Price Setting when Expectations are Unanchored

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March 2026

Motivation: in the Words of Bernanke (2007)

Long-run inflation expectations are not always "anchored" to central banks' objectives

> *"[...] the extent to which they are anchored can change, depending on economic developments and (most important) the current and past conduct of monetary policy."*

First-order implications for monetary policy effectiveness in our models...

> *"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."*

$\Longrightarrow$ Is there a link between observed firms pricing decisions and the anchoring of expectations?

This Paper

Look at Brazilian economy: why?

1. Episode of persistent expectations' de-anchoring and subsequent re-anchoring
2. Leverage micro datasets on both *firms' prices* and *survey-based expectations*

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2. Leverage micro datasets on both *firms' prices* and *survey-based expectations*

We find

– Firms set significantly larger prices changes in response to costs (exchange rate movements) when inflation expectations are unanchored

– Mechanism: calibrated dynamic stochastic general equilibrium model replicates the empirical results quantitatively

Plan of the Talk

1. **Illustrative example and data**
2. (Un)-Anchoring Regimes
3. Empirical exercise
4. Model

De-Anchoring and Firm Pricing: Illustration (Partial Equilibrium)

1. Pricing decision (individual firm). Optimal price under Calvo (ξ prob. of not resetting price)

$$p_t = P_t + \mathbb{E}_t \sum_{j=0}^{\infty} (\xi\beta)^j \left[(1-\xi\beta) mc_{t+j} + \xi\beta\pi_{t+1+j}\right] \qquad [\beta : \text{discount rate}]$$

depends on expected real marginal costs and the expected path of prices

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$\Rightarrow$ Impact on expected marginal cost and inflation

$$\mathbb{E}_t mc_{t+j} = \lambda_{mc} \times \rho^j\varepsilon_t; \qquad \mathbb{E}_t\pi_{t+j} = \mathbb{E}_t\pi^*_{t+j} + \lambda_\pi \times \rho^j\varepsilon_t$$

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3. Anchoring. Perceived inflation target (π^*_t) in line with central bank objectives?

$$\mathbb{E}_t\pi^*_{t+j} = \begin{cases} \pi^* = 0, & \textit{Anchored} \\ \bar{g} \times \rho^j\varepsilon_t + (1-\bar{g})\pi^*, \quad 0 < \bar{g} < 1 & \textit{Unanchored} \end{cases}$$

De-Anchoring and Firm Pricing: Illustration (Partial Equilibrium)

Response when price is re-set:

$$\underbrace{\Delta_\tau p_t \equiv p_t - p_{t-\tau}}_{\text{change after last reset } \tau} = \Delta_\tau P_t + \Delta_\tau \mathbb{E}_t \sum_{j=0}^{\infty} (\xi\beta)^j \left[(1-\xi\beta) mc_{t+j} + \xi\beta\pi_{t+1+j}\right] \qquad [\beta : \text{discount rate}]$$

Substitute for expectations

$$\Delta_\tau p_t = \Delta_\tau P_t + \beta_1 \Delta_\tau \varepsilon_t + \beta_2 \left(\Delta_\tau \varepsilon_t \times \mathbb{1}_t^{Unanch}\right) \qquad [\beta_2 = \frac{\xi\beta\rho}{1-\xi\beta\rho}\bar{g} > 0]$$

Unanchored expectations $\Longrightarrow$ firms respond with a larger price change $\Longrightarrow$

$\Longrightarrow$ $\beta_2 \Uparrow$ with un-anchoring parameters $\bar{g}$

De-Anchoring and Firm Pricing: Brazilian Data (July 2008 to Dec. 2020)

1. Firm prices: p_t. PPI microdata (IBRE-FGV) Details
   - Survey of firms from agriculture, mining, and manufacturing (310 "products" from 21 manf. "sectors"). Comprises 67.8% of PPI
   - Use microdata with prices for individual items Details

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   - Follow international literature (Gopinath and Itskhoki, 2010)
   - Directly affect marginal costs of production: firms must pay attention

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3. Inflation expectations' anchoring: $\mathbb{E}_t \pi_{t+j}$. Focus Survey Details
   - High frequency (daily) survey: short- and long-run professional forecasts
   - Sample period alternates between "anchored" and "unanchored" regimes (Bonomo et al, 2024)
   - New BCB survey of firms' forecasts: $\approx 80\%$ of firms look at Focus Survey to form expectations...

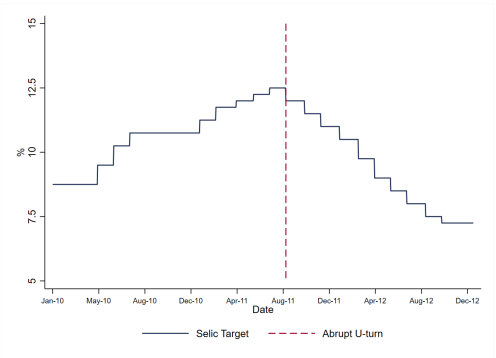
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1. Illustrative example and data
2. **(Un)-Anchoring Regimes**
3. Empirical exercise
4. Model

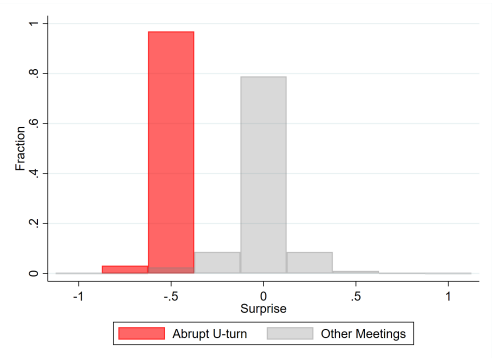
De-Anchoring: Monetary Policy U-Turn

Unexpected easing cycle: signal weaker central bank commitment to its inflation target

(a) *Policy reversal*

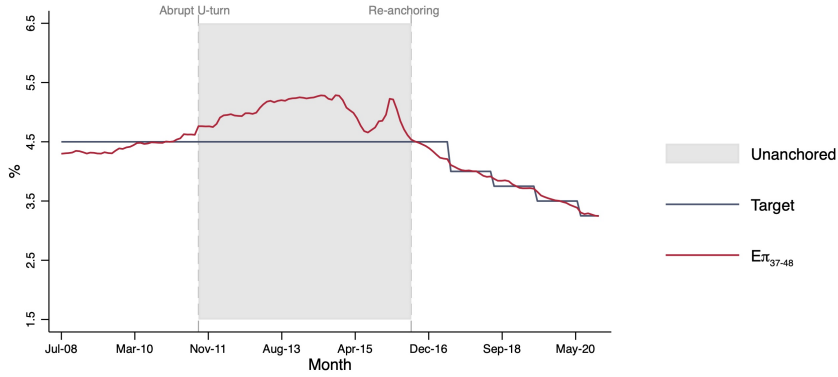


(b) *Large market surprise*



Bonomo et al (2024): $\Rightarrow$ de-anchoring of long-run inflation expectations Details

The Regimes



Re-anchoring: Rouseff removed from office in May 2016 $\rightarrow$ new economic team including BCB governor

$\Rightarrow$ Re-anchoring process completed in August 2016 (Carvalho and Nechio, 2023)

Long-Run Inflation Expectations in the Unanchored Regime

Bonomo et al (2024): Compared to "anchored" regime, long-run (4-yrs ahead) inflation expectations

1. Deviate significantly from *unchanged* inflation target Details
2. Twice as volatile Details
3. Significant pass-through from short-term expectations Details
4. Significant response to 'monetary surprises' Details

$\Longrightarrow$ Unanchored regime: longer-run inflation expectations respond to economic shocks

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De-Anchoring and Firm Pricing: Empirical Strategy

Baseline regression:

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

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 "exogenous" exchange rate over the life of that price spell

$\mathbb{1}_t^{Unanch}$: "Unanchored" regime indicator

x_{it}, $x_{\tau_i t}$: control variables: [include proxies for unobserved marginal costs: see below]

ϵ_{it}: error term.

De-Anchoring and Firm Pricing: Baseline Results

	$\Delta_{\tau_i} e_t$ - **Nominal Exchange Rate**		
Dependent variable: $\Delta_{\tau_i} p_{it}$	(1)	(2)	(3)
$\Delta_{\tau_i} e_t$	0.0410***	0.0225***	0.0115**
	(0.00393)	(0.00545)	(0.00574)
$\Delta_{\tau_i} e_t \times \mathbb{1}_t^{Unanch}$		0.0460***	0.0334***
		(0.00805)	(0.00855)
$\Delta_{\tau_i} p_{it-\tau_{it}}$			-0.122***
			(0.00521)
τ_{it}			0.000634***
			(0.0000840)
$\Delta_{\tau_i} Real\ ULC_t$			0.0151***
			(0.00573)
$\Delta_{\tau_i} Real\ Sectoral\ cost_t$			0.0141
			(0.0104)
$Sectoral\ inventory_t$			-0.000177***
			(0.0000183)
$Sectoral\ demand_t$			0.000323***
			(0.0000287)
$Constant$	0.0435***	0.0428***	0.00339
	(0.00245)	(0.00245)	(0.00380)
N	192502	192502	178442
Adjusted R^2	0.049	0.049	0.0644
Individual Fixed Effects	Yes	Yes	Yes
Time-Fixed Effects	Yes	Yes	Yes
Items/Sectors Controls	No	No	Yes

Exogenous Exchange Rate? Robustness I (Exchange Rate)

Empirical pass-through literature: changes in exchange rate represent a shock to firms' costs

- Orhtogonal to other shocks driving pricing decisions
- Not affected by firms' pricing

Do these assumptions hold here? Instrumental variable approach Results

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

where $\Delta S_t \equiv \frac{(\sum_{k=1}^{7} \Delta s_{k,t})}{7}$: monthly variation of emerging markets currency (s_k) basket comprising 7 countries (Colombia, Mexico, Peru, Chile, China, India, South Africa)

Second stage:

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

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

De-Anchoring and Firm Pricing: Robustness II (Exchange Rate)

Different behavior across regimes? Exchange rate

a. Non-linear FX effect Results

$$\Delta_{\tau_i} p_{it} = \alpha_i + \gamma_t + \beta_1 \Delta_{\tau_i} e_t + \beta_2 \Delta_{\tau_i} e_t \times \mathbb{1}_t^{Unanch} + \beta_3 (\Delta_{\tau_i} e_t)^2 + \text{controls} + \epsilon_{it}$$

b. Asymmetric FX effect Results

$$\Delta_{\tau_i} p_{it} = \alpha_i + \gamma_t + (\beta_1^+ \Delta_{\tau_i} e_t^+ + \beta_1^- \Delta_{\tau_i} e_t^-) + (\beta_2^+ \Delta_{\tau_i} e_t^+ + \beta_2^- \Delta_{\tau_i} e_t^-) \times \mathbb{1}_t^{Unanch} + \text{controls} + \epsilon_{it}$$

De-Anchoring and Firm Pricing: Robustness III

Observed Heterogeneity: price rigidities. Split items according price duration (above-below median)

- Across regimes "sticky-price" firms respond more to shocks Results
- In anchored regime "flexible-price" firms do not respond significantly to shocks
- In unanchored regime both flex and rigid firms display significant response

Observed Heterogeneity: imported inputs' exposure.

- Firms with above-median input shares respond more to shocks ($\mathbb{E}_t^{h} mc_{t+j} = \lambda_{mc}^{\mathsf{h}} \times \rho^j \varepsilon_{t.}$) Results
- Gap narrows in the unanchored regime

Regime-specific response of MC to shocks. ($\mathbb{E}_t mc_{t+j} = \lambda_{mc}^{\mathsf{Unc}} \times \rho^j \varepsilon_{t.}$). Answer: No. Results

De-Anchoring and Firm Pricing: Robustness IV

Alternative regime classification. $Unanch_t = \mathbb{E}_t[\pi_{t+s}] - \pi^T_{t+s}$ Degree of Anchoring

- $E_t[\pi_{t+s}]$: inflation expectation at time t for horizon $t+s$ (4 yrs)
- π^T_{t+s}: inflation target for $t+s$

Degree of anchoring Results

$$\Delta_{\tau_i} p_{it} \equiv p_{it} - p_{it-\tau_{it}} = \alpha_i + \gamma_t + \beta_1 \Delta_{\tau_i} e_t + \beta_2 \Delta_{\tau_i} e_t \times Unanch_t + \text{controls} + \epsilon_{it}$$

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Model

- Standard new Keynesian model with imported inputs.
- Mechanism for unanchoring: inference about inflation target.
  - Agents' beliefs about target are more responsive to short-term monetary and exchange rate shocks.
- We calibrate model to Brazilian economy, simulate artificial data and run regressions analogous to empirical specifications.
- Quantitative results in line with our empirical findings.

