Price Setting when Expectations are Unanchored

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Motivation

Long-run inflation expectations do vary over time. That is, they are not perfectly anchored in real economies; moreover, the extent to which they are anchored can change, depending on economic developments and (most important) the current and past conduct of monetary policy.

...[H]ow do changes in various measures of inflation expectations feed through to actual pricing behavior? Promising recent research has looked at price changes at very disaggregated levels for insight into the pricing decision (Bils and Klenow, 2004; Nakamura and Steinsson, 2007). But this research has not yet linked pricing decisions at the microeconomic level to inflation expectations; undertaking that next step would no doubt be difficult but also very valuable." — *Bernanke (2007)*

What we do

- Present evidence that inflation expectations matter for individual pricing decisions. To that end, we:
- Exploit various micro datasets over a $\sim$ 13-year time period during which the degree of anchoring of inflation expectations varied significantly in Brazil.
- Dissect episode of an abrupt change in monetary policy, arguably exogenous to economic conditions at the time, which caused the unanchoring of expectations.
  - Reanchoring involved presidential impeachment and dramatic change in direction of economic policies.
- Estimate exchange rate passthrough into prices using micro data, allowing for differential effect when expectations are unanchored.
- Develop and calibrate a model in which expectations can become unanchored.
  - Model provides structural interpretation of empirical findings.
  - Allows discussion about mechanisms.

What we find

- Monetary policy can lead to unanchoring of inflation expectations.
- When expectations are unanchored, firms increase passthrough of exchange rate movements into prices. Difference is sizable.
- As in the data, our model produces higher exchange rate passthrough when expectations are unanchored. Quantitative effect also sizable.

Related literature and our contributions

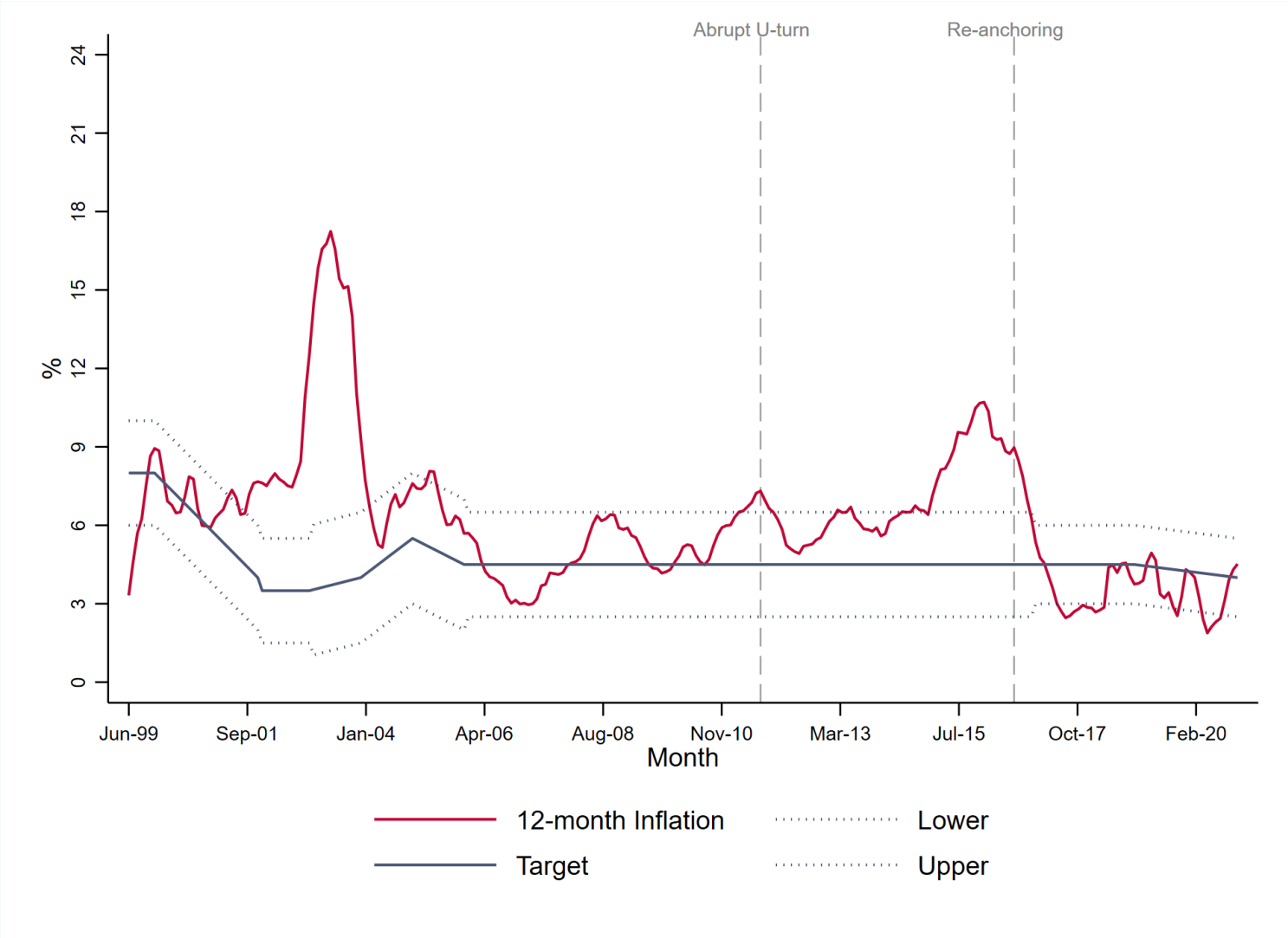
- Empirical literature on price setting (e.g. Bils and Klenow 2004).
- Empirical literature on passthrough from exchange rates into domestic prices using panel regressions with microdata (e.g. Gopinath, Itskhoki, Rigobon 2010).
- Literature that documents and studies anchoring and unanchoring of inflation expectations and its macroeconomic implications (e.g. Carvalho, Eusepi, Moench, Preston 2023; Reis 2021).
- We document anchoring and unanchoring of inflation expectations in Brazil, provide evidence it was caused by an abrupt change in monetary policy, first set of pricing facts when expectations are unanchored, evidence passthrough increases with unanchoring, present a model that provides a structural interpretation of our main empirical findings.

Outline

- A brief history of inflation targeting in Brazil
- Abrupt U-turn* in monetary policy: an unanchoring quasi-experiment (Don't try this at your central bank!!!!)
  - BCB's "Focus Survey": expectations data
- Anchored and unanchored "regimes"
  - Characterization
  - Evidence for anchored and unanchored regimes
- Empirical strategy
- PPI microdata and additional data
- Empirical results
- FX passthrough in a model with unanchoring of expectations
- Conclusion

A brief history of Brazil's IT regime

Figure: **Inflation, targets and tolerance bands**

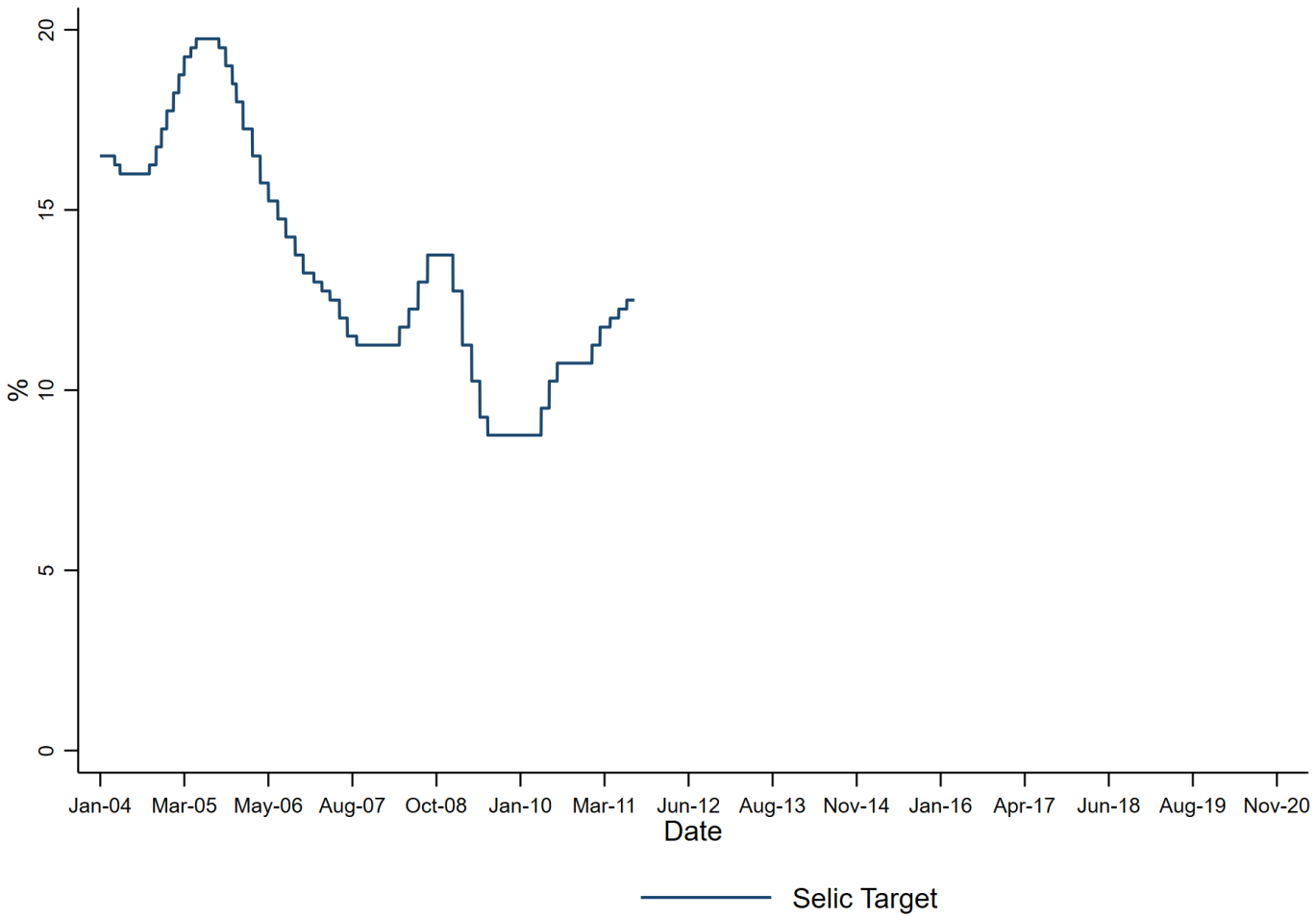


Focus Survey (BCB)

- A survey of professional forecasters covering many macroeconomic variables; commercial banks, asset managers, consulting firms and non-financial firms.
- Unbalanced panel, approximately 300 participants over time.
- Currently, 130-140 participants. Around 100 participants update their nowcasts and forecasts frequently (Gaglianone and Issler, 2021).
- Incentives: contest of best forecasters, published by BCB.
- System available daily for updates. BCB makes daily data available.
- We use inflation forecasts for various horizons and for the SELIC policy rate.
  - Both aggregate and individual forecasts data.
- Longer horizons: calendar years. Fixed horizons by simple interpolation.
- In order to mitigate the effect of temporary supply and exchange rate shocks, we choose to work with a measure of "forward expectations" for the horizon between 36 and 48 months - i.e. "3 years, 1 year forward".

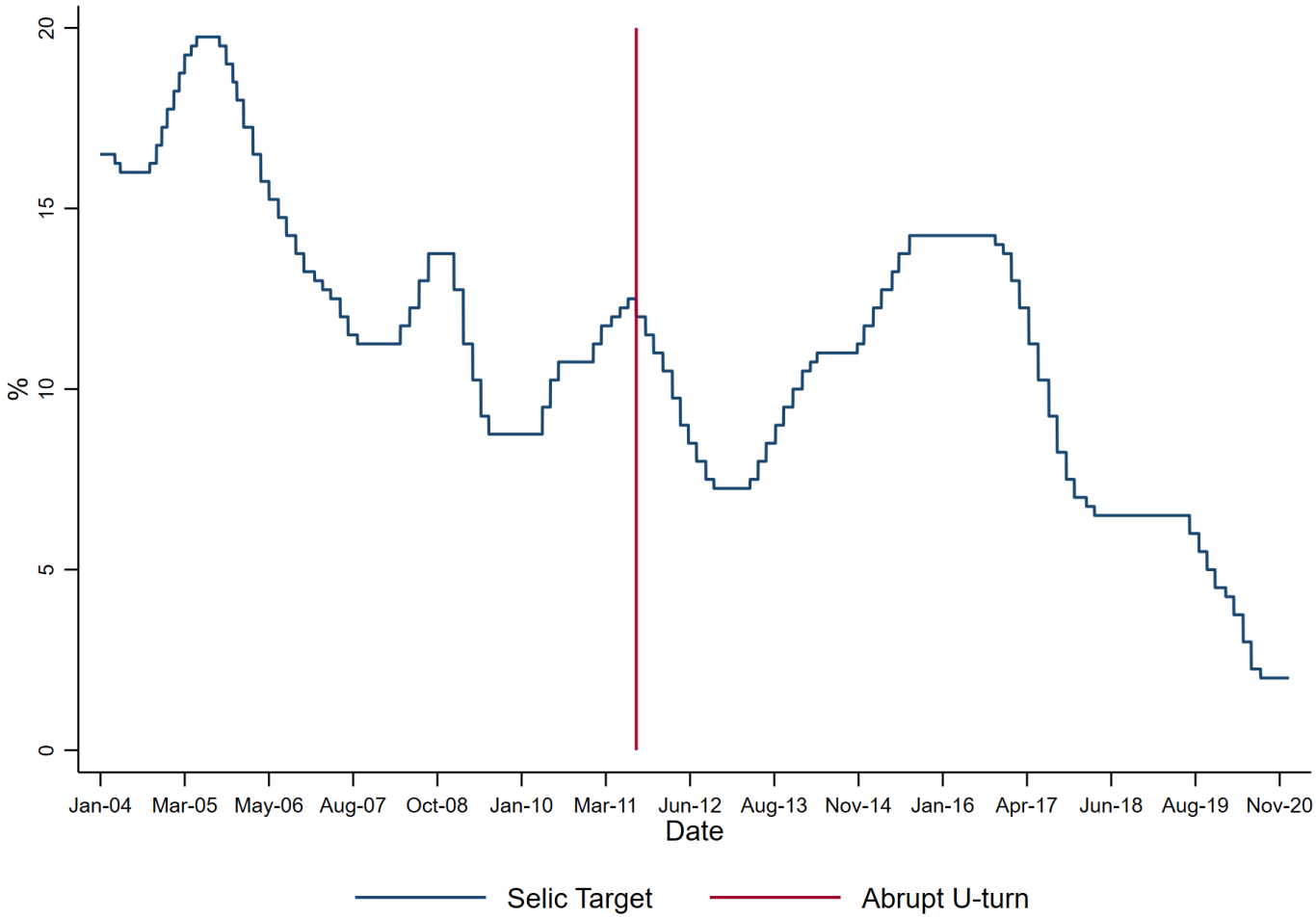
Case study: An abrupt U-turn in monetary policy

