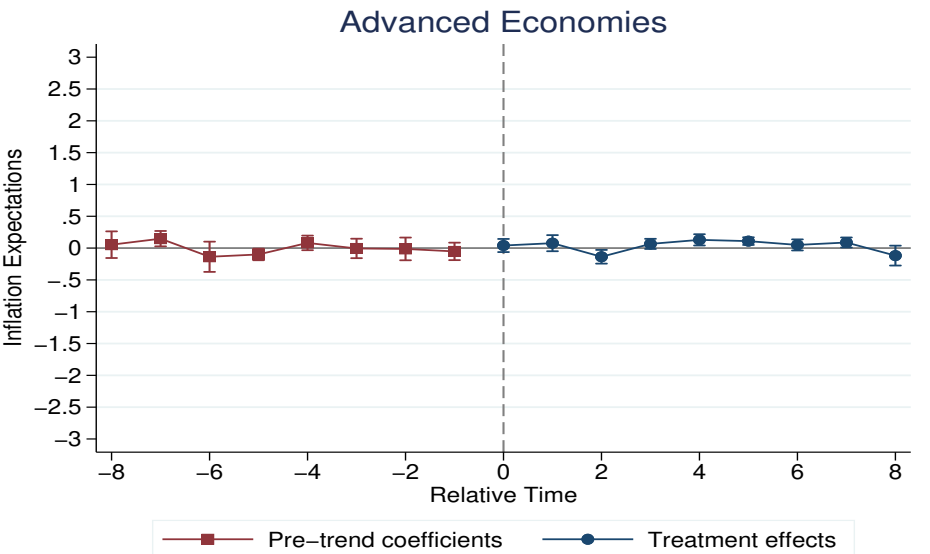
Fact A1: *Inflation expectations do not respond to the implementation of the policy.*

Figure: Inflation Expectations Around Implementation



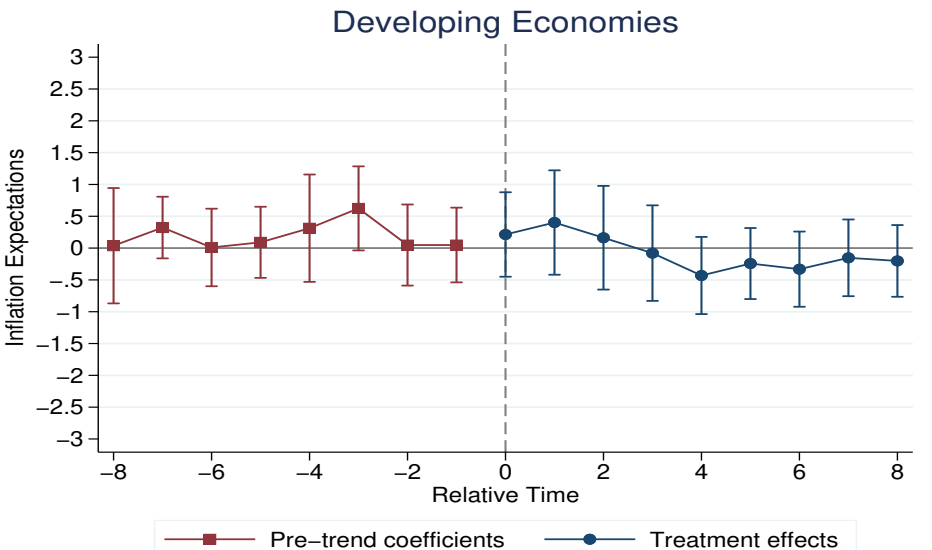
Fact A2:

Figure: Forecast Errors Around Implementation



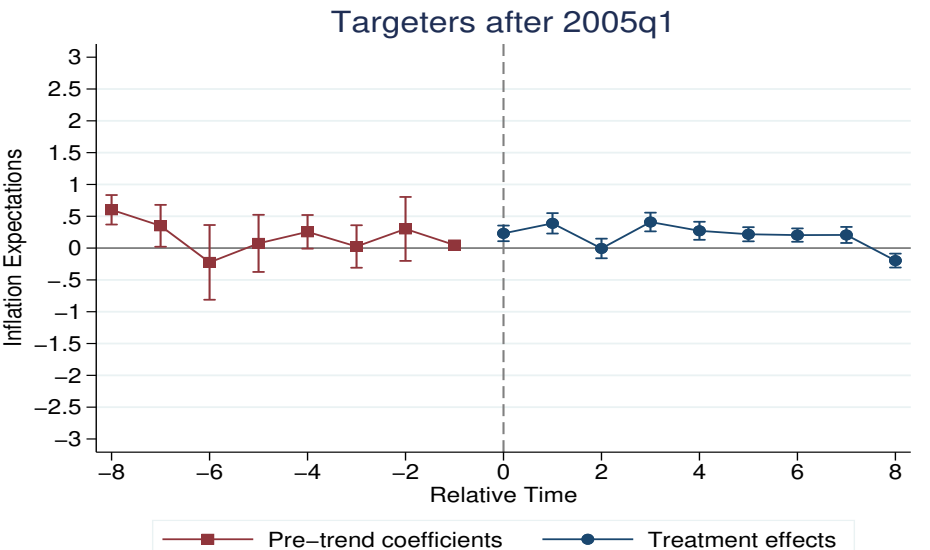
Fact A3:

Figure: Inflation Expectations Around Implementation



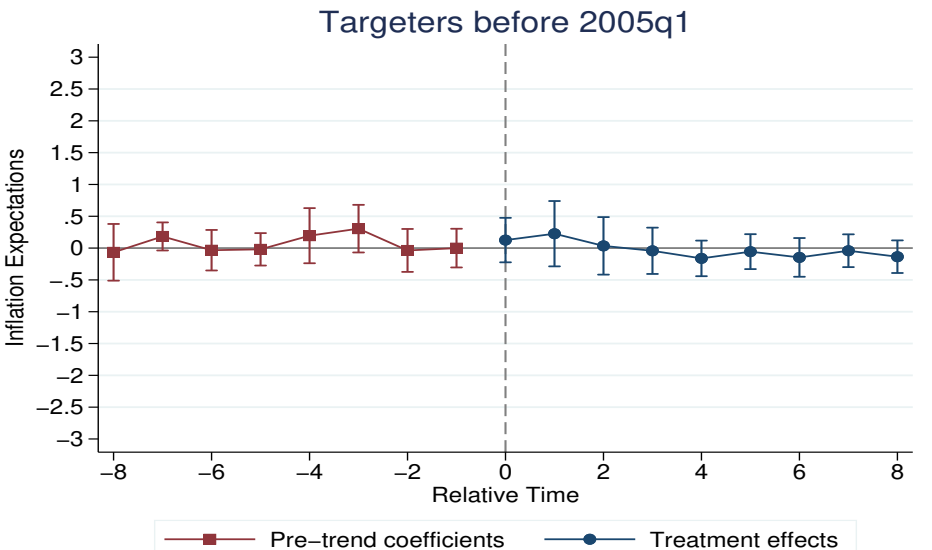
Fact A4:

Figure: Forecast Errors Around Implementation



Fact A5:

Figure: Inflation Expectations Around Implementation



References I

Anderson, T. W. and Hsiao, C. (1981). Estimation of dynamic models with error components. *Journal of the American statistical Association*, 76(375):598–606.

Arellano, M. and Bond, S. (1991). Some tests of specification for panel data: Monte carlo evidence and an application to employment equations. *The review of economic studies*, 58(2):277–297.

Ball, L. M. and Sheridan, N. (2004). Does inflation targeting matter? In *The inflation-targeting debate*, pages 249–282. University of Chicago Press.

Beechey, M. J., Johannsen, B. K., and Levin, A. T. (2011). Are long-run inflation expectations anchored more firmly in the euro area than in the united states? *American Economic Journal: Macroeconomics*, 3(2):104–29.

References II

Borusyak, K., Jaravel, X., and Spiess, J. (2021). Revisiting event study designs: Robust and efficient estimation. *arXiv preprint arXiv:2108.12419*.

Carvalho, C., Eusepi, S., Moench, E., and Preston, B. (2021). Anchored inflation expectations. *Available at SSRN 3018198*.

Coibion, O. and Gorodnichenko, Y. (2012). What can survey forecasts tell us about information rigidities? *Journal of Political Economy*, 120(1):116–159.

Coibion, O. and Gorodnichenko, Y. (2015). Information rigidity and the expectations formation process: A simple framework and new facts. *American Economic Review*, 105(8):2644–78.

Coibion, O., Gorodnichenko, Y., II, E. S. K., and Schoenle, R. (2020). Average inflation targeting and household expectations. Technical report, National Bureau of Economic Research.

References III

Coibion, O., Gorodnichenko, Y., Kumar, S., and Pedemonte, M. (2018). Inflation expectations as a policy tool? Technical report, National Bureau of Economic Research.

Duggal, M. and Rojas, L. E. (2022). (dis)inflation targeting. Working paper, Barcelona.

Gáti, L. (2022). Monetary policy & anchored expectations: an endogenous gain learning model.

Gürkaynak, R. S., Levin, A., and Swanson, E. (2010). Does inflation targeting anchor long-run inflation expectations? evidence from the us, uk, and sweden. *Journal of the European Economic Association*, 8(6):1208–1242.

Hammond, G. et al. (2012). State of the art of inflation targeting. *Handbooks*.

References IV

King, R. G., Lu, Y. K., et al. (2020). Managing expectations in the new keynesian model. Technical report, HKUST Center for Economic Policy.

Kostadinov, R. and Roldán, F. (2020). *Credibility Dynamics and Disinflation Plans*. International Monetary Fund.

Stock, J. H. and Watson, M. W. (2007). Why has us inflation become harder to forecast? *Journal of Money, Credit and banking*, 39:3–33.

Stock, J. H. and Watson, M. W. (2016). Core inflation and trend inflation. *Review of Economics and Statistics*, 98(4):770–784.