Firms' Pricing Decision

- Firm (i) resetting the price

$$p_{i,t} = P_t + \mathbb{E}_t \sum_{T=t}^{\infty} (\xi\beta)^{T-t} \left[(1-\xi\beta)\zeta_1 \left(mc_T - a_{i,T} \right) + \xi\beta\pi_{T+1} \right]$$

where aggregate marginal cost Details

$$mc_T = \zeta_2 \left[(1-\alpha) \underbrace{(e_t - P_t)}_{\text{real exch. rate: } P_t^* = 0} - a_t + \alpha\eta y_t \right] \quad [\zeta_1, \zeta_2\text{: real rigidities.}]$$

- Exchange rate and pricing decisions:
  - Nominal exchange rate: $e_t = \rho_e e_{t-1} + \varepsilon_t^e \Rightarrow$ cost-push shock
  - Direct cost effect of exchange rate through imported inputs
  - General equilibrium effects through expectations.

Central Bank and Expectation (Un)Anchoring

- Taylor rule:

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

- Inflation target:

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

- Monetary policy shock and the exchange rate:

$\varepsilon_t^R = -\tau\varepsilon_t^e + \varepsilon_t^m$, τ "small" $\rightarrow e_t$ depreciates when policy is looser

- 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

- Monetary shocks and anchoring

$$\tilde{\pi}_t = \pi_t^* - \frac{1}{(1-\rho_i)\phi_\pi}\varepsilon_{R,t}, \text{[Signal]}$$

$$\pi^*_{t+1|t} = \rho_{\pi_*}\pi^*_{t|t-1} + \bar{g}\left(\tilde{\pi}_t - \pi^*_{t|t-1}\right) \text{[Update]}$$

- Bounded rationality: agents are 'know the model' but ignore $\mathrm{Cov}(\varepsilon_t^R, \varepsilon_t^e) < 0$

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- Kalman gain: $\bar{g} > 0$ linked to degree of anchoring (Carvalho et al, 2023)

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

Central Bank and Expectation (Un)Anchoring

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$$\tilde{\pi}_t = \pi_t^* - \frac{1}{(1-\rho_i)\phi_\pi}\varepsilon_{R,t}, \text{[Signal]}$$

$$\pi_{t+1|t}^* = \rho_{\pi_*}\pi_{t|t-1}^* + \bar{g}\left(\tilde{\pi}_t - \pi_{t|t-1}^*\right) \text{[Update]}$$

- Exchange rate and anchoring: link between ε_t^e to long-run inflation expectations

$$\pi_{t+1|t}^* = \left(\rho_{\pi_*} - \bar{g}\right)\pi_{t|t-1}^* + \bar{g} \times \frac{1}{(1-\rho)\,\phi_\pi}\tau\varepsilon_t^e$$

Model Calibration

Phillips curve

- Prob. of resetting the price from micro-data: $1-\xi=0.3$. Constant across regimes
- Share of imported inputs: $1-\alpha=0.15$
- Real rigidities
  - ζ_1: Kimball aggregator $\rightarrow$ slope of the Phillips curve w.r.t. output at 0.1
  - ζ_2: Round-about production $\rightarrow$ share of domestic intermediate inputs at $.20$

Monetary policy

- Volatility of monetary policy 'surprises': Focus survey interest rate exp. (Bonomo et al, 2024)
- $\text{Corr}\left(\varepsilon_t^R, \varepsilon_t^e\right) = -0.13$.

Other Details

- Key target: volatility of long-term inflation expectations across regimes ($\rightarrow \bar{g}^{\text{Anchored}}, \bar{g}^{\text{Unanchored}}$)
- Moments: volatility and persistence of inflation, output, interest rate, exchange rate

Baseline Regressions with Model-Generated Data

	Model-generated data		PPI data	
Dependent variable: $\Delta_{\tau_i} p_{it}$	**(1)**	**(2)**	**(3)**	**(4)**
$\Delta_{\tau_i} e_t$	0.060	0.075	0.0586***	0.0653***
$\Delta_{\tau_i} e_t \times \mathbb{1}_t^{Unanch}$	0.024	0.025	0.0351***	0.0286***
$\Delta_{\tau_i} e_{t-\tau_{it}}$		0.021		0.0244***
$\Delta_{\tau_i} e_{t-\tau_{it}} \times \mathbb{1}_t^{Unanch}$		0.003		0.0386***
$\Delta_{\tau_i} p_{it-\tau_{it}}$	-0.119	-0.120	-0.109***	-0.112***
N	174,357	174,357	178,442	172,850
Individual Fixed Effects	No	No	Yes	Yes
Time-Fixed Effects	Yes	Yes	Yes	Yes
Items/Sectors Controls	No	No	No	No

Conclusions

- Present evidence that long-run inflation expectations matter for individual pricing decisions
- Passthrough from exchange rate shocks is considerably higher in the "Unanchored" regime
- We develop and calibrate a model in which expectations can become unanchored. Model provides structural interpretation for empirical findings

Focus Survey

- Professional forecasters covering many macroeconomic variables; commercial banks, asset managers, consulting firms and (a few) 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).
- 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.

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PPI Microdata

- Survey of firms from agriculture, mining, and manufacturing.
  - Sector (National Classification of Economic Activities, 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 disagg. level, individual prices; includes company, model, size, brand, packaging, city etc.
- Summary

	Total	**Monthly average**	
	Raw data*	Raw data*	Price changes
Items	14,164	5,796	1,501
Firms	2,633	1,695	502
Products	310	310	310
Sectors	21	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.

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PPI Microdata: items

Table 1: **Examples of items and products in the PPI-FGV dataset**

Item	Printed tricoline fabric (1.5 M)
Producer	XXXXXXXX
Id. code	175068
CNAE (Product)	202213201
Group Name	Textiles Products
Group Code	2022130
Item	GALVANIZED WIRE BWG 18 (T)
Producer	XXXXXXXX
Id. code	319247
CNAE (Product)	202224301
Group Name	Manufacture of fabricated metal products.
Group Code	2022240
Item	AIR CHAMBER FOR TIRE XXXXXXXX (UNIT)
Producer	XXXXXXXX
Id. code	842344
CNAE (Product)	202222104
Group Name	Manufacture of rubber and plastics products.
Group Code	2022220
Item	UREA FOR FERTILIZER XXXXXXXX (T)
Producer	XXXXXXXX
Id. code	694203
CNAE (Product)	202220108
Group Name	Manufacture of chemicals and chemical products.
Group Code	2022200

Daily Data: monetary policy caused unanchoring



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Expectations deviate meaningfully from target

Dependent variable	$E\left[\pi_{13-24} - \pi^T_{13-24}\right]$	$E\left[\pi_{25-36} - \pi^T_{25-36}\right]$	$E\left[\pi_{37-48} - \pi^T_{37-48}\right]$
$\mathbb{1}_t^{Unanch}$	1.033***	0.677***	0.532***
	(0.006)	(0.006)	(0.007)
$\left(1 - \mathbb{1}_t^{Unanch}\right)$	0.0356***	0.0156***	-0.0379***
	(0.003)	(0.002)	(0.003)
Observations	23,111	20,950	16,218
Adjusted R^2	0.709	0.536	0.387
p-value for H0: $\beta_{Unanch} = \beta_{Anch}$	0	0	0
Estimation method	Pooled OLS	Pooled OLS	Pooled OLS

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Expectations become more volatile

Dependent variable	$\sigma_{iJ}\left(E\pi_{1-12}-\pi^T_{1-12}\right)$	$\sigma_{iJ}\left(E\pi_{13-24}-\pi^T_{13-24}\right)$	$\sigma_{iJ}\left(E\pi_{25-36}-\pi^T_{25-36}\right)$	$\sigma_{iJ}\left(E\pi_{37-48}-\pi^T_{37-48}\right)$
$\mathbb{1}_t^{Unanch}$	0.533***	0.429***	0.398***	0.363***
	(0.0194)	(0.0187)	(0.0228)	(0.0241)
$\left(1-\mathbb{1}_t^{Unanch}\right)$	0.423***	0.190***	0.138***	0.155***
	(0.0129)	(0.00844)	(0.00771)	(0.00888)
Observations	276	287	277	265
Adjusted R^2	0.870	0.808	0.737	0.692
p-value for H0: $\beta_{Unanch}=\beta_{Anch}$	0	0	0	0
Estimation	Pooled OLS	Pooled OLS	Pooled OLS	Pooled OLS

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Sensitivity of long- to short-run expectations increases

Table: **Expectations passthrough regressions – between Focus "contest dates"**

Dependent variable	$\Delta E_i\left[\pi_{25-36} - \pi^T_{25-36}\right]$	$\Delta E_i\left[\pi_{37-48} - \pi^T_{37-48}\right]$
$\Delta E_i\left[\pi_{1-12} - \pi^T_{1-12}\right] \times \mathbb{1}_t{}^{Unanch}$	0.228***	0.175***
	(0.0399)	(0.0345)
$\Delta E_i\left[\pi_{1-12} - \pi^T_{1-12}\right] \times \left(1 - \mathbb{1}_t^{Unanch}\right)$	0.0214	0.0151
	(0.0169)	(0.0220)
Constant	-0.00172	-0.00215
	(0.00371)	(0.00370)
Observations	2,841	2,461
Adjusted R^2	0.0457	0.0242
Estimation method	Fixed effects	Fixed effects
Individual fixed effects	Yes	Yes
Time-fixed effects	No	No

Sensitivity of inflation expectations to interest rate surprises

	One day after policy meetings		
Dependent variable	$\Delta E_i\left[\pi_{13-24} - \pi^T_{13-24}\right]$	$\Delta E_i\left[\pi_{25-36} - \pi^T_{25-36}\right]$	$\Delta E_i\left[\pi_{37-48} - \pi^T_{37-48}\right]$
Abrupt U-turn surprise	-0.939***	-0.852**	-0.637
	(0.184)	(0.363)	(0.498)
Other surprises $\times\ \mathbb{1}_t{}^{Unanch}$	-0.640***	-0.531***	-0.308*
	(0.161)	(0.152)	(0.173)
Other surprises $\times\ \left(1 - \mathbb{1}_t^{Unanch}\right)$	-0.0822	-0.0300	-0.0413
	(0.0547)	(0.0506)	(0.0955)
Constant	0.0203**	0.0155*	0.0120
	(0.00794)	(0.00812)	(0.0112)
Observations	509	471	333
Adjusted R^2	0.208	0.149	0.00974
Estimation method	Fixed effects	Fixed effects	Fixed effects
Individual fixed effects	Yes	Yes	Yes
Time-fixed effects	No	No	No

De-Anchoring and Firm Pricing: IV Results

	$\Delta_{\tau_i} e_t$ - **Instrumented FX**		
Dependent variable: $\Delta_{\tau_i} p_{it}$	(1)	(2)	(3)
$\Delta_{\tau_i} e_t$	0.0855***	0.0684***	0.0644***
	(0.00596)	(0.00812)	(0.00904)
$\Delta_{\tau_i} e_t \times \mathbb{1}_t^{Unanch}$		0.0431***	0.0231*
		(0.0115)	(0.0122)
$\Delta_{\tau_i} p_{it-\tau_{it}}$			-0.123***
			(0.00520)
τ_{it}			0.000422***
			(0.0000893)
$\Delta_{\tau_i} Real\ ULC_t$			-0.00111
			(0.00594)
$\Delta_{\tau_i} Real\ Sectoral\ cost_t$			0.00824
			(0.0103)
$Sectoral\ inventory_t$			-0.000178***
			(0.0000183)
$Sectoral\ demand_t$			0.000325***
			(0.0000288)
$Constant$	0.0445***	0.0441***	0.00552
	(0.00245)	(0.00246)	(0.00380)
N	192502	192502	178442
Adjusted R^2	0.0501	0.0502	0.0649
Individual Fixed Effects	Yes	Yes	Yes
Time-Fixed Effects	Yes	Yes	Yes
Items/Sectors Controls	No	No	Yes

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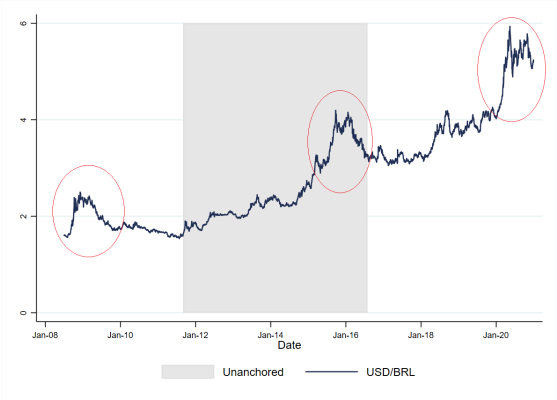
Pass-through regression with lagged FX change

	$\Delta_{\tau_i} e_t$ - 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	0.0865***	0.0561***	0.0507***
	(0.00430)	(0.00650)	(0.00667)	(0.00678)	(0.0102)	(0.0110)
$\Delta_{\tau_i} e_{t-\tau_{it}}$	0.0120***	-0.000287	0.00251	0.0223***	0.0110*	0.0202***
	(0.00348)	(0.00468)	(0.00467)	(0.00510)	(0.00657)	(0.00686)
$\Delta_{\tau_i} e_t \times \mathbb{1}_t^{Unanch}$		0.0618***	0.0513***		0.0623***	0.0513***
		(0.00896)	(0.00898)		(0.0131)	(0.0131)
$\Delta_{\tau_i} e_{t-\tau_{it}} \times \mathbb{1}_t^{Unanch}$		0.0277***	0.0375***		0.0276***	0.0357***
		(0.00676)	(0.00672)		(0.00954)	(0.00968)
N	178973	178973	172850	178973	178973	172850
Adjusted R^2	0.047	0.047	0.064	0.0471	0.0474	0.0642
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

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Exchange rate: Unanchoring or non-linearity?