- Early 2011, inflation above target and rising; expectations also increasing.
- BCB tightening gradually. In July meeting, BCB hiked 25bps.
- In its August 31 meeting, BCB widely expected to stay put.



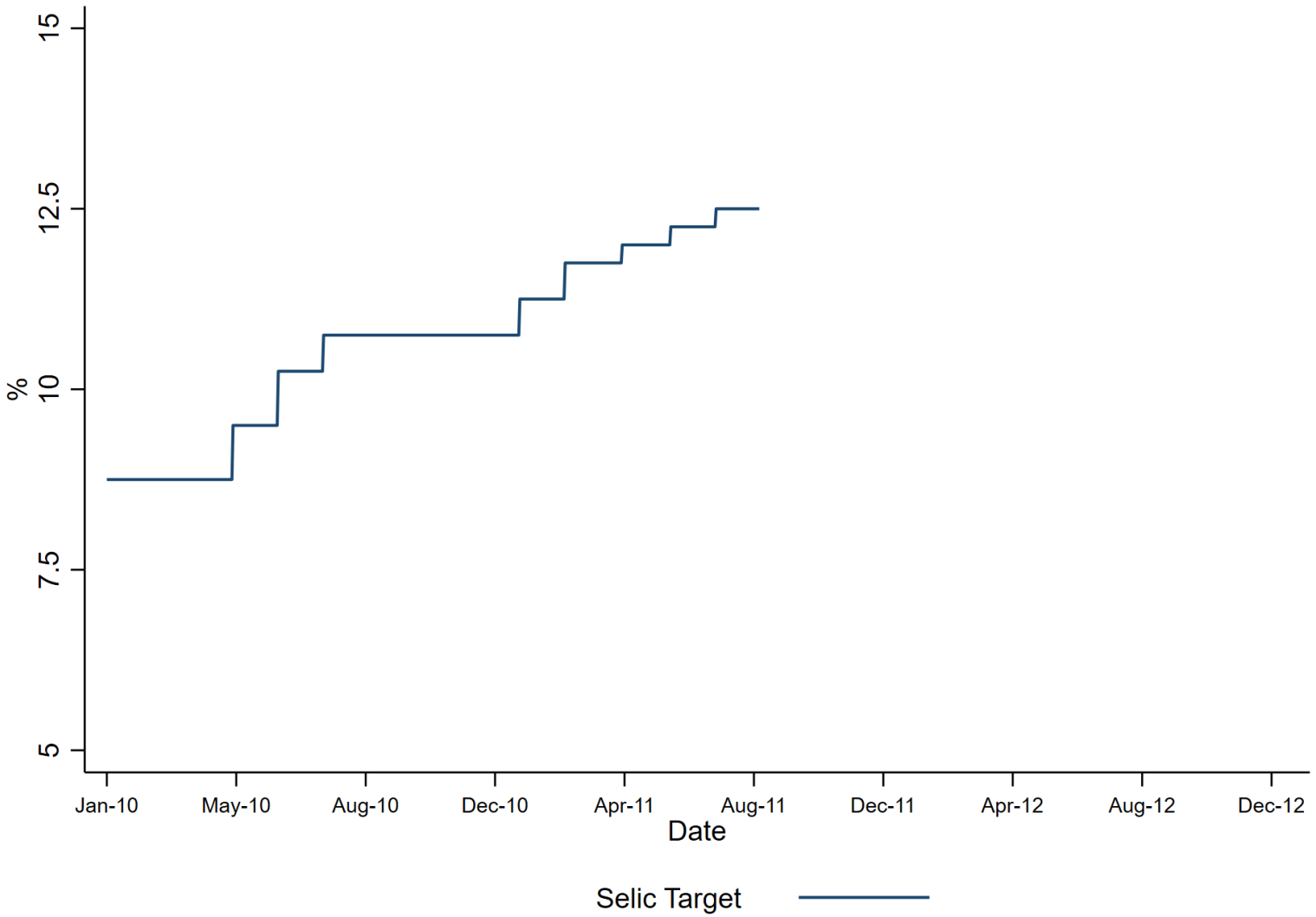
Case study: An abrupt U-turn in monetary policy

- Early 2011, inflation above target and rising; expectations also increasing.
- BCB tightening gradually. In July meeting, BCB hiked 25bps.
- In its August 31 meeting, BCB widely expected to stay put. But it didn't.



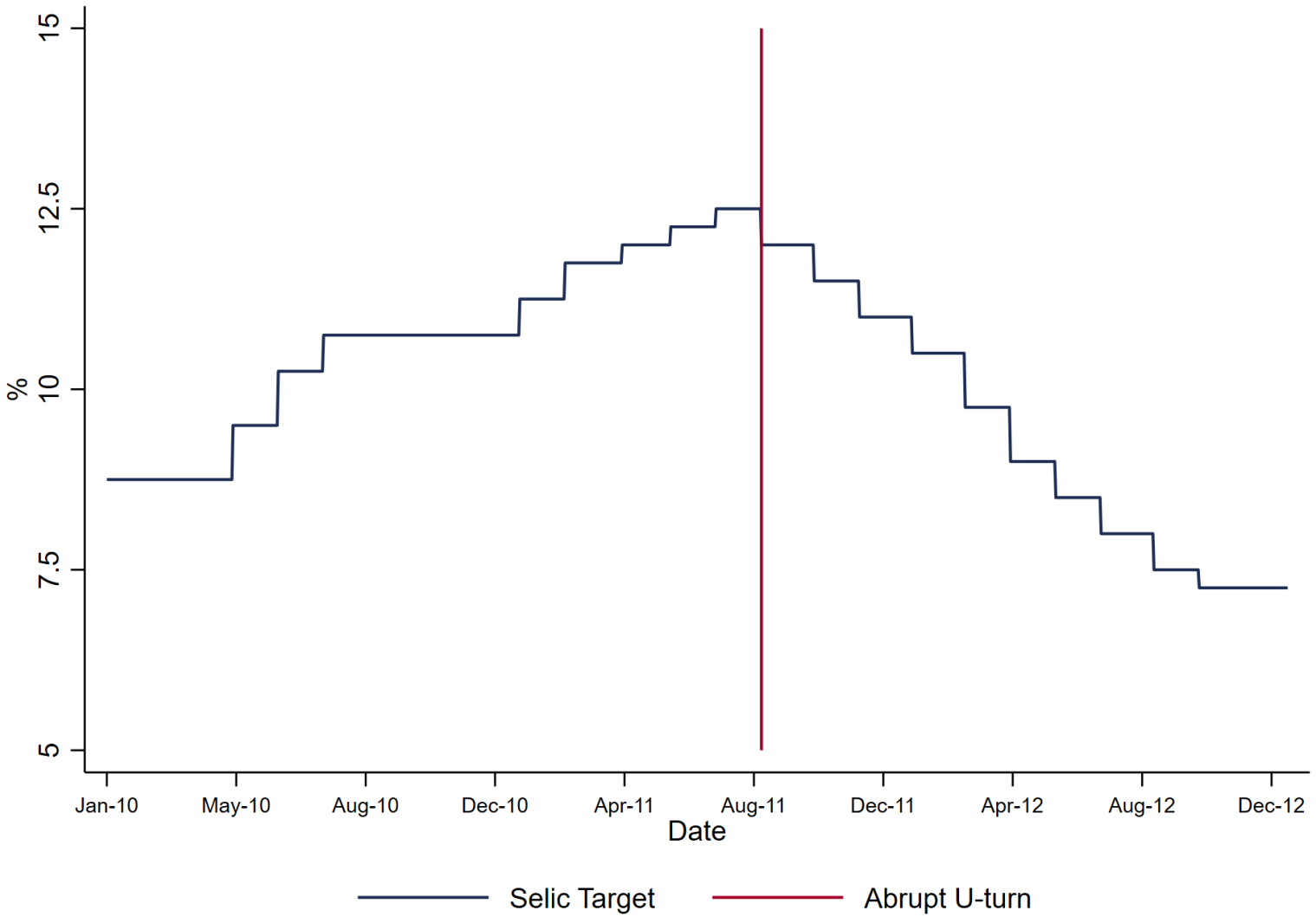
Zooming in on the U-turn

- BCB unexpectedly cut policy rate by 50 bps, starting a sizable easing cycle.

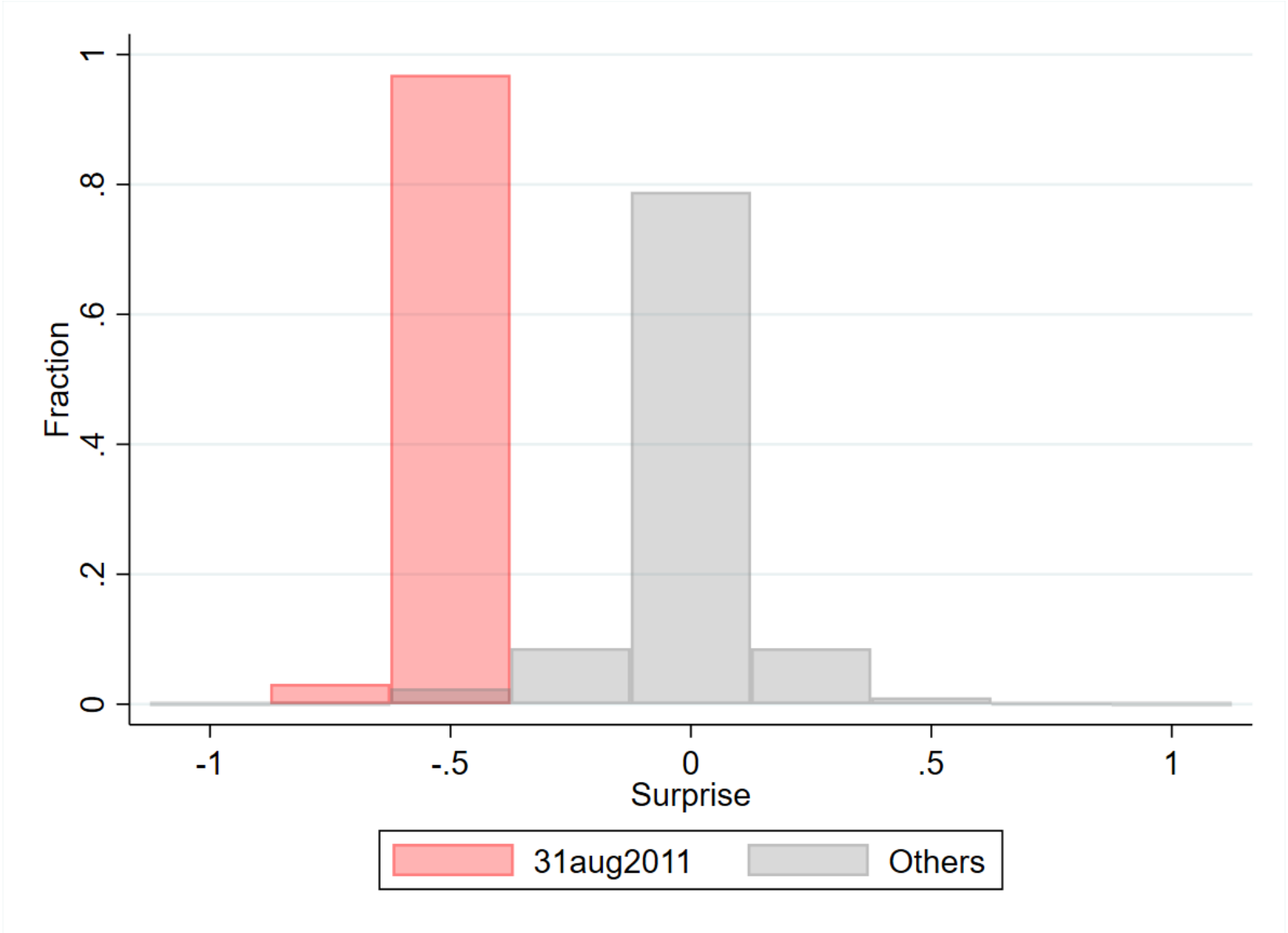


Zooming in on the U-turn

- BCB unexpectedly cut policy rate by 50 bps, starting a sizable easing cycle.