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



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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	0.0855***	0.0684***	0.0787***	0.0659***	0.0592***
	(0.00393)	(0.00545)	(0.00495)	(0.00582)	(0.00602)	(0.00596)	(0.00812)	(0.00796)	(0.00919)	(0.00968)
$\Delta_{\tau_i} e_t \times \mathbb{1}_t^{Unanch}$		0.0460***		0.0425***	0.0337***		0.0431***		0.0417***	0.0252**
		(0.00805)		(0.00834)	(0.00853)		(0.0115)		(0.0117)	(0.0121)
$(\Delta_{\tau_i} e_t)^2$			0.0455***	0.0220	-0.0135			0.0400	0.0179	-0.0232
			(0.0163)	(0.0170)	(0.0188)			(0.0361)	(0.0370)	(0.0422)
N	192502	192502	192502	192502	178442	192502	192502	192502	192502	178442
Adjusted R^2	0.049	0.049	0.049	0.049	0.065	0.0501	0.0502	0.0501	0.0502	0.0650
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

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Unanchoring or asymmetric response to FX?

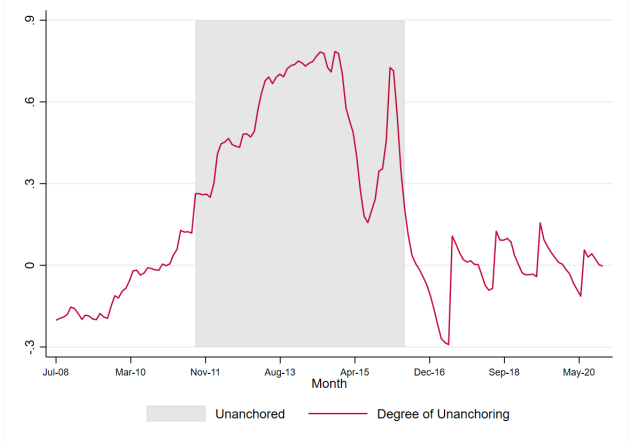
$\Delta_{\tau_i} e_t$ - **Nominal Exchange Rate**

	(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

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A measure of the degree of unanchoring

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



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Pass-through 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***	0.0195***	0.00755	0.0855***	0.0637***	0.0541***
	(0.00393)	(0.00521)	(0.00542)	(0.00596)	(0.00775)	(0.00850)
$\Delta_{\tau_i} e_t \times Unanch_t$		0.109***	0.0700***		0.107***	0.0613***
		(0.0149)	(0.0157)		(0.0196)	(0.0204)
N	192502	192502	178442	192502	192502	178442
Adjusted R^2	0.0492	0.0496	0.0646	0.0501	0.0503	0.0650
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

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Observed Heterogeneity: Price Rigidities

Figure: **Anchored/unanchored regimes and degree of price rigidities**

	$\Delta_{\tau_i} e_t$ - Nominal Exchange Rate		
Dependent variable: $\Delta_{\tau_i} p_{it}$	(1)	(2)	(3)
$\Delta_{\tau_i} e_t \times \mathbb{1}^{below}$	0.0472***	0.00515	-0.0174
	(0.0109)	(0.0163)	(0.0162)
$\Delta_{\tau_i} e_t \times \mathbb{1}_t^{Unanch} \times \mathbb{1}^{below}$		0.102***	0.0501**
		(0.0209)	(0.0210)
$\Delta_{\tau_i} e_t \times \mathbb{1}^{above}$	0.103***	0.0639***	0.0274***
	(0.00400)	(0.00551)	(0.00556)
$\Delta_{\tau_i} e_t \times \mathbb{1}_t^{Unanch} \times \mathbb{1}^{above}$		0.0943***	0.0406***
		(0.00801)	(0.00857)
N	192502	192502	178442
Adjusted R^2	0.060	0.061	0.072
Individual Fixed Effects	No	No	No
Time Fixed Effects	Yes	Yes	Yes
Controls	No	No	Yes
p-value for H_0: $\beta_{blw} = \beta_{abv}$	0.00		
p-value for H_0: $\beta_{blw}^{anc} = \beta_{abv}^{anc}$		0.00	0.01
p-value for H_0: $\beta_{blw}^{unanc} = \beta_{abv}^{unanc}$		0.00	0.00

Note: Heteroskedasticity-robust standard errors in parentheses. Coefficients followed by ***,**, or * are statistically significant at the 1%, 5%, or 10% levels, respectively. $\mathbb{1}^{below}$ denotes items with price durations below the median (more flexible prices), while $\mathbb{1}^{above}$ denotes those with price durations above the median (more rigid prices).

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Observed Heterogeneity: Imported Input Exposure

Figure: **Anchored/unanchored regimes and import shares**

	$\Delta_{\tau_i} e_t$ - Nominal Exchange Rate		
Dependent variable: $\Delta_{\tau_i} p_{it}$	(1)	(2)	(3)
$\Delta_{\tau_i} e_t \times \mathbb{1}^{below}$	0.0276***	0.00745	-0.00997
	(0.00469)	(0.00646)	(0.00680)
$\Delta_{\tau_i} e_t \times \mathbb{1}_t^{Unanch} \times \mathbb{1}^{below}$		0.0504***	0.0470***
		(0.00942)	(0.00988)
$\Delta_{\tau_i} e_t \times \mathbb{1}^{above}$	0.0554***	0.0388***	0.0343***
	(0.00517)	(0.00704)	(0.00720)
$\Delta_{\tau_i} e_t \times \mathbb{1}_t^{Unanch} \times \mathbb{1}^{above}$		0.0412***	0.0190*
		(0.0104)	(0.0111)
N	192502	192502	178442
Adjusted R^2	0.049	0.049	0.049
Individual Fixed Effects	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes
Controls	No	No	Yes
p-value for H_0: $\beta_{blw} = \beta_{abv}$	0.00		
p-value for H_0: $\beta_{blw}^{anc} = \beta_{abv}^{anc}$		0.00	0.00
p-value for H_0: $\beta_{blw}^{unanc} = \beta_{abv}^{unanc}$		0.01	0.07

Note: Heteroskedasticity-robust standard errors in parentheses. Coefficients followed by ***,**, or * are statistically significant at the 1%, 5%, or 10% levels, respectively. $\mathbb{1}^{below}$ denotes items with imported-input share below the median (lower exposure), while $\mathbb{1}^{above}$ denotes those above the median (higher exposure).

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Regime-Specific Response of Marginal Cost to Shocks

Figure: **Anchored/unanchored regimes and marginal costs**

	$\Delta_{\tau_i} e_t$ - Nominal Exchange Rate			
Dependent variable: $\Delta_{\tau_i} p_{it}$	(1)	(2)	(3)	(4)
$\Delta_{\tau_i} e_t$	0.0115**	0.0111*	0.0113*	0.0109*
	(0.00574)	(0.00575)	(0.00577)	(0.00578)
$\Delta_{\tau_i} e_t \times \mathbb{1}_t^{Unanch}$	0.0334***	0.0338***	0.0339***	0.0343***
	(0.00855)	(0.00853)	(0.00861)	(0.00860)
$\Delta_{\tau_i} p_{it-\tau_{it}}$	-0.122***	-0.122***	-0.122***	-0.122***
	(0.00521)	(0.00521)	(0.00521)	(0.00521)
τ_{it}	0.000634***	0.000640***	0.000632***	0.000639***
	(0.0000840)	(0.0000847)	(0.0000840)	(0.0000847)
$\Delta_{\tau_i} Real\ ULC_t$	0.0151***	0.0168**	0.0152***	0.0169**
	(0.00573)	(0.00681)	(0.00574)	(0.00682)
$\Delta_{\tau_i} Real\ ULC_t \times \mathbb{1}_t^{Unanch}$		-0.00666		-0.00679
		(0.0123)		(0.0123)
$\Delta_{\tau_i} Real\ Sectoral\ cost_t$	0.0141	0.0142	0.0177	0.0177
	(0.0104)	(0.0104)	(0.0128)	(0.0128)
$\Delta_{\tau_i} Real\ Sectoral\ cost_t \times \mathbb{1}_t^{Unanch}$			-0.0121	-0.0124
			(0.0189)	(0.0190)
$Sectoral\ inventory_t$	-0.00352***	-0.00352***	-0.00352***	-0.00352***
	(0.000365)	(0.000365)	(0.000365)	(0.000365)
$Sectoral\ demand_t$	0.00415***	0.00415***	0.00415***	0.00416***
	(0.000369)	(0.000369)	(0.000369)	(0.000369)
$Constant$	0.0335***	0.0334***	0.0334***	0.0334***
	(0.00248)	(0.00249)	(0.00248)	(0.00249)
N	178442	178442	178442	178442
Adjusted R^2	0.0644	0.0644	0.0644	0.0644
Individual Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
Items/Sectors Controls	Yes	Yes	Yes	Yes

Note: Heteroskedasticity-robust standard errors in parentheses. Coefficients followed by ***,**, or * are statistically significant at the 1%, 5%, or 10% levels, respectively. Columns (2)–(4) allow the response to marginal-cost proxies to vary by expectations regime via interactions with $\mathbb{1}_t^{Unanch}$.

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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]

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Calibration Results

Parameters	Description		Parameters	Description	
$1-\alpha$	import elasticity	0.150	ρ_{π^*}	π_t^* shock	0.951
β	discount rate	0.997	σ_R	vol. mp shock	0.140
$1-\xi$	freq. Δp^i	0.300	ρ_e	persistence e_t	0.890
$1-\eta$	interm. inputs	0.220	ρ_a	persistence a_t	0.900
ϕ_π	TR: $\pi_t - \pi_t^*$	1.600	ρ_{a_i}	persistence a_{it}	0.920
ϕ_y	TR: y_t	0.003	σ_e	vol. e_t shock	3.975
ρ_i	TR: R_{t-1}	0.803	σ_a	vol. a_t shock	0.306
$\hat{g}^{\text{Unanchored}}$	Kalman gain	0.300	σ_{a_i}	vol. a_{it} shock	18.35
$\hat{g}^{\text{Anchored}}$	Kalman gain	0.014	$\text{Corr}(\varepsilon_t^R, \varepsilon_t^e)$	corr.	-0.127

Moments	Model	Data
$\sigma(\pi_t)$	0.313	0.300
$\sigma(R_t)$	0.299	0.260
$\sigma(e_t)$	8.784	8.720
$\sigma(\hat{y}_t)$	2.427	2.400
$\sigma(\mathbb{E}^{Anc}\pi)$:	0.157	0.160
$\sigma(\mathbb{E}^{Unanc}\pi)$:	0.363	0.360
$\rho(\pi_t, \pi_{t-1})$:	0.649	0.570
$\rho(R_t, R_{t-1})$:	0.882	0.950
$\rho(\hat{y}_t, \hat{y}_{t-1})$:	0.695	0.820
$\rho(e_t, e_{t-1})$:	0.867	0.890
$\mathbb{E}(\lvert\Delta p_t^i\rvert)$:	6.243	6.000

*: fixed

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Price Setting when Expectations are Unanchored

(Draft being completed and revised; please do not circulate)*

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February 2026

Abstract

How does the anchoring of inflation expectations affect firms' pricing decisions? We address this question using a quasi-natural monetary policy experiment in Brazil that produced a sharp loss—and subsequent restoration—of central bank credibility. We show that exchange-rate pass-through more than doubles when expectations become unanchored. This amplification operates through the intensive margin of price adjustment, consistent with firms behaving as if nominal shocks have become more persistent. These results are robust across alternative empirical specifications and an instrumental-variable strategy that isolates global exchange-rate shocks. We interpret the evidence through a calibrated New Keynesian model in which the degree of expectations anchoring depends on perceived central bank credibility, and the model matches the empirical patterns remarkably well. Taken together, our findings provide the first micro-level evidence that shifts in expectations anchoring alter firms' price-setting behavior and offer concrete empirical support for the widely held view that central bank credibility is crucial for macroeconomic stability.