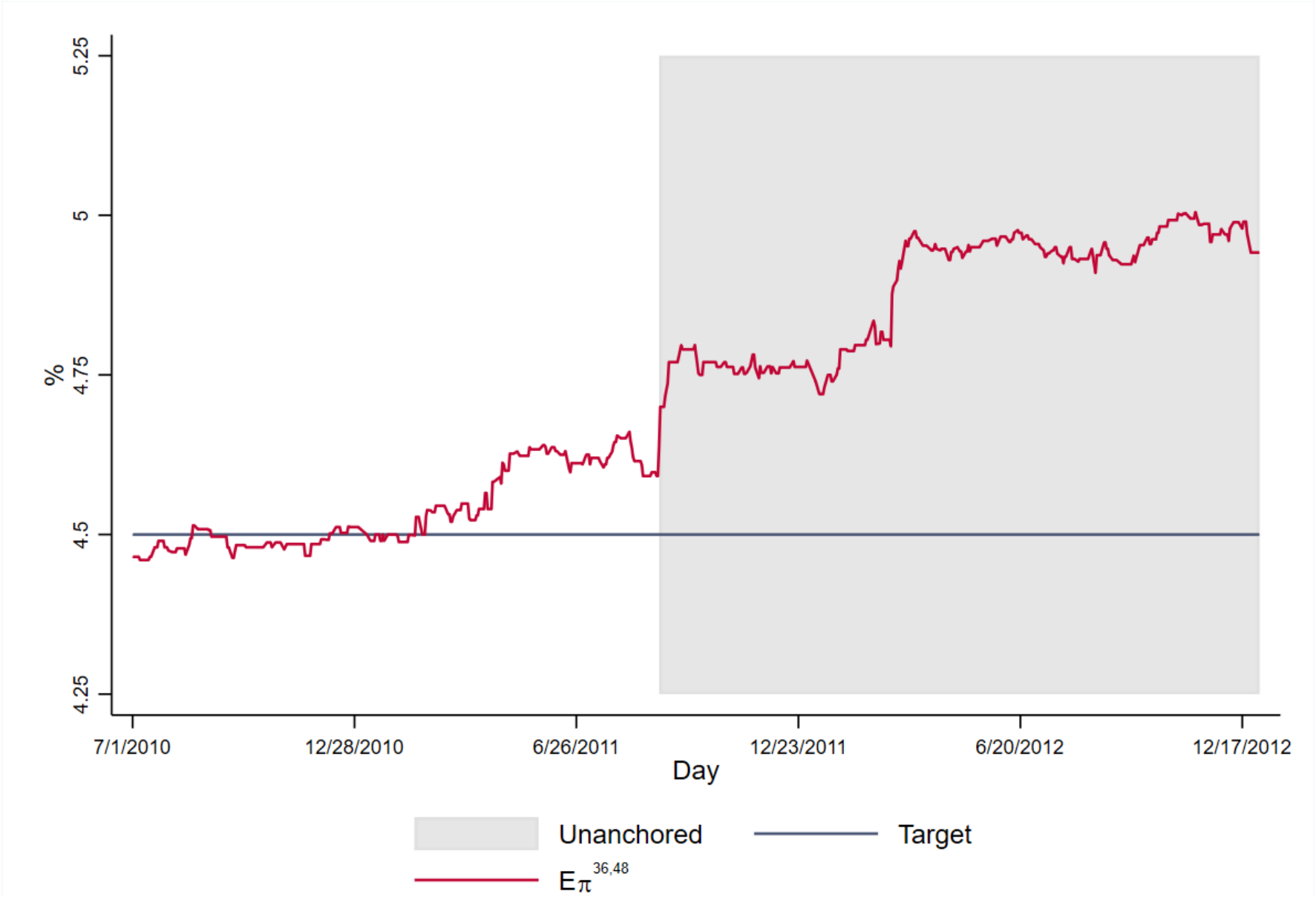
Monetary policy surprises from Focus microdata



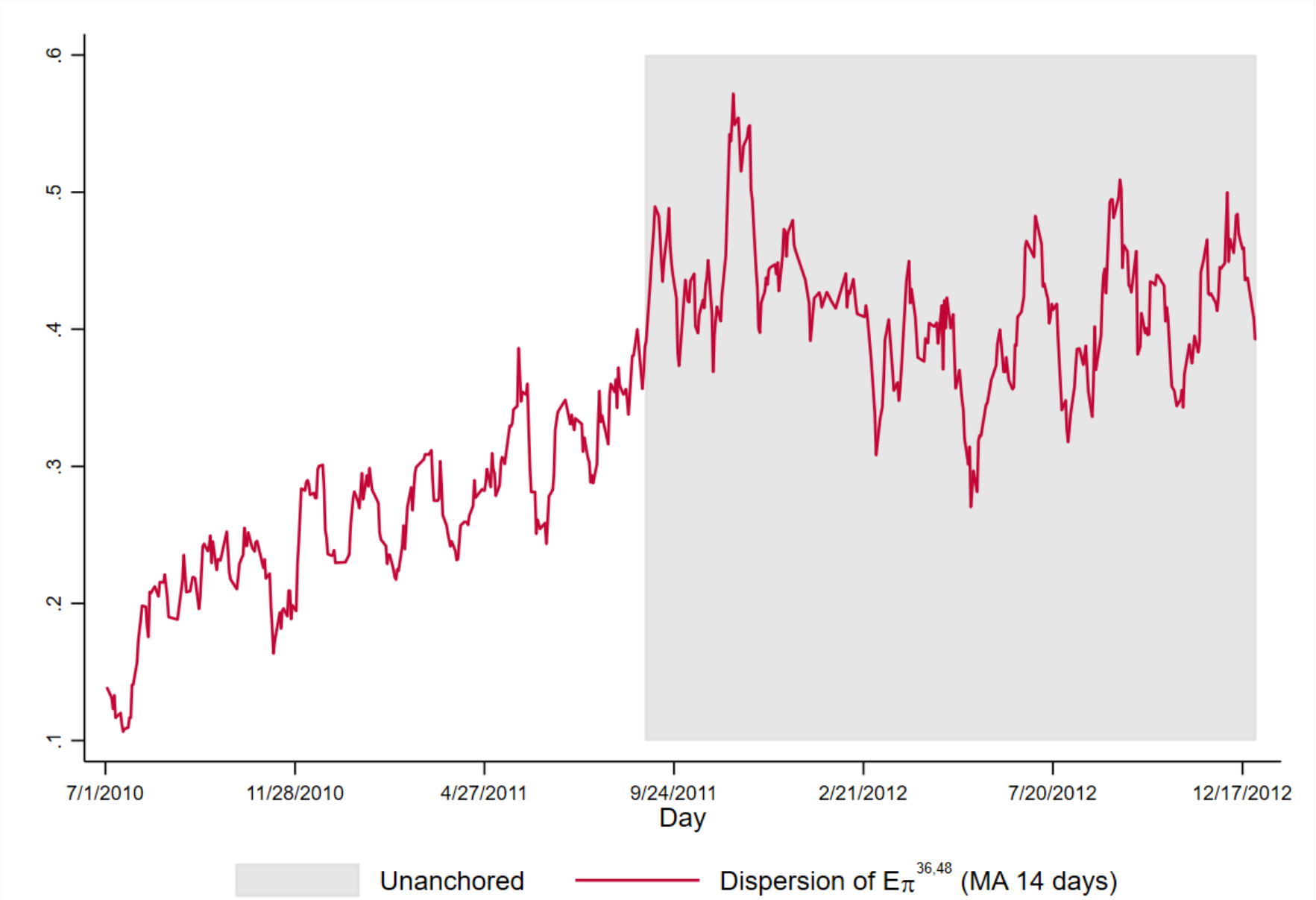
Former Governors' and Deputy Governor's reactions

- "For Loyola, BCB credibility is in check".
- "The inflation target was abandoned, says former BCB Governor's consulting firm".
- "BCB will have problems with inflation expectations, says Schwartsman".
- Newspaper editorial: "BCB under political pressure".
- Newspaper editorial: "BCB caves in to pressure".

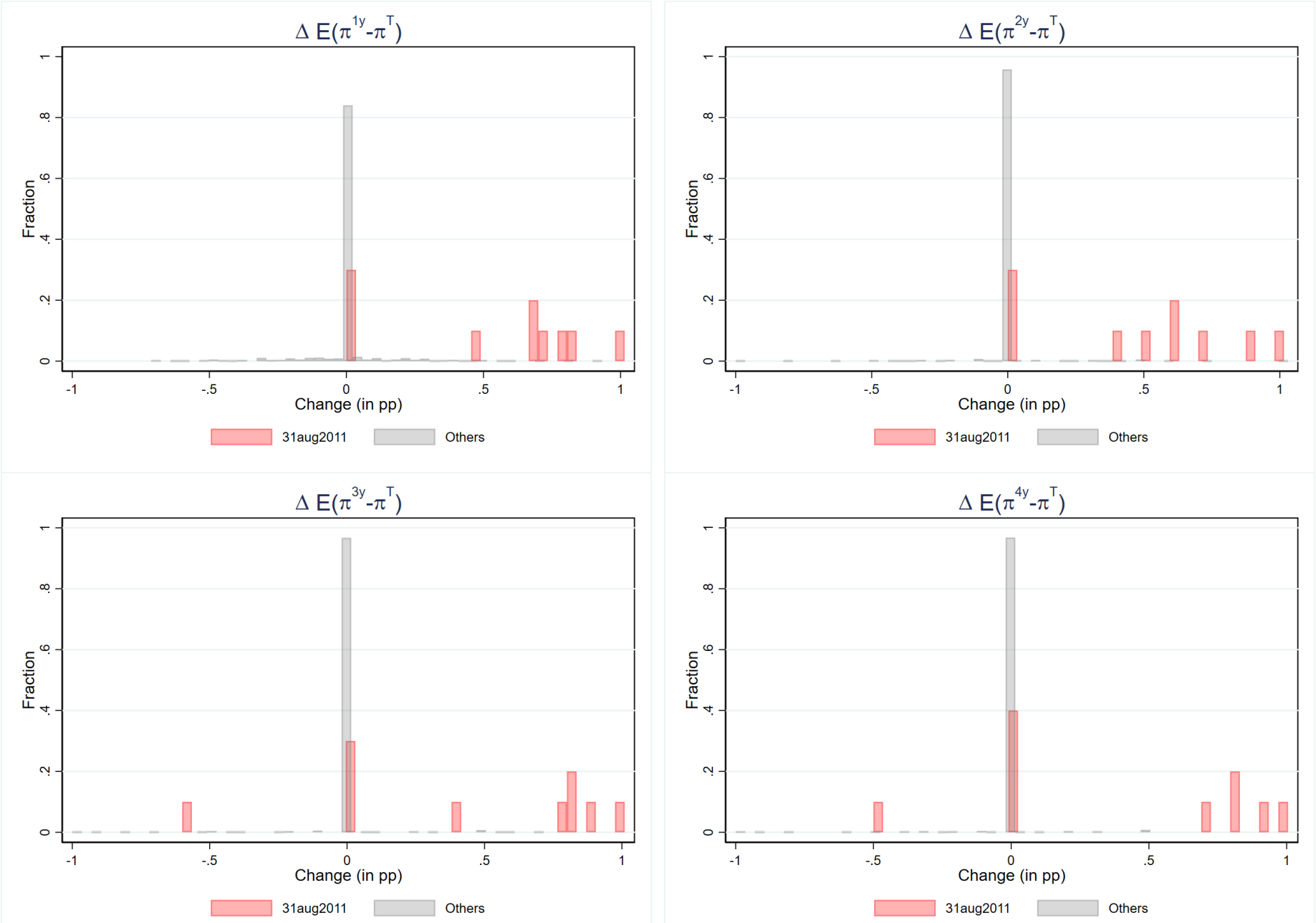
Inflation expectations: Zoom in with daily data