JEL Classification: E31, E52, E58.
Keywords: Inflation expectations, monetary policy, central bank credibility, anchored expectations, unanchored expectations, price setting, producer price microdata, Brazil.

*For comments and suggestions, we thank Ricardo Reis, our Gerzensee discussants Philippe Andrade and Mirko Wiederholt, our Bank of Canada discussant Ina Hajdini, and seminar participants at: Cleveland Fed, UC Berkeley, 2025 SED, Bank of Canada's 2024 Conference, SBE 2023 Meeting, VII Santiago Macro Workshop, EESP-FGV, INSPER, PUC-Rio, 2023 NBER Summer Institute – Monetary Economics, Riksbank, Bank of Finland/CEPR Conference on "Monetary Policy in Times of Large Shocks", Norges Bank's June 2023 Monetary Policy Workshop, I Annual Conference of the Banco Central do Brasil, Banco Central do Brasil, Bank of Canada, NY Fed, Philadelphia Fed, Federal Reserve Board, UCSD, NBU Workshop on "Inflation Targeting in a World of Large and Persistent Shocks", 2022 Gerzensee-JME conference on "Inflation: Expectations & Dynamics", Swiss National Bank, and LuBraMacro 2022. Bonomo: bonomo@insper.edu.br, Carvalho: cvianac@econ.puc-rio.br, Eusepi: stefano.eusepi73@gmail.com, Perrupato: marina.perrupato@gmail.com, Abib: dbarboza@uwo.ca, Ayres: joaoay@iadb.org, Matos: silvia.matos@fgv.br.

> "...[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)

1 Introduction

A central tenet of modern Monetary Economics is that inflation expectations shape firms' pricing decisions. When inflation expectations are well-anchored to central banks' long-run objectives, price setters anticipate that shocks to inflation will be short-lived, leading to muted adjustments in their forward-looking pricing decisions. Consequently, medium- and long-run inflation expectations exhibit reduced sensitivity to short-run inflationary pressures, actual inflation becomes more stable, and the central banks' stabilization trade-offs are improved.[1] Central to this dynamic is the credibility of the central bank. If firms and households lose confidence in the central bank's ability or willingness to stabilize inflation, even temporary disturbances may be perceived as having persistent effects, and hence propagate throughout the entire term structure of expectations.[2] In such circumstances, firms tend to adjust prices more aggressively, thereby reducing the central bank's effectiveness in stabilizing inflation and economic activity. In other words, when expectations are unanchored, firms behave as if nominal shocks are more persistent, amplifying their pricing responses.

This paper provides novel empirical evidence on the fundamental link between inflation expectations and pricing decisions, by exploiting a unique quasi-natural monetary policy experiment that took place in Brazil and led to different "regimes" in terms of the anchoring of inflation expectations. We leverage that episode and the availability of detailed micro-level data on individual producer prices to provide what is, to the best of our knowledge, the first micro-level evidence that shifts in the anchoring of inflation expectations alter firms' pricing decisions.

Owing to an abrupt and unjustifiable "u-turn" in its monetary policy in 2011, the Central Bank of Brazil (BCB) experienced a loss of credibility that led to the unanchoring of inflation expectations. Re-anchoring only took place after five years, driven by a regime change that helped restore central bank credibility. In Bonomo, Carvalho, Eusepi, Perrupato, Abib, Ayres, and Matos (2024), we establish that the abrupt policy shift caused an immediate unanchoring of long-run inflation expectations. Importantly, the regime shift is identified using high-frequency survey data around the policy surprise and we show it was not driven by other possible factors. Hence, in this paper we take that expectations regime shift as exogenous and study its implications for firm pricing behavior.

Crucially, the behavior of agents' inflation expectations differs markedly across these two regimes. During the anchored regime, long-term inflation expectations are largely insulated from short-term inflation developments and from monetary policy surprises. In contrast, following the loss of BCB credibility, inflation expectations at relatively long horizons start to respond significantly to both changes in short-term inflation expectations and to unexpected monetary policy actions. If expectations matter for forward-looking price-setting decisions, pricing behavior should differ across the aforementioned regimes.

To investigate this question, we leverage detailed micro-level data on individual producer prices that allow us to observe both the timing and the size of price changes. Following a successful literature in international economics, we focus on how individual prices respond to movements in the nominal exchange rate. Exchange rate

[1] Bernanke (2007) defines anchored inflation expectations as being "relatively insensitive to incoming data." Carvalho, Eusepi, Moench, and Preston (2023) formalize this concept in a model of learning in which the degree of anchoring is endogenous and time-varying.

[2] citeBCEPAAM2024 provide evidence that supports this claim

fluctuations represent a natural and quantitatively important source of price shocks in an economy such as Brazil, where imported inputs and tradable goods play a significant role. It is therefore natural to expect firms to closely monitor exchange rate movements when setting prices. More specifically, we estimate panel regressions in the spirit of Gopinath, Itskhoki, and Rigobon (2010) and Gopinath and Itskhoki (2010), which exploit cumulative exchange rate changes over the life of individual price spells. Our main empirical finding is that individual price responses to exchange rate movements are substantially stronger during periods of unanchored inflation expectations: exchange-rate pass-through more than doubles relative to anchored regimes.

In our baseline results we follow the literature in using changes in the domestic exchange rate against the U.S. dollar as a "shock." We then raise the bar and show our findings also hold when using a basket of other emerging market currencies to isolate exogenous exchange-rate movements driven by global factors rather than Brazil-specific shocks. Results are also robust to a large number of alternative specifications that account for possible changes across regimes in exchange rate dynamics and in the elasticity of marginal costs to the exchange rate. We also show our empirical findings hold when allowing for observed sectoral heterogeneity in the degree of nominal price stickiness and in the use of imported inputs.

The difference in pricing behavior, with resulting increase in exchange rate pass-through, originates in the intensive margin: conditional on adjusting prices, firms choose larger price changes in response to a given exchange rate movement when expectations are unanchored. It does not operate through the extensive margin, as the frequency of price adjustment is essentially unchanged across the two regimes.

Taken together, these findings provide direct micro-level evidence that the state of inflation expectations matters for firms' pricing decisions. When expectations are unanchored, firms behave as if nominal shocks are longer-lived, leading to larger price adjustments. These results provide empirical support for theoretical models that link inflation expectations to aggregate inflation dynamics through their causal effect on firms' pricing decisions.

In the final part of the paper, we develop a structural New Keynesian model in which inflation expectations can become unanchored in a formal, well-defined sense. In the model, the degree of anchoring depends on agents' perceptions of the central bank's inflation target and credibility. When credibility is high, long-term inflation expectations respond weakly to policy actions and exchange rate shocks. When credibility deteriorates, agents become uncertain about the inflation target and update their beliefs about the central bank's goal based on observed policy actions.

We calibrate the model to match key macroeconomic features of the Brazilian economy, with particular emphasis on the behavior of survey-based inflation expectations across anchored and unanchored regimes. Simulating exchange rate pass-through regressions on synthetic microdata generated by the model reproduces the empirical finding of stronger pricing responses during unanchored periods. In quantitative terms, the effects are quite comparable to our empirical findings.

As a by-product of its novel contributions, the paper also relates to four strands of the literature. First, it contributes to the literature on inflation expectations by providing the first direct microeconomic evidence that shifts in the anchoring of long-run expectations alter firms' price-setting behavior. A large body of work studies the anchoring of expectations using survey data, focusing on deviations from target, disagreement, sensitivity to news, and responsiveness to monetary policy shocks (e.g., Levin, Natalucci, and Piger, 2004; Beechey, Johannsen, and Levin, 2011; Kumar, Afrouzi, Coibion, and Gorodnichenko, 2015; Coibion and Gorodnichenko, 2015; Reis, 2021; Carvalho et al., 2023). Exploiting an exogenous regime shift in Brazil that caused a discrete de-anchoring of long-run expectations (Bonomo et al., 2024), we show that changes in anchoring translate into changes in actual pricing decisions. In doing so, the paper also connects to a growing literature in Macroeconomics that uses randomized

control trials to implement "information treatments" and evaluate whether agents act on their beliefs. A leading example is Coibion, Gorodnichenko, and Ropele (2020), who use a randomized information treatment in a survey of Italian firms to study how shifts in inflation expectations causally affect firms' pricing and other decisions. We contribute to this literature by providing observational evidence from a unique setting that features distinct expectations regimes and allows us to document that (and how) firms' pricing behavior varies across regimes—and in a manner consistent with the model we develop and calibrate.

Second, the paper contributes to the microdata-based price-setting literature by providing the first evidence on individual pricing behavior across expectations regimes. A large literature documents the frequency and size of price changes, sectoral heterogeneity, and the roles of extensive versus intensive margins in shaping inflation dynamics (e.g., Bils and Klenow, 2004; Nakamura and Steinsson, 2008; Klenow and Kryvtsov, 2008). A smaller set of papers exploits variation in inflation levels to study state-dependent pricing (e.g., Gagnon, 2009; Alvarez, Beraja, Gonzalez-Rozada, and Neumeyer, 2019). We instead exploit variation in the anchoring of inflation expectations across regimes, despite only modest differences in average inflation levels. Consistent with Alvarez et al. (2019), we find that the frequency of price adjustment remains relatively stable across regimes. In contrast, firms adjust prices differently along the intensive margin, depending on the state of expectations anchoring.

Third, the paper contributes to the exchange rate pass-through literature by showing that pass-through is systematically state-dependent on the anchoring of inflation expectations. A large empirical literature studies the magnitude and determinants of exchange rate pass-through using micro price data (e.g., Gopinath and Rigobon, 2008; Gopinath et al., 2010; Gopinath and Itskhoki, 2010; Burstein and Gopinath, 2014). This literature highlights invoicing currency, strategic complementarities, imported input shares, and nominal rigidities as key determinants. We introduce a new determinant: the expectations regime. We show that exchange rate pass-through more than doubles when expectations are unanchored, operating entirely through the intensive margin of price adjustment rather than through changes in the frequency of price adjustments. This result implies that the macroeconomic environment—specifically, monetary policy credibility—shapes micro-level price responses to nominal shocks, adding a new expectations-based dimension to the determinants of pass-through.

Fourth, the paper contributes to the monetary policy and central bank credibility literature by documenting a concrete transmission channel through which credibility affects inflation dynamics. Theoretical work emphasizes how credibility and expectations anchoring shape inflation-stabilization trade-offs (e.g., Clarida, Galí, and Gertler, 1999; Woodford, 2003; Erceg and Levin, 2003; Carvalho et al., 2023). Yet empirical validation of this mechanism has been lacking. Using micro-level pricing data and a quasi-natural credibility shock, we show that when credibility deteriorates, firms behave as if nominal shocks become more persistent, adjusting prices more aggressively. This provides a structural microfoundation for the claim that credibility flattens the inflation–output trade-off by dampening the propagation of shocks. To our knowledge, no previous paper has documented this mechanism using firm-level price data.

From a policy perspective, our findings underscore the importance of central bank credibility. When expectations are anchored, firms' pricing decisions help stabilize inflation, reducing the need for aggressive policy interventions. When expectations become unanchored, firms' behavior amplifies shocks, making inflation control more costly.

2 Unanchoring and Price Setting: Motivating Example

In this section we illustrate the intuition underlying the connection between a firms' pricing decision and the degree of inflation expectations anchoring using a simple, partial equilibrium model.