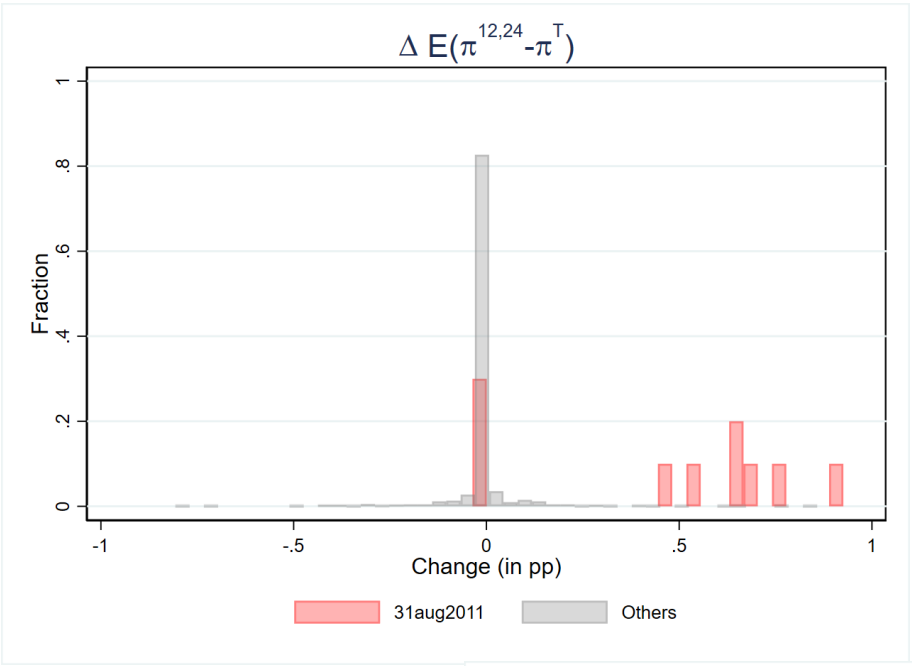
Dispersion of inflation expectations – Zoom in with daily data

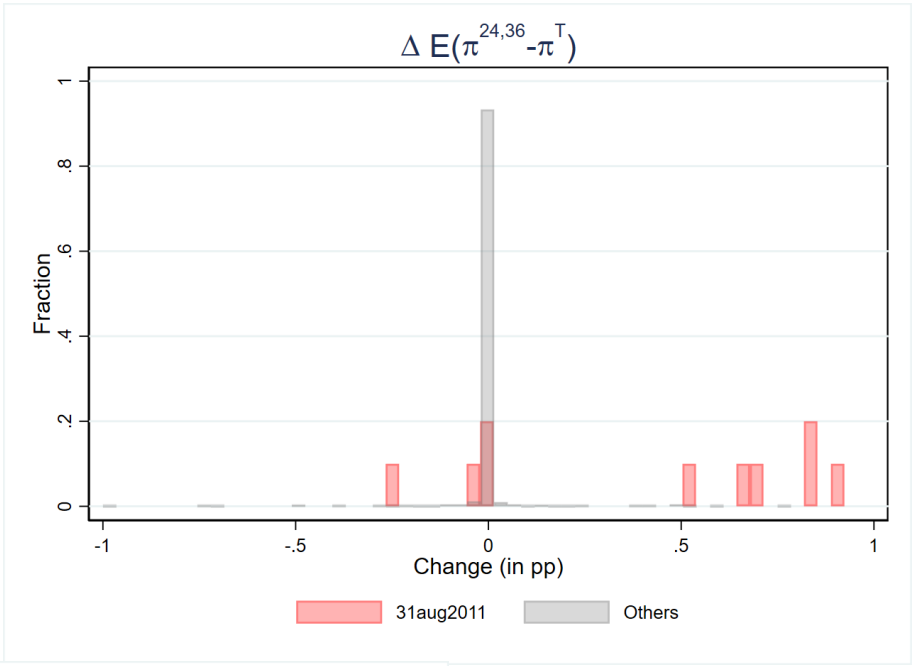


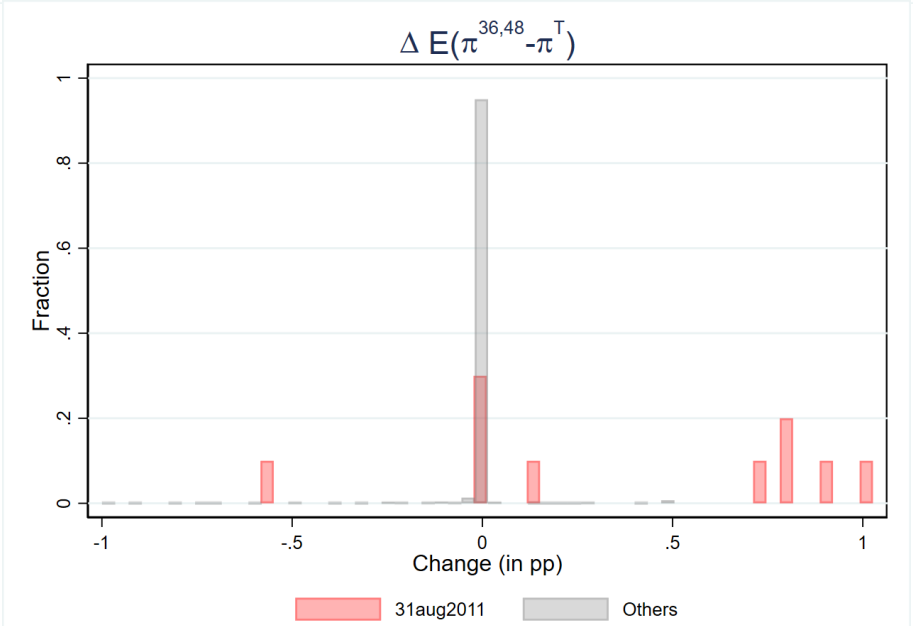
Two-day change in inflation expectations: Fixed events



Two-day change in inflation expectations: Fixed horizons





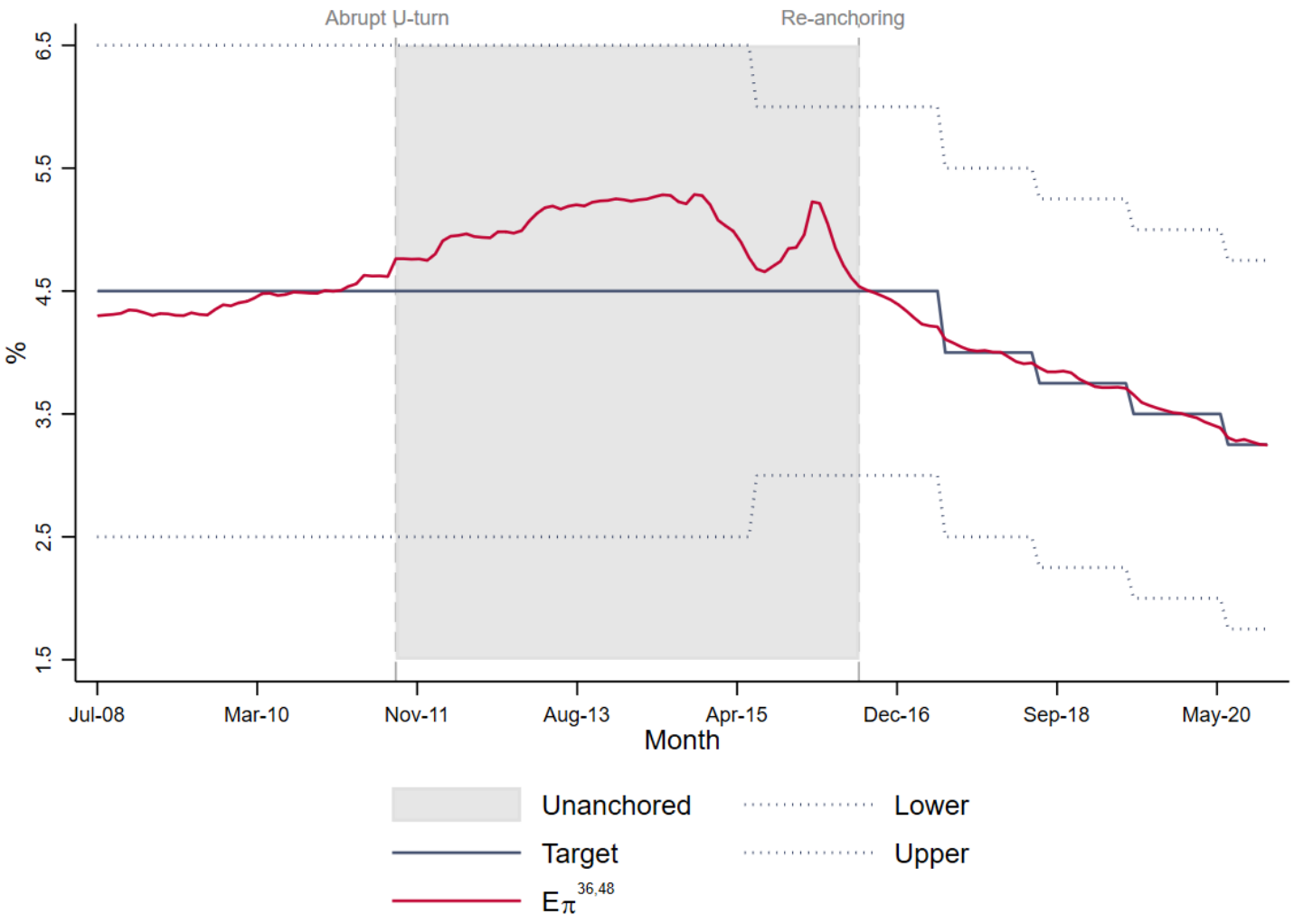


Reanchoring: Regime change

- Presidential impeachment.
- Formal process started in December 2015.
- Expectations start to reverse, currency appreciates.
- President Rouseff removed from office in May 2016; Michel Temer takes office as acting president; process completed in August 2016.
- New economic team, ambitious reform agenda, tight monetary policy.
- Expectations reanchored; by July/August 2016, back to pre U-turn levels.
- See also Carvalho and Nechio (2023) on "Challenges to Disinflation: The Brazilian Experience".

Anchored and unanchored regimes

Figure: **Expected inflation between months 36-48, target and tolerance bands**



What we mean by (un)anchored expectations

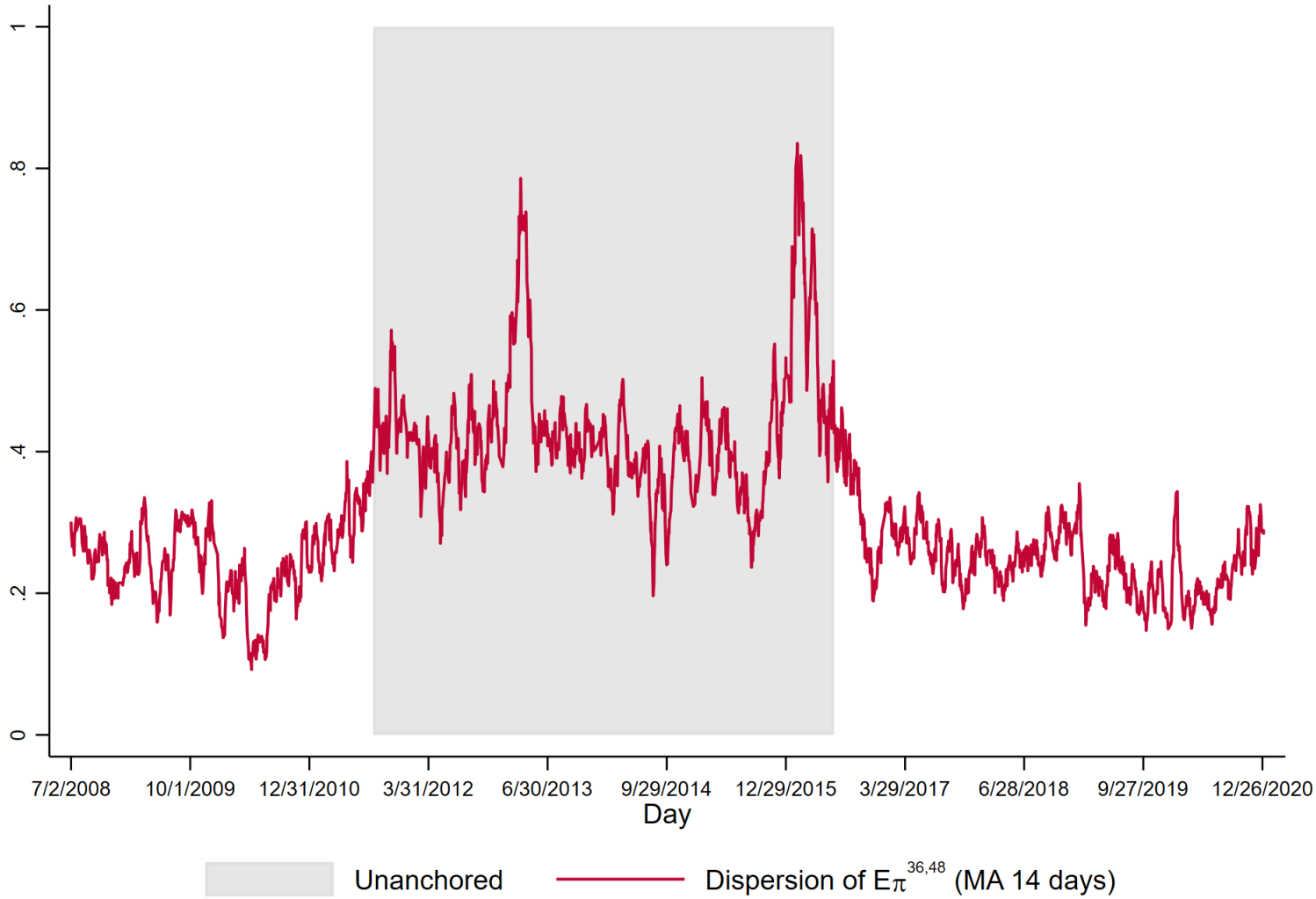
- Our characterization combines narrative approach with expectations data
- Carvalho et al. (2023) on anchored inflation expectations:
  - Long-run expectations consistent with the inflation target.
- Kumar et al. (2015):
  - Average beliefs should be close to the inflation target of the central bank.