Consider an individual firm operating in a monopolistically competitive market subject to Calvo nominal fric-

tions. The first order approximation to the pricing decision,[3] conditional on re-setting its price relative to the overall price index, is

$$p_t = \mathbb{E}_t \sum_{h=0}^{\infty} \tilde{\xi}^h \left[(1-\tilde{\xi}) mc_{t+h} + \tilde{\xi} \pi_{t+h+1} \right]$$

where mc_t measures the real marginal cost and π_t is the inflation rate. The parameter $0 < \tilde{\xi} < 1$ denotes the (constant) probability of not resetting the price at any given time, scaled by the firms' discount rate. Conditional on resetting, the optimal price depends on the present discounted value of its expected real marginal cost and inflation. Consider an aggregate exogenous shock ε_t. The optimal price response the shock depends on its impact on marginal costs and overall inflation. Expectations

$$\begin{aligned} \mathbb{E}_t mc_{t+h} &= \lambda_{mc} \rho^h \varepsilon_t; \\ \mathbb{E}_t \pi_{t+h} &= \mathbb{E}_t \pi^*_{t+h} + \lambda_\pi \rho^h \varepsilon_t \end{aligned}$$

are driven by temporary shocks (ε_t) and the perceived inflation target π^*_t. The parameter $0 < \rho < 1$ measures the shock's persistence and λ_{mc}, $\lambda_\pi > 0$ capture the elasticity of expectations to the shock. If the central bank is fully credible the perceived inflation target is always equal to the announced target, assumed here to be time invariant (which we normalize to zero): expectations are anchored. Conversely, the loss of central bank credibility lead market participants to believe that the announced target is not the real long-run objective of the central bank. Agents then extract information about the 'true' target from current policy actions and current economic outcomes.[4] This learning process creates a link between the aggregate shock and the perceived inflation target. For example, higher than expected inflation, driven by an increase in ε_t, leads to an upward revision of the perceived inflation target. The perceived inflation target is given by

$$\mathbb{E}_t \pi^*_{t+h} = \begin{cases} \pi^* = 0, & \text{(Anchored)} \\ \bar{g} \rho^h \varepsilon_t, \quad 0 < \bar{g} < 1 & \text{(Unanchored)}, \end{cases}$$

where $\bar{g}$ measures the degree of inflation unanchoring. Substituting for expectations in the pricing decision, we can express the firm's relative price's change from the last re-set period τ as

$$\begin{aligned} p_t - p_{t-\tau} = & \underbrace{\frac{1-\tilde{\xi}}{1-\tilde{\xi}\rho} \lambda_{mc} \left(\varepsilon_t - \varepsilon_{t-\tau} \right)}_{\text{Expected marginal cost}} + \underbrace{\frac{\tilde{\xi}\rho}{1-\tilde{\xi}\rho} \lambda_\pi \left(\varepsilon_t - \varepsilon_{t-\tau} \right)}_{\text{Expected inflation: anchored}} + \\ & + \underbrace{\frac{\tilde{\xi}\rho}{1-\tilde{\xi}\rho} \bar{g} \left(\varepsilon_t - \varepsilon_{t-\tau} \right)}_{\text{Expected inflation: unanchored}} \times \mathbb{1}_t^{Unanch}, \end{aligned}$$

where the indicator variable $\mathbb{1}_t^{Unanch}$ is set to zero in the anchored regime. The price response to the shock increases with the degree of expectations unanchoring. The above expression can be re-written in more compact form as

$$\Delta_\tau p_t \equiv p_t - p_{t-\tau} = \beta_1 \Delta_\tau \varepsilon_t + \beta_2 \left(\Delta_\tau \varepsilon_t \times \mathbb{1}_t^{Unanch} \right), \tag{1}$$

[3] It is appropriate to think of all variables in log-deviations from steady state.
[4] See Gürkaynak, Sack, and Swanson (2005), Carvalho et al. (2023),Bonomo et al. (2024).

where

$$\beta_1 = \left[\frac{(1-\tilde{\xi})\lambda_{mc}}{1-\tilde{\xi}\rho} + \frac{\tilde{\xi}\rho\lambda_{\pi}}{1-\tilde{\xi}\rho}\right] > 0; \qquad \beta_2 = \frac{\tilde{\xi}\rho\lambda_{\pi}}{1-\tilde{\xi}\rho}\bar{g} > 0.$$

This simple model not only illustrates the economic mechanism we wish to explore, but it also motivates our empirical strategy. Implementation requires three key data sources. A panel of individual firms' pricing decisions; a dataset of measured expectations that allows us to identify both regimes of anchored and unanchored inflation expectations; a large and observable macroeconomic shock that firms pay attention to. Data and methodology are discussed in the next section.

The pricing decision (1) reflects a set of assumptions about the economic environment. First, the probability of re-setting the price is time-invariant and, in particular, it does not depend on the degree of central bank credibility. As shown in Section 3.2, this lack of state-dependence is consistent with firms' pricing behavior observed in our sample. Second, firms have identical exposure to the aggregate shock through both their marginal costs (λ_{mc}) and expectations (λ_{π}). In addition, they have same the degree of price rigidities (ξ). These characteristics may vary across sectors and industries, leading to heterogenous price responses to the shock, and therefore heterogeneity in β_1 and β_2. Finally, the elasticity of the marginal cost to the shock (λ_{mc}) and the properties of the shock itself are assumed to be invariant to the anchoring regime. However, in general equilibrium the response of marginal costs to the aggregate shock will be tied to the degree of anchoring. Section 4 reports baseline results that broadly reflect the assumption of the simple model but also extends the empirical analysis to account for observed heterogeneity and regime-specific responses. Lastly, while the simple example articulated in this section relies on partial equilibrium assumptions, in section 5 we present a general equilibrium model with expectations anchoring, where pricing decisions are endogenous to the anchoring regime. The model is used to support the empirical analysis presented below.

3 Data and Methodology

Guided by the illustrative model presented in the previous section, our empirical analysis leverages two primary datasets covering the Brazilian economy. The first includes firm-level micro-data from Brazil's producer price index (PPI), encompassing pricing information in the manufacturing sector. The second is the Focus Survey, a daily survey of inflation expectations conducted by the Brazilian Central Bank, covering a sample period where inflation expectations alternate between anchored and unanchored regimes. Finally, following Gopinath and Itskhoki (2010) we use the nominal exchange rate with the US as the aggregate source of price fluctuations. The exchange rate movements produce sizable and observable 'shocks'. Because they directly affect marginal costs of production, it is reasonable to assume firms pay attention this variable when setting prices.

3.1 Firms' prices: PPI microdata

The PPI-FGV dataset contains detailed price information from the survey used to construct IBRE-FGV's Producer Price Index. It comprises 67.8% of the PPI. Individual prices are collected through monthly telephone surveys, which target formal firms in the manufacturing sectors that have at least thirty employees.[5] Firms are asked to report the prices of individual goods sold to other firms, alongside a description of the physical characteristics of the goods and information about the transactions.

[5]Number of employees is based on the Annual Survey of Industry from the Brazilian Institute of Geography and Statistics (PIA-IBGE).

Table 1: **Examples of items and products in the PPI-FGV dataset**

Item	Printed tricoline fabric (1.5 M)
Producer	XXXXXXXX
Id. code	175068
CNAE (Product)	202213201
Group Name	Textiles Products
Group Code	2022130
Item	GALVANIZED WIRE BWG 18 (T)
Producer	XXXXXXXX
Id. code	319247
CNAE (Product)	202224301
Group Name	Manufacture of fabricated metal products.
Group Code	2022240
Item	AIR CHAMBER FOR TIRE XXXXXXXX (UNIT)
Producer	XXXXXXXX
Id. code	842344
CNAE (Product)	202222104
Group Name	Manufacture of rubber and plastics products.
Group Code	2022220
Item	UREA FOR FERTILIZER XXXXXXXX (T)
Producer	XXXXXXXX
Id. code	694203
CNAE (Product)	202220108
Group Name	Manufacture of chemicals and chemical products.
Group Code	2022200

We refer to the most disaggregated level of our data as an item. An item is associated with a set of characteristics, including the company name, location, product classification, model, size, brand, and packaging. Items are classified into one of 343 products specified in the National Classification of Economic Activities (CNAE).[6] Weights are given at the product level to compute the aggregate producer price index.[7] A few examples of items and products are provided in Table 1.[8]

Our PPI sample covers the period from January 2008 to December 2020. It results from the merging of the (active) dataset currently used to calculate the PPI-FGV with an inactive dataset. The latter comprises those items discontinued from the current dataset, which belonged to the PPI-FGV at some point since January 2008. An item may be deemed inactive if its price has been missing for a long period. A particular feature of this data set is that there is never a substitution of an item by another similar one belonging to the same product category. If a price is not reported in a round of the survey, the quote line will feature a missing value.

3.2 The extensive margin of price adjustment

One key feature of the data is that the frequency of price change does not change across anchored and unanchored regimes. As shown in Table 2, the Calvo setup introduced in the previous section seems a good approximation of the data generating process during this period. The mean (median) frequency of price changes is roughy 40% (30%) within each regime. The size of price changes is also not affected by the anchoring regime. This finding

[6] The list of products is chosen by FGV based on their relevance in PIA-IBGE.
[7] Weights are also based on PIA-IBGE.
[8] For confidentiality reasons, information that may identify specific firms or products has been replaced with "XXXXX".

reflects the fact that the behavior of aggregate inflation did not change dramatically across regimes. When looking at CPI Inflation, its yearly average was little over 4% in the anchored regime and increase to about 7% in the unanchored regime, while its unconditional yearly volatility increased from 1.3% in the anchored regime to 1.7% in the unanchored regime. [ADD DISCUSSION ON PPI AND POSSIBLY FIGURE]

Table 2: **Price Rigidity Across Regimes**

	Whole Sample		Anchored		Unanchored	
	Mean	Median	Mean	Median	Mean	Median
Freq. of price changes	0.395	0.316	0.403	0.324	0.382	0.306
Size of price changes	0.059	0.046	0.063	0.048	0.053	0.044

3.3 Measures of Firms' Production Costs

Since we do not observe directly firm-specific marginal costs, to control for this unobserved heterogeneity we proxy for cost variation using (i) an aggregate measure of labor costs and productivity and (ii) a sector-level input-cost index that varies over time and across manufacturing sectors. All cost variables are expressed in real terms and are accumulated over the duration of each price spell to match the dependent variable construction.

For labor costs, we use the Unit Labor Cost (ULC) series published by the Central Bank of Brazil (BCB). The BCB constructs ULC as unit labor costs in domestic industry expressed in U.S. dollars, combining an index of the wage bill and an index of industrial production, and converting into dollars using the end-of-period nominal exchange rate.[9]

Because the published ULC series is denominated in USD by construction, we first recover a BRL-denominated ULC by multiplying it by the corresponding end-of-period nominal BRL/USD exchange rate. We then deflate this series by the consumer price index (IPCA) to obtain a real measure of unit labor costs. Intuitively, this variable captures time variation in labor costs per unit of output, net of changes in aggregate prices.

To control for sectoral costs, we include in our regressions a variable called "Real Sectoral costs". Following a methodology employed by BCB, IBRE-FGV builds monthly input-cost indices for 30 manufacturing sectors using constant input shares from the 2015 Industrial Input–Output Matrix. For each sector, the input–output structure identifies the relevant intermediate inputs and their expenditure shares; each input is then matched to the most appropriate disaggregated price index (from the PPI when available, and from the IPCA for service inputs). The sectoral cost index is constructed as a fixed-weight average of these component price indices, where weights correspond to each input's share in the sector's total intermediate consumption.[10]

Finally, we deflate the nominal sectoral cost index by the IPCA, obtaining a real measure that can be interpreted as the sector's input-cost pressure relative to the overall price level. An increase in Real Sectoral Costs therefore indicates that intermediate input costs in a given sector are rising faster than aggregate prices.

[9] In the BCB methodology, ULC is computed as $ULC_t = (FS_t/PFI_t) \times (1/TxCbN_t)$, where FS_t is an index of the nominal wage bill, PFI_t is an index of industrial physical production, and $TxCbN_t$ is the end-of-period nominal exchange rate (sale rate). The wage-bill index is sourced from IBGE-PIMES up to 2015 and from the CNI wage-bill series from 2016 onward, after converting the latter from real to nominal using the INPC.

[10] See the BCB Quarterly Inflation Report (March 2021) and IBRE-FGV documentation. A complete list of sector codes and the PPI/IPCA series used for matching is provided in Appendix Tables 18 and 20.

3.4 Sectoral Demand and Inventory Controls

We use sectoral indicators that capture relevant information for firms' pricing decisions. These data come from IBRE-FGV's "Survey of Industrial Conditions," which we observe at a monthly frequency. Using the survey's information on firms' main product lines, we construct a concordance between a subset of the products in our PPI micro-price dataset and the survey sectors. The questionnaire includes items on domestic and external demand, inventories, business conditions, and production.

We leverage unpublished data from the Manufacturing Industry Survey provided by IBRE-FGV grouped in 63 sectors (rather than the 19 sectors in the published series). We use indices related to "Total Demand" and "Inventory Level."[11] Since these indicators are reported as indices on an arbitrary scale, we standardize them (mean zero and unit standard deviation) so that coefficients are comparable across controls. The "Sectoral Demand" index captures sector-level demand conditions, which shift firms' desired markups and pricing incentives. 'Sectoral Inventory" captures stock imbalances, which can affect pricing through inventory-holding costs and the need to clear excess inventories.

3.5 The Un-Anchoring of Inflation Expectations: Focus Survey

The primary focus of this paper is the relationship between firms' price setting and the and the degree of expectations anchoring. To this end we leverage an "abrupt U-turn" in monetary policy by the Banco Central do Brasil (BCB) in 2011, which triggered the unanchoring of long-run inflation expectations. Despite firm economic activity and inflation being above target, the BCB in August 2011 interrupted the ongoing tightening cycle and eased policy. The policy move was a very unusual large surprise to markets and it was the outcome of a rare split decision. It was widely interpreted as a signal of weaker commitment to the central bank inflation target (Bonomo et al., 2024, Cortes and Paiva, 2017).[12]

Bonomo et al., 2024 document the switching between anchored and unanchored regimes in the 2008-2020 years using measure of expectations from the BCB Focus Survey. This is a survey of professional forecasters which includes 140 institutions, comprising mostly banks and asset managers.[13] The high frequency of the survey clearly identifies the shift in behavior of inflation expectations with the U-turn episode. In contrast to the period preceding the controversial policy move, long-run inflation expectations are shown to deviate substantially from target and to become responsive to changes in short-run inflation expectations and to monetary policy shocks. In addition inflation dispersion increases markedly across inflation participants. This behavior is consistent with a loss of credibility of the central bank. Market participants do not believe the announced inflation target and attempt to learn the 'true' *unobserved* target from realized inflation and observed interest rate decisions. Re-anchoring takes place mid-2016 amid a radical change in the direction of economic policies, following the impeachment of President Rousseff and the appointment of a new BCB chair. Long-run inflation expectations across market participant revert to being aligned to the announced target of the central bank, and unresponsive to current policy decisions and inflation outcomes.

[11] In order to construct the inventory index, we consider a "net index": "excessive level" minus "insufficient level".

[12] Accredited institutions can update their forecasts at any time through the *Market Expectation System*, and the central bank compiles them every working day.

[13] The group of forecasters also includes other institutions such as nonfinancial companies, brokers, and consulting firms. To participate in the survey, all candidate institutions must have a research-dedicated unit and a chief economist whose profile must be approved by BCB.

3.6 Methodology

Motivated by the simple model presented in section 2 and by the literature on exchange-rate pass-through that makes use of micro price data, we estimate the following baseline regression model:

$$\Delta_{\tau_i} p_{i,t} = \alpha_i + \gamma_t + \beta_1 \Delta_{\tau_i} e_t + \beta_2 (\Delta_{\tau_i} e_t \times \mathbb{1}_t^{Unanch}) + \theta \tau_{it} + \lambda_\tau X_{\tau_i,t} + \lambda X_{i,t} + \epsilon_{i,t},$$

where $\Delta_{\tau_i} p_{i,t}$ denotes the accumulated price change over a price spell of length τ_i ending in period t, α_i are item fixed effects, γ_t are time fixed effects, $\Delta_{\tau_i} e_t$ is the cumulative change in the nominal exchange rate (against the U.S. dollar) over the same spell, and $\mathbb{1}_t^{Unanch}$ is an indicator for unanchored regimes. The term τ_{it} is the length (in months) of item i's price spell ending at t and controls for differences in the horizon over which the dependent variable is computed; in the motivating model this horizon effect corresponds to the spell-level change in the aggregate price index defining the relative price (equation 1). The vector $X_{\tau_i,t}$ includes additional spell-level controls such as cumulative changes in real unit labor costs (Δ_{τ_i}Real ULC$_t$) and sector-specific real input costs (Δ_{τ_i}Real Sectoral Cost$_t$), while $X_{i,t}$ includes time-varying sectoral controls such as inventory levels (Sectoral Inventory$_t$) and demand conditions (Sectoral Demand$_t$). In the baseline specification, exchange-rate changes are treated as exogenous cost shocks orthogonal to other drivers of price-setting decisions; time fixed effects absorb shocks common to all items in a given period, while item fixed effects absorb time-invariant differences across products. We then study heterogeneity in β_1 and β_2 across sectors, consistent with differences in price rigidity and in exposure of marginal costs to exchange-rate movements, and we assess robustness to regime-specific exchange-rate dynamics and regime-specific responses of price setting to marginal costs.

4 Empirical Evidence

4.1 Baseline Results

Our findings indicate larger price adjustments in response to nominal shocks during unanchored regimes. In the baseline specification, the estimated response of prices to exchange rate movements is about three times larger when expectations are unanchored. This pattern is robust across alternative specifications that allow for lagged exchange rate effects due to real rigidities, and for regime-specific exchange rate dynamics, including non-linearities and asymmetries between appreciations and depreciations, as well as to alternative measures of expectations anchoring.

Table 3 presents the baseline results. Column 1 shows that, on average, a 10% nominal exchange rate depreciation during a price spell is associated with a 0.4% increase in prices at the first price change. When regime-specific effects are introduced in Column 2, a 10% depreciation is associated with a 0.22% price increase in anchored regimes, while the corresponding response rises to 0.68% in unanchored regimes. Including spell-level and sectoral controls in Column 3 further underscores this pattern: the estimated price response to a depreciation remains modest in anchored regimes, while it is substantially larger in unanchored regimes.

These findings indicate that the state of inflation expectations is associated with firms' pricing behavior. When expectations are unanchored, the estimated price response to a given exchange rate change is larger, consistent with nominal shocks being treated as more persistent. While the frequency of price changes is similar across regimes (Table 2), the results point to differences along the intensive margin: conditional on adjusting, firms implement larger price changes in response to a given exchange rate movement in unanchored periods.

Table 3: Baseline regression

	$\Delta_{\tau_i} e_t$ - Nominal Exchange Rate		
Dependent variable: $\Delta_{\tau_i} p_{it}$	(1)	(2)	(3)
$\Delta_{\tau_i} e_t$	0.0410***	0.0225***	0.0115**
	(0.00393)	(0.00545)	(0.00574)
$\Delta_{\tau_i} e_t \times \mathbb{1}_t^{Unanch}$		0.0460***	0.0334***
		(0.00805)	(0.00855)
$\Delta_{\tau_i} p_{it-\tau_{it}}$			-0.122***
			(0.00521)
τ_{it}			0.000634***
			(0.0000840)
$\Delta_{\tau_i} Real\ ULC_t$			0.0151***
			(0.00573)
$\Delta_{\tau_i} Real\ Sectoral\ cost_t$			0.0141
			(0.0104)
$Sectoral\ \ inventory_t$			-0.00352***
			(0.000365)
$Sectoral\ \ demand_t$			0.00415***
			(0.000369)
$Constant$	0.0435***	0.0428***	0.0335***
	(0.00245)	(0.00245)	(0.00248)
N	192502	192502	178442
Adjusted R^2	0.0492	0.0495	0.0644
Individual Fixed Effects	Yes	Yes	Yes
Time-Fixed Effects	Yes	Yes	Yes
Items/Sectors Controls	No	No	Yes

Note: Heteroskedasticity-robust standard errors in parentheses. Coefficients followed by ***,**, or * are statistically significant at the 1%, 5%, or 10% levels, respectively.

4.2 Robustness

4.2.1 Instrumenting changes in the exchange rate Despite being standard practice in the international macroeconomics literature, a possible identification concern is that movements in the USD/BRL exchange rate may partly reflect Brazil-specific shocks—for instance, changes in sovereign risk premia or domestic macro news—that also affect firms' desired prices through markups, financing conditions, or demand. In that case, we would observe a correlation between exchange rate changes and price adjustments that is not informative about the pass-through of nominal cost shocks. Time fixed effects absorb shocks that are common to all items in a given month, and item fixed effects absorb permanent differences across narrowly defined products. However, they do not rule out endogeneity arising from time-varying Brazil-specific shocks that simultaneously move the exchange rate and differentially affect pricing incentives across items or sectors during a spell.

To address this concern, we complement the baseline specification with an instrumental-variable approach that isolates exchange rate movements driven by global factors. Specifically, we instrument monthly USD/BRL changes with changes in a basket of other emerging-market currencies.

First Stage:

$$\Delta e_t = \theta_0 + \theta_1 \Delta S_t + \varepsilon_t,$$

Table 4: IV regression

	$\Delta_{\tau_i} e_t$ - **Instrumented FX**		
Dependent variable: $\Delta_{\tau_i} p_{it}$	(1)	(2)	(3)
$\Delta_{\tau_i} e_t$	0.0855***	0.0684***	0.0644***
	(0.00596)	(0.00812)	(0.00904)
$\Delta_{\tau_i} e_t \times \mathbb{1}_t^{Unanch}$		0.0431***	0.0231*
		(0.0115)	(0.0122)
$\Delta_{\tau_i} p_{it-\tau_{it}}$			-0.123***
			(0.00520)
τ_{it}			0.000422***
			(0.0000893)
$\Delta_{\tau_i} Real\ ULC_t$			-0.00111
			(0.00594)
$\Delta_{\tau_i} Real\ Sectoral\ cost_t$			0.00824
			(0.0103)
$Sectoral\ inventory_t$			-0.00354***
			(0.000365)
$Sectoral\ demand_t$			0.00417***
			(0.000369)
$Constant$	0.0445***	0.0441***	0.0358***
	(0.00245)	(0.00246)	(0.00250)
N	192502	192502	178442
Adjusted R^2	0.0501	0.0502	0.0649
Individual Fixed Effects	Yes	Yes	Yes
Time-Fixed Effects	Yes	Yes	Yes
Items/Sectors Controls	No	No	Yes

Note: Heteroskedasticity-robust standard errors in parentheses. Coefficients followed by ***,**, or * are statistically significant at the 1%, 5%, or 10% levels, respectively.

where $\Delta S_t = \frac{\sum_{k=1}^{7} \Delta s_{k,t}}{7}$ is the monthly variation in a basket of seven emerging market currencies (Colombia, Mexico, Peru, Chile, China, India, and South Africa).

Second Stage:

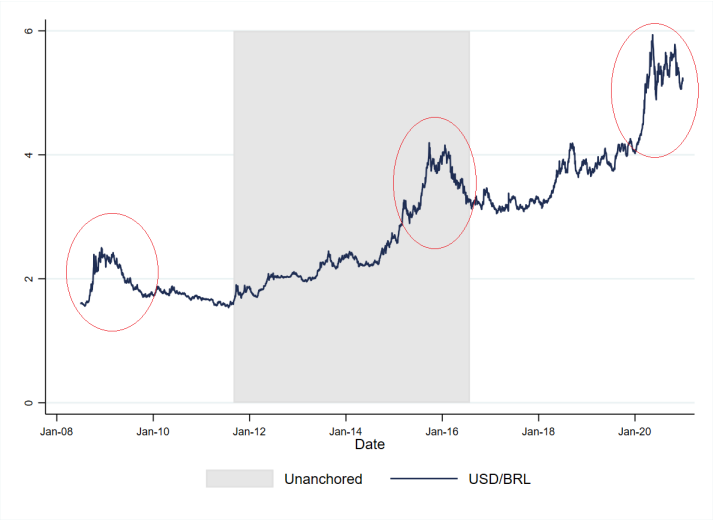
$$\Delta_{\tau_i} p_{i,t} = \alpha_i + \gamma_t + \beta_1 \Delta_{\tau_i} \hat{e}_t + \beta_2 (\Delta_{\tau_i} \hat{e}_t \times \mathbb{1}_t^{Unanch}) + \lambda_\tau X_{\tau_i,t} + \lambda X_{i,t} + \epsilon_{i,t},$$

where $\Delta_{\tau_i} \hat{e}_t = \hat{e}_t - \hat{e}_{t-\tau_i}$ represents the instrumented exchange rate change over the price spell.

The identifying assumption is that innovations to ΔS_t shift USD/BRL primarily through global shocks to emerging-market currencies (e.g., global risk sentiment) and are orthogonal to Brazil- and item-specific determinants of price-setting during the spell (conditional on the fixed effects and controls included in the regression).

Results are qualitatively the same and are reported in Table 4 in Section 4.2.1. Consistent with our baseline findings, the IV results show a larger price response to nominal shocks in unanchored regimes. On average, a 10% currency depreciation during a price spell leads to a 0.85% increase in prices (Column 1). During anchored regimes, a 10% exchange rate depreciation is associated with a 0.68% increase in prices, while in unanchored periods the implied response rises to about 1.1% (Column 2). This implies that pass-through is more than 50% larger in unanchored regimes, reinforcing the conclusion that expectations anchoring plays a critical role in price setting behavior.

Figure 1: **USDBRL and anchored/unanchored regimes**



4.2.2 Unanchoring or non-linearity in price responses? Our baseline regression assumes the behavior of the nominal exchange rate does not change across anchoring regimes. In that case the larger price response estimated for unanchored regimes could reflect the larger exchange rate movements observed in those periods, combined with non-linear responses to shock size. Brazil experienced sizable depreciations in both anchored (e.g. in 2008) and unanchored (e.g. in 2015) regimes — see Figure 1 —which provides a useful setting to distinguish these possibilities. Results show our findings are driven by the state of expectations rather than non-linearity in pass-through.