Other characterizations of (un)anchored expectations

- Kumar et al. (2015):
  - Beliefs should not be too dispersed across agents.
  - Agents should be confident in their forecasts.
  - Agents should display small forecast revisions, especially at longer horizons.
  - There should be little comovement between revisions in long-run inflation expectations (which should be pinned down by the inflation target) and in short-run inflation expectations (which should move with transitory shocks).
- We add:
  - Medium/long-run expectations should be revised infrequently/less frequently.
  - Medium/long-run expectations should not be much responsive to monetary policy surprises.

Dispersion of inflation expectations

Figure: **Dispersion of inflation expectations**



Inflation expectations volatility

Std Dev of Inflation Expectation Deviation from Target

	$E_i\left(\pi^{1y}-\pi^T\right)$	$E_i\left(\pi^{2y}-\pi^T\right)$	$E_i\left(\pi^{3y}-\pi^T\right)$	$E_i\left(\pi^{4y}-\pi^T\right)$	$E_i\left(\pi^{36,48}-\pi^T\right)$
Anchored	0.35	0.17	0.17	0.18	0.16
Unanchored	0.49	0.42	0.35	0.33	0.34
Ratio: Unanchored/Anchored	1.37	2.38	2.06	1.88	2.08

Std Dev of Change in Inflation Expectation Deviation from Target

	$\Delta E_i\left(\pi^{1y}-\pi^T\right)$	$\Delta E_i\left(\pi^{2y}-\pi^T\right)$	$\Delta E_i\left(\pi^{3y}-\pi^T\right)$	$\Delta E_i\left(\pi^{4y}-\pi^T\right)$	$\Delta E_i\left(\pi^{36,48}-\pi^T\right)$
Anchored	0.04	0.02	0.02	0.02	0.02
Unanchored	0.07	0.05	0.04	0.03	0.03
Ratio: Unanchored/Anchored	1.82	2.19	1.66	1.36	1.49

Expectations passthrough regressions – reference dates

Dependent variable	$\Delta E_i\left(\pi^{24,36} - \pi^T\right)$	$\Delta E_i\left(\pi^{36,48} - \pi^T\right)$
$\Delta E_i\left[\pi^{12m}\right]$	0.0134	0.00384
	(0.0115)	(0.0161)
$\Delta E_i\left[\pi^{12m}\right] \times \mathbb{1}_t{}^{Unanch}$	0.183***	0.145***
	(0.0318)	(0.0309)
Constant	-0.000142	-0.00103
	(0.00333)	(0.00342)
N	3,268	2,762
Adjusted R^2	0.0415	0.0188
Individual Fixed Effects	Yes	Yes

Expectations passthrough regressions – 30-day rolling windows

Dependent variable	$\Delta E_i\left(\pi^{24,36} - \pi^T\right)$	$\Delta E_i\left(\pi^{36,48} - \pi^T\right)$
$\Delta E_i\left[\pi^{12m}\right]$	0.0264***	0.00735***
	(0.00187)	(0.00218)
$\Delta E_i\left[\pi^{12m}\right] \times \mathbb{1}_t{}^{Unanch}$	0.147***	0.107***
	(0.00598)	(0.00445)
Constant	-0.00180***	-0.00189***
	(0.000399)	(0.000417)
N	172,868	145,924
Adjusted R^2	0.0592	0.0334
Individual Fixed Effects	Yes	Yes

Frequency of inflation expectation updates

Duration of spells between expectation updates

	Mean (days)			
	$E_i\left(\pi^{1y} - \pi^T\right)$	$E_i\left(\pi^{2y} - \pi^T\right)$	$E_i\left(\pi^{3y} - \pi^T\right)$	$E_i\left(\pi^{4y} - \pi^T\right)$
Anchored	71.20	192.69	234.83	152.59
Unanchored	69.98	167.65	218.23	152.68

Two-day response of inflation expectations to policy surprises

Table: Two-day response of inflation expectations to monetary surprises – fixed events

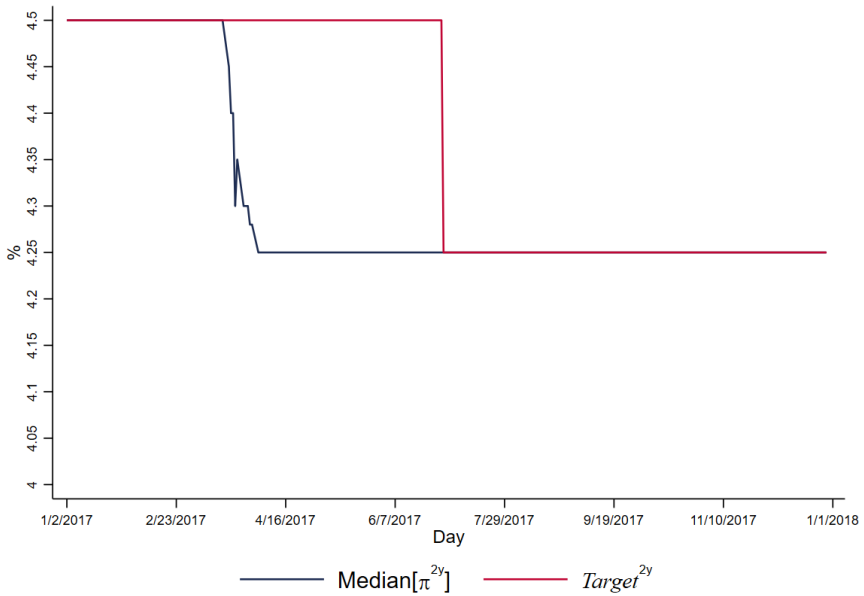
Dependent variable	$\Delta E_i\left(\pi^{1y}-\pi^{T}\right)$	$\Delta E_i\left(\pi^{2y}-\pi^{T}\right)$	$\Delta E_i\left(\pi^{3y}-\pi^{T}\right)$	$\Delta E_i\left(\pi^{4y}-\pi^{T}\right)$
Abrupt U-turn surprise	-0.918***	-0.817***	-0.751***	-0.715**
	(0.138)	(0.209)	(0.285)	(0.319)
Other surprises$\times \mathbb{1}_t^{Unanch}$	-0.489***	-0.423***	-0.319***	-0.167
	(0.127)	(0.116)	(0.1000)	(0.125)
Other surprises$\times(1-\mathbb{1}_t^{Unanch})$	-0.0949**	-0.0340	0.00233	-0.0118
	(0.0393)	(0.0301)	(0.0315)	(0.0515)
Constant	0.00267	0.00924**	0.00305	0.00247
	(0.00457)	(0.00444)	(0.00481)	(0.00571)
Data Structure	Panel	Panel	Panel	Panel
N	1,234	1,080	984	747
Adjusted R^2	0.175	0.168	0.0947	0.0825
Individual Fixed Effects	Yes	Yes	Yes	Yes

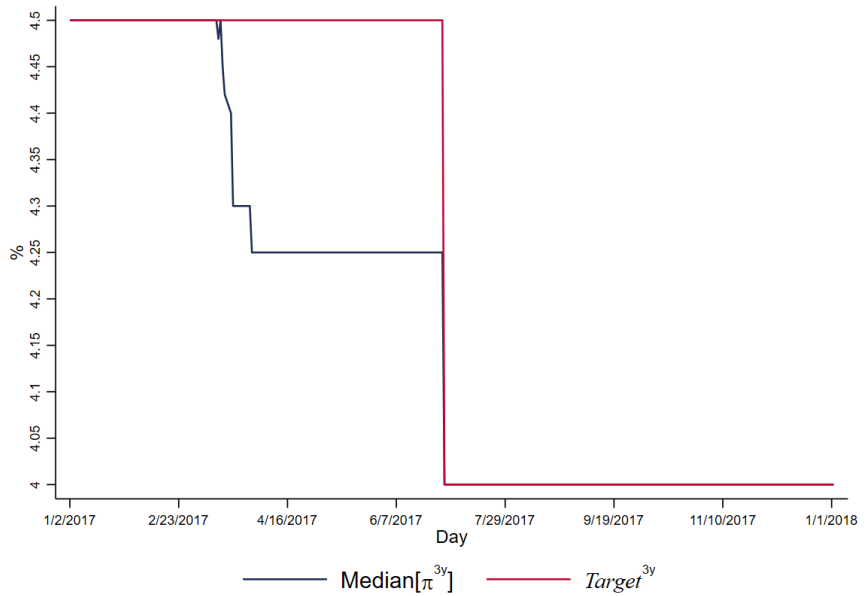
Two-day response of inflation expect. to policy surprises – 2

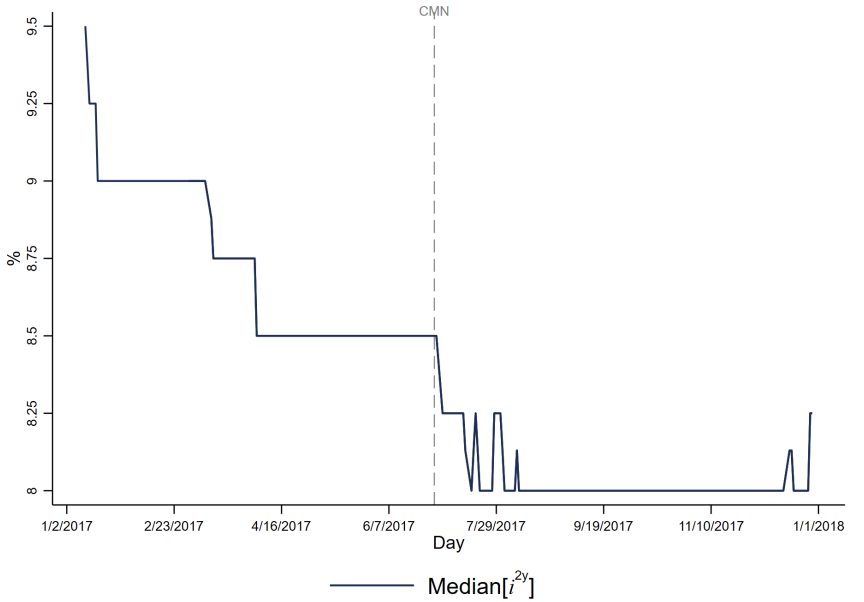
Table: Two-day response of inflation expectations to monetary surprises – fixed horizons

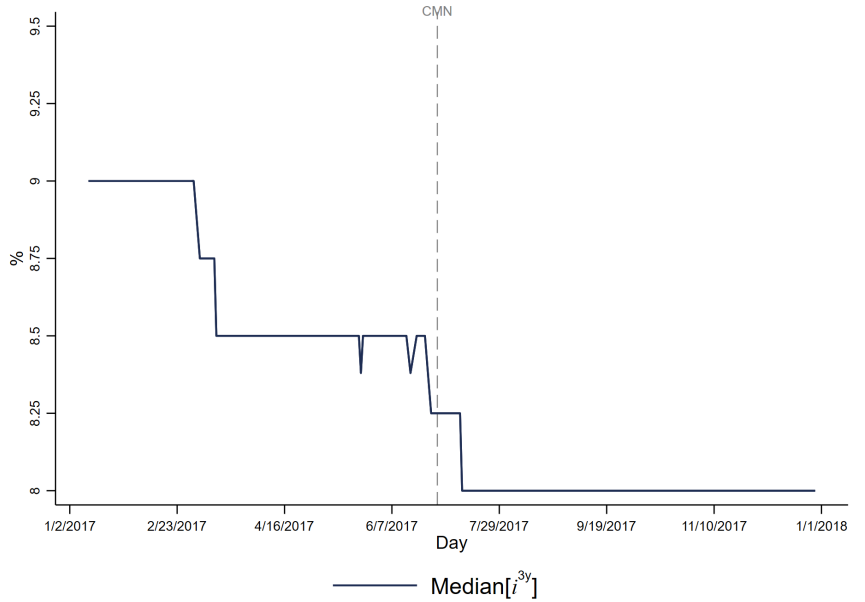
Dependent variable	$\Delta E_i\left(\pi^{12,24} - \pi^T\right)$	$\Delta E_i\left(\pi^{24,36} - \pi^T\right)$	$\Delta E_i\left(\pi^{36,48} - \pi^T\right)$
Abrupt U-turn surprise	-0.804***	-0.756***	-0.711**
	(0.152)	(0.257)	(0.329)
Other surprises$\times \mathbb{1}_t^{Unanch}$	-0.517***	-0.445***	-0.247*
	(0.132)	(0.122)	(0.142)
Other surprises$\times(1 - \mathbb{1}_t^{Unanch})$	-0.0785**	-0.0267	-0.0338
	(0.0347)	(0.0319)	(0.0467)
Constant	0.00770*	0.00823*	0.00223
	(0.00458)	(0.00463)	(0.00571)
Data Structure	Panel	Panel	Panel
N	1,078	978	747
Adjusted R^2	0.185	0.147	0.0909
Individual Fixed Effects	Yes	Yes	Yes

Reanchored: Evidence from lower inflation targets









Empirical strategy

$$\Delta_{\tau_i} p_{it} \equiv p_{it} - p_{it-\tau_{it}} = \alpha_i + \gamma_t + \beta_1 \Delta_{\tau_i} e_t + \beta_2 \Delta_{\tau_i} e_t \times \mathbb{1}_t^{Unanch} + \lambda_x x_{it} + \lambda_\tau x_{\tau_i t} + \epsilon_{it}$$

τ_{it}: item i price spell that ends in period t

$\Delta_{\tau_i} p_{it} \equiv p_{it} - p_{it-\tau_{it}}$: price change over that spell

$\Delta_{\tau_i} e_t \equiv e_t - e_{t-\tau_{it}}$: change in exchange rate over the life of that price spell

e_t: nominal exchange rate

or

$\hat{e}_t$: instrumented exchange rate

$\mathbb{1}_t^{Unanch}$: unanchored inflation expectations regime indicator

x_{it}, $x_{\tau_i t}$: control variables

α_i and γ_t: item- and time-fixed effects

ϵ_{it}: error term.

Empirical strategy - Instrumental Variable

First stage: $\Delta e_t = \theta_0 + \theta_1 \Delta S_t + \varepsilon_t$

Δe_t: monthly variation of nominal exchange rate (BRL/USD)

$\Delta S_t \equiv \frac{\left(\sum_{k=1}^{9} \Delta s_{k,t}\right)}{9}$: monthly variation of emerging markets currency (s_k) basket comprising 9 countries (Argentina, Colombia, Mexico, Peru, Chile, Russia, China, India, South Africa)

ε_t: error term.

Second stage:

$$\Delta_{\tau_i} p_{it} \equiv p_{it} - p_{it-\tau_{it}} = \alpha_i + \gamma_t + \beta_1 \Delta_{\tau_i} \hat{e}_t + \beta_2 \Delta_{\tau_i} \hat{e}_t \times \mathbb{1}_t^{Unanch} + \lambda_x x_{it} + \lambda_\tau x_{\tau_i t} + \epsilon_{it}$$

$\Delta_{\tau_i} \hat{e}_t \equiv \hat{e}_t - \hat{e}_{t-\tau_{it}}$: change in instrumented exchange rate over the life of that price spell

PPI microdata (IBRE-FGV)

- Survey of firms from agriculture, mining, and manufacturing.
  - Total of 310 (out of 343) "products" from 21 manufacturing "sectors"
- Structure:
  - sector (CNAE 3.0): set of products in the same sector. E.g. Textile products.
  - product (CNAE 2.0): set of items classified as being from the same product. Level at which weights are available. E.g. Cotton fabrics.
  - item: most disaggregated level, individual prices; includes company, model, size, brand, packaging, city etc.
- Sample: July 2008 to December 2020.
- Weights: IBRE-FGV. Our sample comprises 67.8% of the PPI.

	Total	**Monthly average**
	Raw data*	Raw data*
Items	14,164	5,796
Firms	2,633	1,695
Products	310	310
Sectors	21	21
Price Quotes	883,782	

*Raw data refers to the dataset treated for outliers and missing values. Unbalanced panel, some items are missing in any given month.

Manufacturing Industry Survey (IBRE-FGV)

- Monthly survey with manufacturing firms, used to produce leading indicators.
- Questions about:
  - demand
  - inventories
  - employment, access to credit, capacity utilization, general business conditions
- Firms associated with 63 "industries" defined by IBRE-FGV.
  - We associate each industry with one or more products.
  - Hence, MIS serves as a source of "sector/product-level" data.
- We also use data from a quarterly question about individual firms' pricing intentions (plans to increase, decrease, or keep prices constant in the following quarter).
  - For this question we have unique firm identifiers that allow us to associate answers with PPI microdata (only for 167 firms, which produce 489 items).

Basic price setting statistics

	Whole Sample		Anchored		Unanchored	
	Mean	**Median**	**Mean**	**Median**	**Mean**	**Median**
Freq. of price changes	0.395	0.317	0.400	0.320	0.384	0.312
Size of price changes	0.057	0.041	0.059	0.043	0.050	0.038

Baseline passthrough regressions

	$\Delta_{\tau_i} e_t$ - Nominal Exchange Rate			$\Delta_{\tau_i} e_t$ - Instrumented FX		
Dependent variable: $\Delta_{\tau_i} p_{it}$	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta_{\tau_i} e_t$	0.0410***	0.0225***	0.00822	0.0747***	0.0553***	0.0397***
	(0.00393)	(0.00545)	(0.00568)	(0.00593)	(0.00789)	(0.00860)
$\Delta_{\tau_i} e_t \times \mathbb{1}_t^{Unanch}$		0.0460***	0.0322***		0.0513***	0.0346***
		(0.00805)	(0.00844)		(0.0115)	(0.0120)
$\Delta_{\tau_i} p_{it-\tau_{it}}$			-0.122***			-0.123***
			(0.00521)			(0.00520)
τ_{it}			0.000359***			0.000286***
			(0.0000974)			(0.0000990)
$\Delta_{\tau_i} ULC_t$			0.0289***			0.0217***
			(0.00608)			(0.00615)
Δ_{τ_i} *Sectoral cost*$_t$			0.0347***			0.0323***
			(0.0104)			(0.0103)
Sectoral inventory$_t$			-0.000177***			-0.000177***
			(0.0000184)			(0.0000183)
Sectoral demand$_t$			0.000325***			0.000327***
			(0.0000288)			(0.0000288)
Constant	0.0435***	0.0428***	0.00214	0.0443***	0.0437***	0.00344
	(0.00245)	(0.00245)	(0.00380)	(0.00245)	(0.00246)	(0.00380)
N	192502	192502	178442	192502	192502	178442
Adjusted R^2	0.049	0.049	0.065	0.050	0.050	0.065
Individual Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

Empirical strategy – additional specifications

- Lagged FX change:

$$\Delta_{\tau_i} p_{it} = \alpha_i + \gamma_t + \beta_1 \Delta_{\tau_i} e_t + \beta_2 \Delta_{\tau_i} e_{t-\tau_{it}} + (\beta_3 \Delta_{\tau_i} e_t + \beta_4 \Delta_{\tau_i} e_{t-\tau_{it}}) \times \mathbb{1}_t^{Unanch} + \lambda_x x_{it} + \lambda_\tau x_{\tau_i t} + \epsilon_{it}$$

- Non-linear FX effect:

$$\Delta_{\tau_i} p_{it} = \alpha_i + \gamma_t + \beta_1 \Delta_{\tau_i} e_t + \beta_2 \Delta_{\tau_i} e_t \times \mathbb{1}_t^{Unanch} + \beta_3 (\Delta_{\tau_i} e_t)^2 + \lambda_x x_{it} + \lambda_\tau x_{\tau_i t} + \epsilon_{it}$$

- Asymmetric FX effect:

$$\Delta_{\tau_i} p_{it} = \alpha_i + \gamma_t + (\beta_1^+ \Delta_{\tau_i} e_t^+ + \beta_1^- \Delta_{\tau_i} e_t^-) + (\beta_2^+ \Delta_{\tau_i} e_t^+ + \beta_2^- \Delta_{\tau_i} e_t^-) \times \mathbb{1}_t^{Unanch} + \lambda_x x_{it} + \lambda_\tau x_{\tau_i t} + \epsilon_{it}$$

- Above-average inflation:

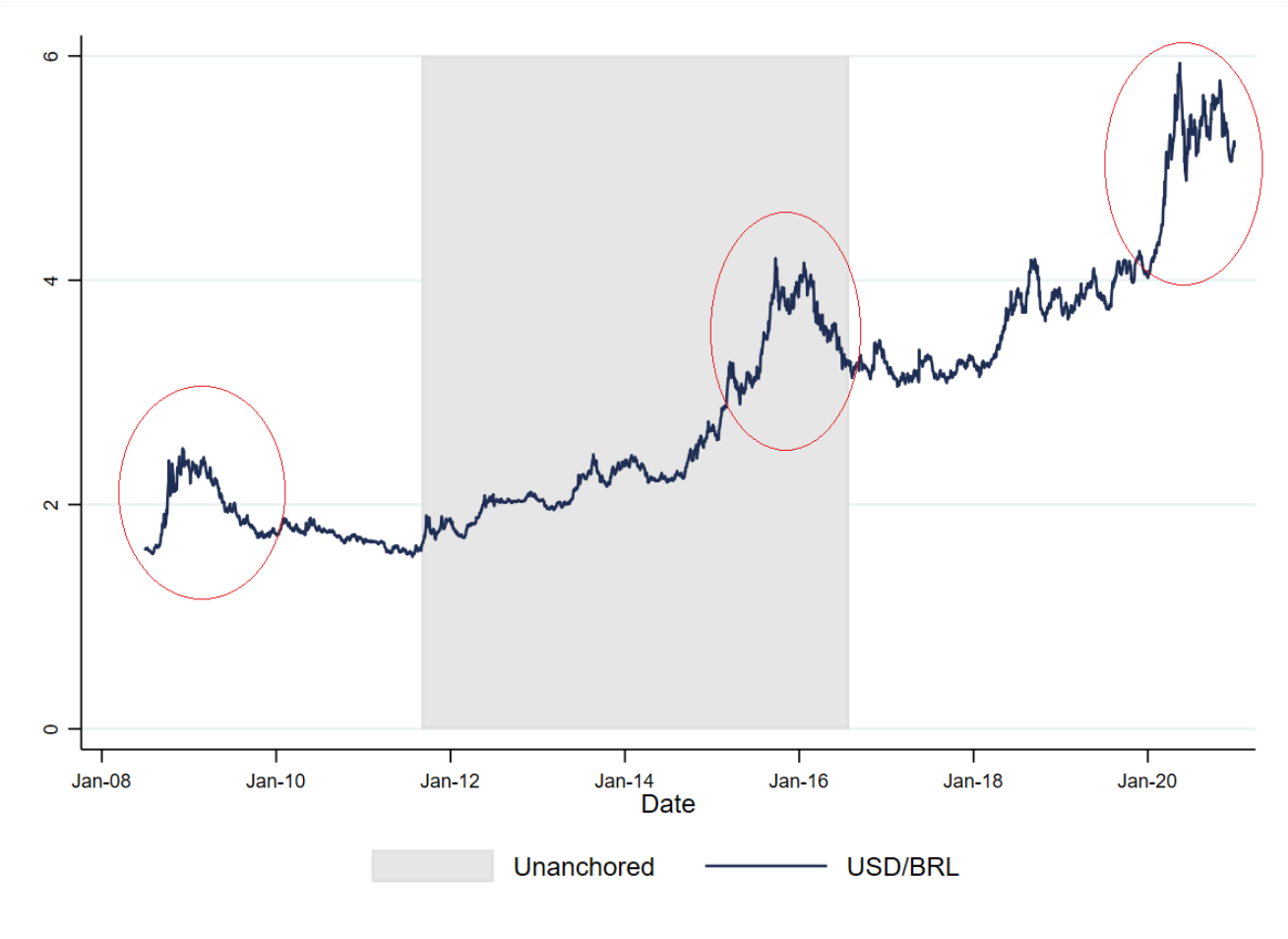
$$\Delta_{\tau_i} p_{it} = \alpha_i + \gamma_t + \beta_1 \Delta_{\tau_i} e_t + \beta_2 \Delta_{\tau_i} e_t \times \mathbb{1}_t^{Unanch} + \beta_3 \Delta_{\tau_i} e_t \times \pi_t + \lambda_x x_{it} + \lambda_\tau x_{\tau_i t} + \epsilon_{it}$$

Passthrough regression with lagged FX change

	$\Delta_{\tau_i} e_t$ - Nominal Exchange Rate			$\Delta_{\tau_i} e_t$ - Instrumented FX		
Dependent variable: $\Delta_{\tau_i} p_{it}$	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta_{\tau_i} e_t$	0.0420***	0.0128**	0.00370	0.0695***	0.0361***	0.0249**
	(0.00430)	(0.00650)	(0.00667)	(0.00666)	(0.00967)	(0.0104)
$\Delta_{\tau_i} e_{t-\tau_{it}}$	0.0120***	-0.000287	0.00251	0.00584	-0.00976	-0.00405
	(0.00348)	(0.00468)	(0.00467)	(0.00545)	(0.00669)	(0.00676)
$\Delta_{\tau_i} e_t \times \mathbb{1}_t^{Unanch}$		0.0618***	0.0513***		0.0753***	0.0675***
		(0.00896)	(0.00898)		(0.0130)	(0.0129)
$\Delta_{\tau_i} e_{t-\tau_{it}} \times \mathbb{1}_t^{Unanch}$		0.0277***	0.0375***		0.0393***	0.0510***
		(0.00676)	(0.00672)		(0.00875)	(0.00875)
N	178973	178973	172850	178973	178973	172850
Adjusted R^2	0.047	0.047	0.064	0.047	0.047	0.064
Individual Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Items/Sectors Controls	No	No	Yes	No	No	Yes

Unanchoring or non-linearity?

Figure: **USDBRL and anchored/unanchored regimes**



Unanchoring or non-linearity?