Table 5 augments the baseline specification with a quadratic term in exchange rate changes to capture potential non-linearities. Column 3 indicates a positive and statistically significant quadratic component when regime interactions are not included. However, once responses are allowed to differ by anchoring regime (Columns 4 and 5), the quadratic term becomes statistically insignificant, while the unanchored interaction remains positive and precisely estimated. In Column 4, the implied response to a 10% depreciation is 0.19% in anchored periods and 0.62% in unanchored periods, consistent with the baseline magnitude. This result reinforces the view that the anchoring of expectations, rather than shock size or non-linearity, drives the differences in price setting behavior.

Table 5: Unanchoring or non-linearity?

	$\Delta_{\tau_i} e_t$ - Nominal Exchange Rate				
Dependent variable: $\Delta_{\tau_i} p_{it}$	(1)	(2)	(3)	(4)	(5)
$\Delta_{\tau_i} e_t$	0.0410***	0.0225***	0.0315***	0.0193***	0.0134**
	(0.00393)	(0.00545)	(0.00495)	(0.00582)	(0.00608)
$\Delta_{\tau_i} e_t \times \mathbb{1}_t^{Unanch}$		0.0460***		0.0425***	0.0350***
		(0.00805)		(0.00834)	(0.00863)
$(\Delta_{\tau_i} e_t)^2$			0.0455***	0.0220	-0.0154
			(0.0163)	(0.0170)	(0.0188)
$\Delta_{\tau_i} p_{it-\tau_{it}}$					-0.122***
					(0.00521)
τ_{it}					0.000666***
					(0.0000924)
$\Delta_{\tau_i} Real\ ULC_t$					0.0151***
					(0.00573)
$\Delta_{\tau_i} Real\ Sectoral\ cost_t$					0.0136
					(0.0105)
$Sectoral\ inventory_t$					-0.00352***
					(0.000365)
$Sectoral\ demand_t$					0.00414***
					(0.000369)
Constant	0.0435***	0.0428***	0.0431***	0.0426***	0.0335***
	(0.00245)	(0.00245)	(0.00246)	(0.00246)	(0.00248)
N	192502	192502	192502	192502	178442
Adjusted R^2	0.0492	0.0495	0.0493	0.0495	0.0644
Individual Fixed Effects	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes
Items/Sectors Controls	No	No	No	No	Yes

Note: Heteroskedasticity-robust standard errors in parentheses. Coefficients followed by ***,**, or * are statistically significant at the 1%, 5%, or 10% levels, respectively.

4.2.3 Unanchoring or asymmetric response to FX? We also investigate if the larger price response estimated for unanchored regimes reflects asymmetric adjustment to exchange rate movements—in particular, stronger responses to depreciations than to appreciations—rather than a regime shift in price-setting behavior.

To test this, Table 6 separates the cumulative exchange rate change into appreciations ($\Delta_{\tau_i} e_t^{app}$) and depreciations ($\Delta_{\tau_i} e_t^{dep}$). Column 2 shows that price adjustments are indeed stronger in response to depreciations. However, when we control for the state of expectations (Column 5), the regime effect remains significant. While a 10% depreciation of the Brazilian real leads to a 0.3% increase in prices on average, pass-through more than doubles to 0.73% when expectations are unanchored. Column 6 shows that this conclusion is preserved after adding controls. This suggests that although firms respond asymmetrically to the direction of exchange rate shocks, the state of expectations is an important factor amplifying price adjustments in unanchored periods.

Table 6: Unanchoring or asymmetric response to FX?

	$\Delta_{\tau_i} e_t$ - Nominal Exchange Rate					
Dependent variable: $\Delta_{\tau_i} p_{it}$	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta_{\tau_i} e_t$	0.0410***		0.0225***	0.0115**		
	(0.00393)		(0.00545)	(0.00574)		
$\Delta_{\tau_i} e_t^{app}$		0.00792			0.00709	0.0175
		(0.00964)			(0.0103)	(0.0112)
$\Delta_{\tau_i} e_t^{dep}$		0.0531***			0.0310***	0.00811
		(0.00501)			(0.00730)	(0.00824)
$\Delta_{\tau_i} e_t \times \mathbb{1}_t^{Unanch}$			0.0460***	0.0334***		
			(0.00805)	(0.00855)		
$\Delta_{\tau_i} e_t^{app} \times \mathbb{1}_t^{Unanch}$					0.0264	-0.000254
					(0.0268)	(0.0273)
$\Delta_{\tau_i} e_t^{dep} \times \mathbb{1}_t^{Unanch}$					0.0423***	0.0387***
					(0.00948)	(0.00980)
$\Delta_{\tau_i} p_{it-\tau_{it}}$				-0.122***		-0.122***
				(0.00521)		(0.00521)
τ_{it}				0.000634***		0.000648***
				(0.0000840)		(0.0000969)
$\Delta_{\tau_i} Real\ ULC_t$				0.0151***		0.0149***
				(0.00573)		(0.00574)
$\Delta_{\tau_i} Real\ Sectoral\ cost_t$				0.0141		0.0144
				(0.0104)		(0.0105)
$Sectoral\ inventory_t$				-0.00352***		-0.00352***
				(0.000365)		(0.000365)
$Sectoral\ demand_t$				0.00415***		0.00415***
				(0.000369)		(0.000368)
$Constant$	0.0435***	0.0423***	0.0428***	0.0335***	0.0422***	0.0337***
	(0.00245)	(0.00248)	(0.00245)	(0.00248)	(0.00249)	(0.00251)
N	192502	192502	192502	178442	192502	178442
Adjusted R^2	0.0492	0.0493	0.0495	0.0644	0.0495	0.0644
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

Note: Heteroskedasticity-robust standard errors in parentheses. Coefficients followed by ***,**, or * are statistically significant at the 1%, 5%, or 10% levels, respectively.

4.2.4 Regime-specific price response to marginal cost

The unanchoring of expectations might affect price setting through an additional and complementary channel. In addition to shifting the path of inflation expectations, expectations' un-anchoring could also steepen the slope of the pricing decision rule, so that changes in the expected path of the marginal cost induce a stronger price response. In terms of our the simple model this implies $\lambda_{mc,f}$ with $f \in (Anc, Unc)$. While we have no direct observation of firm-specific marginal costs and expectations, the regression equation (2) interacts the anchoring dummy with aggregate measured sector-specific real marginal costs.

$$\begin{aligned}\Delta_{\tau_i} p_{i,t} = \alpha_i + \gamma_t + \beta_1 \Delta_{\tau_i} e_t + \beta_2 \big(\Delta_{\tau_i} e_t \times \mathbb{1}_t^{Unanch}\big) \\ + \theta_1 \Delta_{\tau_i} Real\ ULC_t + \theta_2 \big(\Delta_{\tau_i} Real\ ULC_t \times \mathbb{1}_t^{Unanch}\big) \\ + \kappa_1 \Delta_{\tau_i} Real\ Sectoral\ cost_t + \kappa_2 \big(\Delta_{\tau_i} Real\ Sectoral\ cost_t \times \mathbb{1}_t^{Unanch}\big) \\ + \lambda_\tau X_{\tau_i,t} + \lambda X_{i,t} + \epsilon_{i,t}.\end{aligned} \tag{2}$$

The estimates do not provide evidence that the regime dependence in price adjustments operates through a steeper pricing rule; instead, it remains concentrated in the response to nominal exchange rate movements.

Table 7: Regime-specific price response to marginal cost

	$\Delta_{\tau_i} e_t$ - Nominal Exchange Rate			
Dependent variable: $\Delta_{\tau_i} p_{it}$	(1)	(2)	(3)	(4)
$\Delta_{\tau_i} e_t$	0.0115**	0.0111*	0.0113*	0.0109*
	(0.00574)	(0.00575)	(0.00577)	(0.00578)
$\Delta_{\tau_i} e_t \times \mathbb{1}_t^{Unanch}$	0.0334***	0.0338***	0.0339***	0.0343***
	(0.00855)	(0.00853)	(0.00861)	(0.00860)
$\Delta_{\tau_i} p_{it-\tau_{it}}$	-0.122***	-0.122***	-0.122***	-0.122***
	(0.00521)	(0.00521)	(0.00521)	(0.00521)
τ_{it}	0.000634***	0.000640***	0.000632***	0.000639***
	(0.0000840)	(0.0000847)	(0.0000840)	(0.0000847)
$\Delta_{\tau_i} Real\ ULC_t$	0.0151***	0.0168**	0.0152***	0.0169**
	(0.00573)	(0.00681)	(0.00574)	(0.00682)
$\Delta_{\tau_i} Real\ ULC_t \times \mathbb{1}_t^{Unanch}$		-0.00666		-0.00679
		(0.0123)		(0.0123)
$\Delta_{\tau_i} Real\ Sectoral\ cost_t$	0.0141	0.0142	0.0177	0.0177
	(0.0104)	(0.0104)	(0.0128)	(0.0128)
$\Delta_{\tau_i} Real\ Sectoral\ cost_t \times \mathbb{1}_t^{Unanch}$			-0.0121	-0.0124
			(0.0189)	(0.0190)
$Sectoral\ inventory_t$	-0.00352***	-0.00352***	-0.00352***	-0.00352***
	(0.000365)	(0.000365)	(0.000365)	(0.000365)
$Sectoral\ demand_t$	0.00415***	0.00415***	0.00415***	0.00416***
	(0.000369)	(0.000369)	(0.000369)	(0.000369)
$Constant$	0.0335***	0.0334***	0.0334***	0.0334***
	(0.00248)	(0.00249)	(0.00248)	(0.00249)
N	178442	178442	178442	178442
Adjusted R^2	0.0644	0.0644	0.0644	0.0644
Individual Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
Items/Sectors Controls	Yes	Yes	Yes	Yes

Note: Heteroskedasticity-robust standard errors in parentheses. Coefficients followed by ***,**, or * are statistically significant at the 1%, 5%, or 10% levels, respectively. Columns (2)–(4) allow the response to marginal-cost proxies to vary by expectations regime via interactions with $\mathbb{1}_t^{Unanch}$.

Table 7 reports specifications that interact the unanchored indicator with two measures of real marginal costs: real unit labor costs and a broader measure of sectoral real costs. Column 1 replicates the baseline specification with the full set of controls. Across Columns 2–4, the interaction terms are small and statistically insignificant, indicating no systematic regime dependence in the response of price changes to these marginal-cost proxies. The point estimate on real unit labor costs remains positive and similar in magnitude across specifications, while the unanchored interaction is close to zero. Likewise, the interaction with real sectoral costs is negative but imprecisely estimated. In contrast, the regime difference in the exchange-rate coefficient remains stable across columns: for a 10% depreciation, the implied price response is about 0.11% in anchored periods and rises to roughly 0.45% in unanchored periods.

In summary, unanchoring does not seem to primarily affect how sensitive price adjustments are to measured real marginal costs. Instead, when we account for regime dependence in these cost channels, the estimated response to nominal exchange rate movements remains largely unchanged. This supports our baseline specification, which indicates that the primary regime dependence occurs through the nominal shock term, while the coefficients related to observed marginal-cost proxies remain relatively stable across regimes.

4.2.5 Observed firm heterogeneity: Price rigidity To characterize heterogeneity in price-setting responses to nominal shocks along the price-rigidity dimension, we split items according to their price duration. We allow price setting to be depend on sector-specific price rigidities:

INSERT ACTUAL REGRESSION

where $j \in$ (above, below) indicates items with price spells below (or above) the median spell duration: i.e. "below" means more flexible prices. The simple model predicts firms subject to higher rigidities should have a stronger response on average, as they expect their prices to be stuck for longer. In the regression we define the indicator function $\mathbb{1}^{below}$ as items with price spells below the median price duration (more flexible prices) and $\mathbb{1}^{above}$ as items with price spells above the median (more rigid prices). We then re-estimate the baseline specification allowing the exchange-rate coefficient to differ across these two groups and across anchoring regimes by interacting $\Delta_{\tau_i} e_t$ with $\mathbb{1}^{below}$ and $\mathbb{1}^{above}$, and further interacting these terms with the unanchored indicator. Under this specification, the anchored-regime price response for each group is given by the corresponding $\Delta_{\tau_i} e_t \times \mathbb{1}^{group}$ coefficient, while the unanchored-regime response adds the relevant triple-interaction term.

Table 8 shows that the estimated response of price changes to exchange rate movements is indeed larger for more rigid items. At the same time, in the unanchored regime both flexible and rigid firms exhibit a larger price response to changes in the exchange rate when compared to the anchored regime.