	$\Delta_{\tau_i} e_t$ - **Nominal Exchange Rate**					$\Delta_{\tau_i} e_t$ - **Instrumented FX**				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\Delta_{\tau_i} e_t$	0.0410***	0.0225***	0.0315***	0.0193***	0.00989	0.0747***	0.0553***	0.0665***	0.0510***	0.0439***
	(0.00393)	(0.00545)	(0.00495)	(0.00582)	(0.00602)	(0.00593)	(0.00789)	(0.00798)	(0.00930)	(0.00983)
$\Delta_{\tau_i} e_t \times \mathbb{1}_t^{Unanch}$		0.0460***		0.0425***	0.0337***		0.0513***		0.0498***	0.0353***
		(0.00805)		(0.00834)	(0.00853)		(0.0115)		(0.0115)	(0.0119)
$(\Delta_{\tau_i} e_t)^2$			0.0455***	0.0220	-0.0135			0.0467	0.0279	-0.0324
			(0.0163)	(0.0170)	(0.0188)			(0.0358)	(0.0361)	(0.0417)
N	192502	192502	192502	192502	178442	192502	192502	192502	192502	178442
Adjusted R^2	0.049	0.049	0.049	0.049	0.065	0.050	0.050	0.050	0.050	0.065
Individual Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Items/Sectors Controls	No	No	No	No	Yes	No	No	No	No	Yes

Unanchoring or asymmetric response to FX?

$\Delta_{\tau_i} e_t$ - **Nominal Exchange Rate**

	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta_{\tau_i} e_t$	0.0410***		0.0225***	0.00822		
	(0.00393)		(0.00545)	(0.00568)		
$\Delta_{\tau_i} e_t^{app}$		0.00792			0.00709	0.0108
		(0.00964)			(0.0103)	(0.0112)
$\Delta_{\tau_i} e_t^{dep}$		0.0531***			0.0310***	0.00692
		(0.00501)			(0.00730)	(0.00819)
$\Delta_{\tau_i} e_t \times \mathbb{1}_t^{Unanch}$			0.0460***	0.0322***		
			(0.00805)	(0.00844)		
$\Delta_{\tau_i} e_t^{app} \times \mathbb{1}_t^{Unanch}$					0.0264	0.00626
					(0.0268)	(0.0274)
$\Delta_{\tau_i} e_t^{dep} \times \mathbb{1}_t^{Unanch}$					0.0423***	0.0357***
					(0.00948)	(0.00971)
N	192502	192502	192502	178442	192502	178442
Adjusted R^2	0.049	0.049	0.049	0.065	0.050	0.065
Individual Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Items/Sectors Controls	No	No	No	Yes	No	Yes

Unanchoring or asymmetric response to FX?

$\Delta_{\tau_i} e_t$ - **Instrumented FX**

	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta_{\tau_i} e_t$	0.0747***		0.0553***	0.0397***		
	(0.00593)		(0.00789)	(0.00860)		
$\Delta_{\tau_i} e_t^{app}$		0.0637***			0.0665***	0.0595***
		(0.0146)			(0.0173)	(0.0182)
$\Delta_{\tau_i} e_t^{dep}$		0.0773***			0.0518***	0.0328***
		(0.00645)			(0.00888)	(0.00978)
$\Delta_{\tau_i} e_t \times \mathbb{1}_t^{Unanch}$			0.0513***	0.0346***		
			(0.0115)	(0.0120)		
$\Delta_{\tau_i} e_t^{app} \times \mathbb{1}_t^{Unanch}$					-0.0100	-0.0298
					(0.0307)	(0.0317)
$\Delta_{\tau_i} e_t^{dep} \times \mathbb{1}_t^{Unanch}$					0.0587***	0.0433***
					(0.0122)	(0.0126)
N	192502	192502	192502	178442	192502	178442
Adjusted R^2	0.050	0.050	0.050	0.065	0.050	0.065
Individual Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Items/Sectors Controls	No	No	No	Yes	No	Yes

Unanchoring or higher inflation?

	$\Delta_{\tau_i} e_t$ - **Nominal Exchange Rate**					$\Delta_{\tau_i} e_t$ - **Instrumented FX**				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\Delta_{\tau_i} e_t$	0.0410***	0.0225***	0.0125*	0.0111	-0.00281	0.0747***	0.0553***	0.0478***	0.0463***	0.0326***
	(0.00393)	(0.00545)	(0.00755)	(0.00758)	(0.00732)	(0.00593)	(0.00789)	(0.0102)	(0.0103)	(0.0103)
$\Delta_{\tau_i} e_t \times \mathbb{1}_t^{Unanch}$		0.0460***		0.0355***	0.0224**		0.0513***		0.0407***	0.0265*
		(0.00805)		(0.00921)	(0.00976)		(0.0115)		(0.0136)	(0.0143)
$\Delta_{\tau_i} e_t \times \pi_t$			0.0547***	0.0299**	0.0282**			0.0536***	0.0259	0.0199
			(0.0111)	(0.0127)	(0.0125)			(0.0147)	(0.0175)	(0.0171)
N	192502	192502	192502	192502	178442	192502	192502	192502	192502	178442
Adjusted R^2	0.049	0.049	0.049	0.050	0.065	0.050	0.050	0.050	0.050	0.065
Individual Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Items/Sectors Controls	No	No	No	No	Yes	No	No	No	No	Yes

Unanchoring or higher 12m inflation?

	$\Delta_{\tau_i} e_t$ - Nominal Exchange Rate					$\Delta_{\tau_i} e_t$ - Instrumented FX				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\Delta_{\tau_i} e_t$	0.0410***	0.0225***	-0.0132	0.00216	-0.0249*	0.0747***	0.0553***	0.00293	0.0120	-0.0103
	(0.00393)	(0.00545)	(0.0106)	(0.0119)	(0.0123)	(0.00593)	(0.00789)	(0.0160)	(0.0180)	(0.0187)
$\Delta_{\tau_i} e_t \times \mathbb{1}_t^{Unanch}$		0.0460***		0.0298*	0.00565		0.0513***		0.0165	-0.00544
		(0.00805)		(0.0122)	(0.0129)		(0.0115)		(0.0170)	(0.0179)
$\Delta_{\tau_i} e_t \times \pi_t^{12m}$			0.00875***	0.00434	0.00695**			0.0121***	0.00950**	0.0108**
			(0.00155)	(0.00236)	(0.00244)			(0.00246)	(0.00364)	(0.00379)
N	192502	192502	192502	192502	178442	192502	192502	192502	192502	178442
Adjusted R^2	0.049	0.049	0.049	0.050	0.065	0.050	0.050	0.050	0.050	0.065
Individual Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Items/Sectors Controls	No	No	No	No	Yes	No	No	No	No	Yes

A measure of the degree of unanchoring

- Inspired by Cecchetti and Krause's (2002) credibility measure for an inflation targeting central bank:

$$Unanch_t = \begin{cases} 1 & \text{if } \mathbb{E}_t\left[\pi_{t+s}\right] > \pi^{max}_{t+s}; \\ \frac{\mathbb{E}_t[\pi_{t+s}] - \pi^{T}_{t+s}}{\pi^{max}_{t+s} - \pi^{T}_{t+s}} & \text{if } \pi^{T}_{t+s} \leq \mathbb{E}_t\left[\pi_{t+s}\right] \leq \pi^{max}_{t+s}; \\ 0 & \text{if } \mathbb{E}_t\left[\pi_{t+s}\right] < \pi^{T}_{t+s}, \end{cases}$$

$E_t\left[\pi_{t+s}\right]$: inflation expectation at time t for horizon $t+s$,

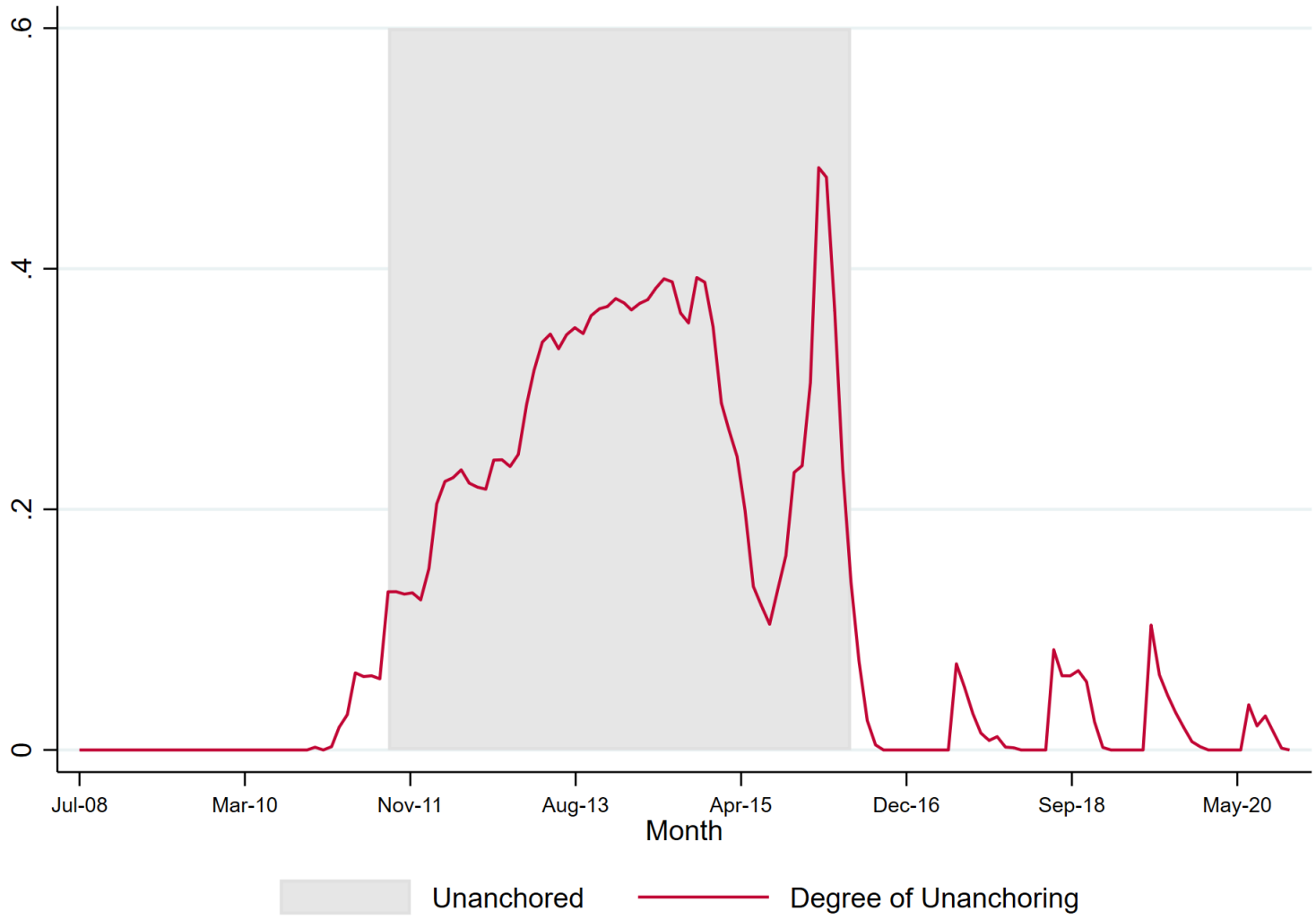
π^{T}_{t+s}: inflation target for $t+s$,

π^{max}_{t+s}: arbitrary measure associated with "full unanchoring". For Brazil, we pick the top of the tolerance band.

- Expectation horizon: not too short
  - Short horizons: temporary shocks to which CB may do well not to respond to.
  - BCB formally focuses on inflation between 6 and 18 months ahead.
  - Our choice: Inflation between 36 and 48 months ahead (longest available).

Regimes and degree of unanchoring

Figure: **Anchored/unanchored regimes and degree of unanchoring**



Passthrough regression with degree of unanchoring

	$\Delta_{\tau_i} e_t$ - Nominal Exchange Rate			$\Delta_{\tau_i} e_t$ - Instrumented FX		
Dependent variable: $\Delta_{\tau_i} p_{it}$	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta_{\tau_i} e_t$	0.0410***	0.0185***	0.00626	0.0747***	0.0497***	0.0359***
	(0.00393)	(0.00523)	(0.00543)	(0.00593)	(0.00769)	(0.00840)
$\Delta_{\tau_i} e_t \times Unanch_t$		0.199***	0.133***		0.217***	0.147***
		(0.0271)	(0.0285)		(0.0361)	(0.0373)
N	192502	192502	178442	192502	192502	178442
Adjusted R^2	0.049	0.050	0.065	0.050	0.050	0.065
Individual Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Items/Sectors Controls	No	No	Yes	No	No	Yes

(Degree of) Unanchoring or non-linearity?

	$\Delta_{\tau_i} e_t$ - **Nominal Exchange Rate**					$\Delta_{\tau_i} e_t$ - **Instrumented FX**				
Dependent variable: $\Delta_{\tau_i} p_{it}$	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\Delta_{\tau_i} e_t$	0.0410***	0.0185***	0.0315***	0.0155***	0.00806	0.0747***	0.0497***	0.0665***	0.0465***	0.0407***
	(0.00393)	(0.00523)	(0.00495)	(0.00571)	(0.00588)	(0.00593)	(0.00769)	(0.00798)	(0.00916)	(0.00962)
$\Delta_{\tau_i} e_t \times Unanch_t$		0.199***		0.191***	0.137***		0.217***		0.213***	0.150***
		(0.0271)		(0.0277)	(0.0285)		(0.0361)		(0.0360)	(0.0369)
$(\Delta_{\tau_i} e_t)^2$			0.0455***	0.0186	-0.0135			0.0467	0.0206	-0.0385
			(0.0163)	(0.0169)	(0.0187)			(0.0358)	(0.0362)	(0.0418)
N	192502	192502	192502	192502	178442	192502	192502	192502	192502	178442
Adjusted R^2	0.049	0.050	0.049	0.050	0.065	0.050	0.050	0.050	0.050	0.065
Individual Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Items/Sectors Controls	No	No	No	No	Yes	No	No	No	No	Yes

(Degree of) Unanchoring or above-average monthly inflation?

	$\Delta_{\tau_i} e_t$ - **Nominal Exchange Rate**					$\Delta_{\tau_i} e_t$ - **Instrumented FX**				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\Delta_{\tau_i} e_t$	0.0410***	0.0185***	0.0125*	0.0104	-0.00315	0.0747***	0.0497***	0.0478***	0.0448***	0.317***
	(0.00393)	(0.00523)	(0.00755)	(0.00758)	(0.00732)	(0.00593)	(0.00769)	(0.0102)	(0.0103)	(0.0103)
$\Delta_{\tau_i} e_t \times Unanch_t$		0.199***		0.178***	0.109***		0.217***		0.201***	0.134***
		(0.0271)		(0.0299)	(0.0314)		(0.0361)		(0.0411)	(0.0425)
$\Delta_{\tau_i} e_t \times \pi_t$			0.0547***	0.0201	0.0229*			0.0536***	0.0132	0.0111
			(0.0111)	(0.0122)	(0.0118)			(0.0147)	(0.0168)	(0.0163)
N	192502	192502	192502	192502	178442	192502	192502	192502	192502	178442
Adjusted R^2	0.05	0.05	0.05	0.05	0.07	0.050	0.050	0.050	0.050	0.065
Individual Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Items/Sectors Controls	No	No	No	No	Yes	No	No	No	No	Yes

(Degree of) Unanchoring or above-average 12m inflation?

	$\Delta_{\tau_i} e_t$ - **Nominal Exchange Rate**					$\Delta_{\tau_i} e_t$ - **Instrumented FX**				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\Delta_{\tau_i} e_t$	0.0410***	0.0185***	-0.0132	0.00865	-0.0168	0.0747***	0.0497***	0.00293	0.0277	0.00585
	(0.00393)	(0.00523)	(0.0106)	(0.0110)	(0.0113)	(0.00593)	(0.00769)	(0.0160)	(0.0168)	(0.0176)
$\Delta_{\tau_i} e_t \times Unanch_t$		0.199***		0.179***	0.0842*		0.217***		0.171***	0.0839
		(0.0271)		(0.0339)	(0.0362)		(0.0361)		(0.0461)	(0.0484)
$\Delta_{\tau_i} e_t \times \pi_t^{12m}$			0.00875***	0.000196	0.00455*			0.0121***	0.00460	0.00621
			(0.00155)	(0.00193)	(0.00202)			(0.00246)	(0.00315)	(0.00331)
N	192502	192502	192502	192502	178442	192502	192502	192502	192502	178442
Adjusted R^2	0.049	0.050	0.049	0.050	0.065	0.050	0.050	0.050	0.050	0.065
Individual Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Items/Sectors Controls	No	No	No	No	Yes	No	No	No	No	Yes

Empirical strategy – individual firms' pricing intentions

$$Forecast^{i}_{t,t+1} = \begin{cases} 1 & if \;\; E^{i}_{t}[p_{it+1}] > p_{it}; \\ 0 & if \;\; E^{i}_{t}[p_{it+1}] = p_{it}; \\ -1 & if \;\; E^{i}_{t}[p_{it+1}] < p_{it}, \end{cases}$$

$$Outcome^{i}_{t+1} = \begin{cases} 1 & if \;\; p_{it+1} > p_{it}; \\ 0 & if \;\; p_{it+1} = p_{it}; \\ -1 & if \;\; p_{it+1} < p_{it}. \end{cases}$$

$$Mistake^{i}_{t+1} = \begin{cases} 1 & if \; Outcome^{i}_{t+1} = Intention^{i}_{t,t+1}; \\ 0 & otherwise, \end{cases}$$

Panel logit regression:

$$Mistake^{i}_{t} = F(\alpha_i + \gamma_t + \beta_1 \mathbb{1}_t{}^{Unanch} + \beta_2 \tau_{it} + \beta_3 x_{it}) + u_{it}.$$

Also, specification degree of unanchoring instead of $\mathbb{1}_t{}^{Unanch}$.

Accuracy of firms' own-price forecasts

Dependent Variable: $Mistake_t^i$	**(1)**	**(2)**	**(3)**	**(4)**
$\mathbb{1}_q^{Unanch}$	-0.186***			
	(0.08)			
$Unanch_q$		-0.310		
		(0.23)		
$\overline{\mathbb{1}_q^{Unanch}}$			-0.220***	
			(0.08)	
$\overline{Unanch_q}$				-0.398*
				(0.22)
τ_{iq}	-0.0520***	-0.0510***	-0.0523***	-0.0513***
	(0.007)	(0.007)	(0.007)	(0.007)
$\mathbb{1}_{\Delta p_{iq-1}}$	-0.217***	-0.211***	-0.218***	-0.212***
	(0.09)	(0.09)	(0.09)	(0.09)
N	2920	2920	2920	2920
$pseudo.R^2$	0.0172	0.0160	0.0178	0.0164
Individual fixed effects	Yes	Yes	Yes	Yes
Time fixed effects	No	No	No	No

Because these data are quarterly, we also consider specifications in which the monthly unanchoring variables are averaged over the quarter. These specifications are indicated with a "bar" above the unanchoring variable.

Model

- Standard new Keynesian model with imported inputs: source of exchange rate passthrough.
- Mechanism for unanchoring: inference about inflation target.
  - Agents' beliefs about target are more responsive to short-term monetary surprises $\Rightarrow$ long-term expectations become more sensitive to exchange rate shocks, leading to higher passthrough.
- We calibrate model to Brazilian economy, simulate artificial data and run passthrough regressions analogous to empirical specifications.
- Quantitative results in line with our empirical findings.

Firms' technology and pricing

- Firm i's output Y_{it}:

$$Y_{it} = A_{it}\left(L_{it}^{\eta} I_{it}^{1-\eta}\right)^{\alpha} M_{it}^{(1-\alpha)},$$

L_{it}: labor
I_{it}: domestic intermediate inputs (source of real rigidities)
M_{it}: imported input
A_{it}: productivity (firm-specific and aggregate).

- Firm i's real marginal cost:

$$MC_{it} \propto A_{it}^{-1}\omega_t^{\alpha\eta} q_t^{1-\alpha},$$

ω_t: real wage
q_t: real exchange rate. [Partial equilibrium approach: constant foreign price level]

- Nominal exchange rate: $e_t = \rho_e e_{t-1} + \varepsilon_t^e \Rightarrow$ cost-push shock

- Calvo pricing.

Firms' pricing decision

- Firm (i) resetting the price

$$\tilde{p}^{r}_{i,t} = \mathbb{E}_t \sum_{T=t}^{\infty} (\xi\beta)^{T-t} \left[(1-\xi\beta) \left(\hat{mc}_T - a_{i,T} \right) + \xi\beta\pi_{T+1} \right]$$

where aggregate marginal cost

$$mc_t = \zeta \left[(1-\alpha)\hat{q}_t - \hat{a}_t + \alpha\eta\hat{y}_t \right]$$

where ζ measures the degree of real rigidities.

- Exchange rate and pricing decisions:
  - Direct cost effect of exchange rate through imported inputs.
  - Indirect cost effect of exchange rate through domestic intermediate inputs.
  - Equilibrium effects through expectations.

$\Rightarrow$ Expectations anchoring depends on policy expectations.

Central bank and expectation (un)anchoring

- Taylor rule:

$$R_t = \rho R_{t-1} + (1-\rho)\left[\phi_\pi\left(\pi_t - \pi_t^*\right) + \phi_y \hat{y}_t\right] + \varepsilon_t^R$$

- Inflation target:

$$\pi_t^* = \rho_{\pi_*} \pi_{t-1}^* + \varepsilon_t^*.$$

- Monetary policy shock: $\mathrm{Cov}(\varepsilon_t^R, \varepsilon_t^e) < 0 \rightarrow$ accommodate exchange rate depreciation

- Learning about π_t^*:
  1. Agents cannot separately identify ε_t^R and π_t^*
  2. Signal extraction problem: Kalman filter

Central bank and expectation (un)anchoring

- Policy surprises and anchoring

$$\begin{aligned} \tilde{\pi}_t &= \pi_t^* - \frac{1}{(1-\rho_i)\phi_\pi}\varepsilon_{R,t}, \text{[Signal]} \\ \pi^*_{t+1|t} &= \rho_{\pi_*}\pi^*_{t|t-1} + \bar{g}\left(\tilde{\pi}_t - \pi^*_{t|t-1}\right) \text{[Update]} \end{aligned}$$

- $\bar{g} > 0$: Kalman gain
  1. $\bar{g}^{\text{Anchored}}$ (small): reflects correct signal-to-noise ratio from DGP of π_t^* and $\varepsilon_{R,t}$
  2. $\bar{g}^{\text{Unanchored}} >> \bar{g}^{\text{Anchored}}$: higher perceived volatility in the inflation target
     - ★ Carvalho et al.(2023) $\Rightarrow$ large policy surprise induces switch to high gain

- Exchange rate and anchoring
  - Link between exchange rate shocks and policy surprises $\varepsilon_{R,t}$
  - Bounded rationality: agents know the model but ignore $\text{Cov}(\varepsilon_t^R, \varepsilon_t^e) < 0$

Model calibration

- Model calibrated to Brazilian economy.
- We simulate the model, sample a panel of 5800 firms over 156 months (sample period).
- Assume windows of anchored/unanchored/anchored expectations as in the data, and run passthrough regressions analogous to empirical specifications.
- Monte Carlo experiment: perform 1000 replications and look at the mean regression outcomes.

Calibration results

Parameters	Description		Parameters	Description	
$1-\alpha$	import elasticity	0.050	ρ_{π^*}	π_t^* shock	0.940
β	discount rate	0.995	σ_R	vol. mp shock	0.101
$1-\theta$	freq. Δp^i	0.200	ρ_e	persistence e_t	0.890
$1-\eta$	interm. inputs	0.200	ρ_a	persistence a_t	0.002
ϕ_π	TR: $\pi_t - \pi_t^*$	1.164	ρ_{a_i}	persistence a_{it}	0.700
ϕ_y	TR: y_t	0.002	σ_e	vol. e_t shock	4.044
ρ_i	TR: R_{t-1}	0.880	σ_a	vol. a_t shock	0.603
$\hat{g}^{\text{Unanchored}}$	Kalman gain	0.208	σ_{a_i}	vol. a_{it} shock	9.047
$\hat{g}^{\text{Anchored}}$	Kalman gain	0.019	$\text{Corr}(\varepsilon_t^R, \varepsilon_t^e)$	corr.	-.099

Moments	Model	Data
$\sigma(\pi_t)$	0.439	0.300
$\sigma(R_t)$	0.157	0.260
$\sigma(e_t)$	8.720	8.720
$\sigma(\hat{y}_t)$	2.381	2.400
$\sigma(\mathbb{E}^{Anc}\pi)$:	0.090	0.090
$\sigma(\mathbb{E}^{Unanc}\pi)$:	0.250	0.250
$\rho(\pi_t, \pi_{t-1})$:	0.653	0.570
$\rho(R_t, R_{t-1})$:	0.850	0.950
$\rho(\hat{y}_t, \hat{y}_{t-1})$:	0.624	0.820
$\rho(e_t, e_{t-1})$:	0.862	0.890
$\mathbb{E}(\lvert\Delta p_t^i\rvert)$:	5.833	6.000

Passthrough regressions with model-generated data

Dependent variable: $\Delta_{\tau_i} p_{it}$	**(1)**	**(2)**
$\Delta_{\tau_i} e_t$	0.040	0.049
$\Delta_{\tau_i} e_t \times \mathbb{1}_t^{Unanch}$	0.022	0.051
$\Delta_{\tau_i} e_{t-\tau_{it}}$		0.012
$\Delta_{\tau_i} e_{t-\tau_{it}} \times \mathbb{1}_t^{Unanch}$		0.043
$\Delta_{\tau_i} p_{it-\tau_{it}}$	-0.351	-0.352
constant	-0.0115	-0.0044
N	174,357	174,357
Num. of Items	5,800	5,800
Individual Fixed Effects	No	No
Time Fixed Effects	Yes	Yes

Conclusion

- Monetary policy can lead to unanchoring of expectations.
- Present evidence that inflation expectations matter for individual pricing decisions.
  - In such circumstances, passthrough is much higher.
  - They also make fewer mistakes when trying to anticipate how they will set their own prices in the future.
- We develop and calibrate a model in which expectations can become unanchored. Model provides structural interpretation for empirical findings.
  - As in the data, higher exchange rate passthrough when expectations are unanchored.
  - Sizable quantitative effects.