Column 1 reports the specification without regime interactions and indicates that the coefficient for above-median duration items is more than twice as large as for below-median duration items. Column 2 allows responses to differ by anchoring regime. During anchored periods, the estimated response for below-median duration items is close to zero, whereas for above-median duration items a 10% depreciation is associated with roughly a 0.64% increase in prices. In unanchored periods, the implied responses rise for both groups, to about 1.07% for below-median items and 1.58% for above-median duration items. Column 3 shows that this ranking is preserved after adding controls. The difference between rigid and flexible items is statistically significant in both anchored and unanchored regimes (bottom rows).

Summing up, these patterns suggest two features of price-setting behavior. First, items that adjust prices less frequently display larger adjustments conditional on a reset, consistent with the idea that infrequent adjusters incorporate a larger share of cumulative nominal shocks when they update prices. Second, when expectations are unanchored, the sensitivity of price changes to exchange rate movements increases for both groups.

4.2.6 Observed firm heterogeneity: Imported input exposure To study whether cost exposure to imported inputs shapes price-setting responses to nominal shocks, we split items according to their imported-input share. Here we aim at capturing heterogeneity in the response of firms' marginal cost to the movements in the exchange rate. We run the regression

INSERT ACTUAL REGRESSION

In terms of the simple model, $\lambda_{mc,j}$ is firm-specific and it measures sector-specific marginal cost's response to movements in the exchange rate. For each item, this is defined as belonging to sectors with imported-input exposure below the median (lower exposure) or belonging to sectors above the median (higher exposure). Similar to our previous investigation, we re-estimate the baseline specification allowing the exchange-rate coefficient to differ across these two groups (adding the indicator function $\mathbb{1}^h, h \in$ (above,below)) and across anchoring regimes

Table 8: Firm heterogeneity – price rigidity

	$\Delta_{\tau_i} e_t$ - Nominal Exchange Rate		
Dependent variable: $\Delta_{\tau_i} p_{it}$	(1)	(2)	(3)
$\Delta_{\tau_i} e_t \times \mathbb{1}^{below}$	0.0472***	0.00515	-0.0174
	(0.0109)	(0.0163)	(0.0162)
$\Delta_{\tau_i} e_t \times \mathbb{1}_t^{Unanch} \times \mathbb{1}^{below}$		0.102***	0.0501**
		(0.0209)	(0.0210)
$\Delta_{\tau_i} e_t \times \mathbb{1}^{above}$	0.103***	0.0639***	0.0274***
	(0.00400)	(0.00551)	(0.00556)
$\Delta_{\tau_i} e_t \times \mathbb{1}_t^{Unanch} \times \mathbb{1}^{above}$		0.0943***	0.0406***
		(0.00801)	(0.00857)
N	192502	192502	178442
Adjusted R^2	0.060	0.061	0.072
Individual Fixed Effects	No	No	No
Time Fixed Effects	Yes	Yes	Yes
Controls	No	No	Yes
p-value for H_0: $\beta_{blw} = \beta_{abv}$	0.00		
p-value for H_0: $\beta_{blw}^{anc} = \beta_{abv}^{anc}$		0.00	0.01
p-value for H_0: $\beta_{blw}^{unanc} = \beta_{abv}^{unanc}$		0.00	0.00

Note: Heteroskedasticity-robust standard errors in parentheses. Coefficients followed by ***,**, or * are statistically significant at the 1%, 5%, or 10% levels, respectively. $\mathbb{1}^{below}$ denotes items with price durations below the median (more flexible prices), while $\mathbb{1}^{above}$ denotes those with price durations above the median (more rigid prices).

by interacting $\Delta_{\tau_i} e_t$ with $\mathbb{1}^{below}$ and $\mathbb{1}^{above}$, and further interacting these terms with the unanchored indicator. Under this specification, the anchored-regime response for each group is given by the corresponding $\Delta_{\tau_i} e_t \times \mathbb{1}^{group}$ coefficient, while the unanchored-regime response adds the relevant triple-interaction term.

Table 9 shows that higher imported-input exposure (larger $\lambda_{mc,j}$) is associated with larger price responses to exchange rate movements. Yet both firms display larger price responses in the unanchored regime. Overall, the estimates suggest that imported-input exposure is an important source of heterogeneity when expectations are anchored, whereas in unanchored episodes responses become less differentiated by exposure. In fact the exposure gap narrows in unanchored regimes as we should expect. When expectations are anchored, exchange rate movements matter more for items with higher direct exposure through imported inputs, and low-exposure items adjust relatively less. When expectations are unanchored, the same nominal movement is associated with larger price adjustments even among low-exposure items, narrowing the high–low exposure gap. In this sense, unanchored regimes are associated with a broader dissemination of nominal shocks across items, rather than responses being concentrated in those with the most direct cost exposure. In terms of the simple model in section 2, the coefficient β_2 in the simple example is tied to the response of aggregate inflation, λ_π, and thus it is tied to the aggregate response of inflation changes in the exchange rate, not to individual characteristic of the firm. In detail, column 1 indicates that the estimated coefficient is substantially larger for above-median exposure items: a 10% nominal exchange rate depreciation is associated with a 0.55% increase in prices for high-exposure items, compared to 0.28% for low-exposure items. Column 2 allows responses to differ by anchoring regime. During anchored periods, the estimated response for below-median exposure items is small and not statistically significant (0.07% for a 10% depreciation), whereas the corresponding response for above-median exposure items is positive and statistically significant (0.39%). During unanchored periods, implied responses increase for both groups, to about 0.58% for low-exposure items and 0.80% for high-exposure items. As a result, the high–low exposure gap narrows relative to

Table 9: Firm heterogeneity – imported input exposure

	$\Delta_{\tau_i} e_t$ - **Nominal Exchange Rate**		
Dependent variable: $\Delta_{\tau_i} p_{it}$	(1)	(2)	(3)
$\Delta_{\tau_i} e_t \times \mathbb{1}^{below}$	0.0276***	0.00745	-0.00997
	(0.00469)	(0.00646)	(0.00680)
$\Delta_{\tau_i} e_t \times \mathbb{1}_t^{Unanch} \times \mathbb{1}^{below}$		0.0504***	0.0470***
		(0.00942)	(0.00988)
$\Delta_{\tau_i} e_t \times \mathbb{1}^{above}$	0.0554***	0.0388***	0.0343***
	(0.00517)	(0.00704)	(0.00720)
$\Delta_{\tau_i} e_t \times \mathbb{1}_t^{Unanch} \times \mathbb{1}^{above}$		0.0412***	0.0190*
		(0.0104)	(0.0111)
N	192502	192502	178442
Adjusted R^2	0.049	0.049	0.049
Individual Fixed Effects	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes
Controls	No	No	Yes
p-value for H_0: $\beta_{blw} = \beta_{abv}$	0.00		
p-value for H_0: $\beta_{blw}^{anc} = \beta_{abv}^{anc}$		0.00	0.00
p-value for H_0: $\beta_{blw}^{unanc} = \beta_{abv}^{unanc}$		0.01	0.07

Note: Heteroskedasticity-robust standard errors in parentheses. Coefficients followed by ***,**, or * are statistically significant at the 1%, 5%, or 10% levels, respectively. $\mathbb{1}^{below}$ denotes items with imported-input share below the median (lower exposure), while $\mathbb{1}^{above}$ denotes those above the median (higher exposure).

anchored periods (from roughly 0.31 p.p. to 0.22 p.p. for a 10% depreciation). Column 3 shows that this pattern is preserved after adding controls: implied responses in unanchored periods are about 0.37% for low-exposure items and 0.53% for high-exposure items, and the residual high–low gap is modest and only marginally statistically significant.

5 Model and Calibration

We develop a New Keynesian model where expectations can become unanchored: that is, market participants' perceived inflation target deviates substantially from what is officially announced by the central bank. Firms form beliefs about the central bank's inflation target based on observed interest rate decisions so that when longer term inflation expectations become unanchored, they become tightly linked to short-term economic fluctuations. As a result, in the unanchored regime firms' prices display a stronger response to exogenous changes in the nominal exchange rate. The model is calibrated to match key moments from the Brazilian data, including the volatility of inflation and inflation expectations across anchoring regimes. Simulated data from the model replicate the empirical findings, providing a structural interpretation of our empirical regression results.

5.1 The model

We study the price-setting implications of unanchored inflation expectations in a simple new Keynesian model, building on Woodford (2003). Households derive utility from a composite consumption good, and incur disutility from supplying labor to firms. Firms produce and sell differentiated goods in a monopolistically competitive environment, subject to Calvo (1983)-type nominal rigidities. The central bank sets the short-term interest rate in response to inflation and output in deviation from their targets. We depart from most common assumptions in two ways. First, firms use both labor, a domestic and a foreign intermediate good as production inputs. The real exchange rate directly impact firms' marginal cost of production in the model, creating a channel for exchange rate pass-through – see Bonomo et al. (2016). Second, we model different regimes of inflation expectations that depend on the credibility of the central bank. Below we discuss the main equations of the model, with emphasis on the anchoring of inflation expectations. Standard equations are presented already in log-linear form. The full model is described in the Appendix.

5.1.1 Private sector

Firm i's output, denoted by Y_{it}, is produced according to the Cobb-Douglas production function

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

based on three sets of factors used in the production process: domestic input, foreign inputs and exogenous productivity. The foreign input is denoted by M_{it} and its share relative to domestic factors is measured by the elasticity parameter $0 < 1 - \alpha < 1$. Domestic inputs include labor, L_{it} and a domestic intermediate input I_{it} – a composite of goods produced by other firms in the economy. Their relative shares are dictated by the parameter $0 < \eta < 1$. Domestic intermediate inputs are a source of real rigidities in the sense of Ball and Romer (1990). Production is subject to shocks to firm-specific ($A_{i,t}$) and aggregate (A_t) productivity.

Firm cost minimization yields real marginal cost:

$$mc_{it} \quad \propto \quad A_t^{-1} A_{it}^{-1} w_t^{\alpha\eta} q_t^{1-\alpha},$$

where w_t is the economy-wide real wage and q_t is the real exchange rate. These, together with fluctuations in productivity, are the "fundamental" drivers of inflation in the model. As discussed below, fluctuations in the real exchange affect directly marginal costs proportionally to their share in labor inputs.

The model is log-linearized around its non-stochastic steady state.[14] The economy's aggregate output is the sum of private consumption and intermediate inputs

$$\hat{y}_t = \frac{I}{y}\hat{I}_t + \left(1 - \frac{I}{y}\right)\hat{c}_t$$

and aggregate consumption is described by the familiar consumption Euler equation

$$\hat{c}_t = \mathbb{E}_t\hat{c}_{t+1} - (R_t - \mathbb{E}_t\pi_{t+1}),$$

where R_t is the short-term interest rate, π_t is the domestic inflation rate, and $\mathbb{E}_t$ denotes the expectations operator, discussed below.

Firms reset prices with probability $1-\xi$. When resetting its price, firm i's optimal decision is given by

$$\tilde{p}_{it}^{opt} = \mathbb{E}_t \sum_{T=t}^{\infty} (\xi\beta)^{T-t} \left[\frac{1-\xi\beta}{1+\bar{\theta}\varepsilon_\mu}\hat{mc}_T^i + \xi\beta\pi_{T+1}\right], \tag{3}$$

where $\tilde{p}_{i,t}^{opt}$ denotes the optimal price relative to the economy-wide price level and where β is the household's discount rate. The term $1+\bar{\theta}\varepsilon_\mu$ captures real rigidities at the firm level, stemming from the Kimball demand aggregator, where $\bar{\theta}$ denotes the steady-state elasticity of demand and ε_μ measure the elasticity of the firm's markup to changes in relative demand.

Firm i's real marginal cost can be written as

$$\hat{mc}_{it} = \alpha\eta\hat{w}_t + (1-\alpha)\,\hat{q}_t - (\hat{a}_t + \hat{a}_{i,t}). \tag{4}$$

Marginal cost is impacted by exogenous shifts in aggregate ($\hat{a}_t$) and firm-specific ($\hat{a}_{i,t}$) productivity – both modeled as AR(1) processes. The real exchange rate is defined by

$$\hat{q}_t = \hat{e}_t + \hat{p}_t^f - \hat{p}_t,$$

where $\hat{e}_t$ denotes the nominal exchange rate, $\hat{p}_t$ is the domestic price level and $\hat{p}_t^f$ is the foreign price level. We take a partial equilibrium approach and assume the nominal exchange rate and the foreign price level evolve exogenously.[15] Given our focus on movements in the nominal exchange rate, we keep the foreign price level constant – $\hat{p}_t^f = 0$. $\hat{e}_t$ evolves according to a persistent *exogenous* AR(1) process. Notice here that the nominal exchange rate affects the marginal costs *directly* through the real exchange rate and indirectly through the wage via *general equilibrium* effects. To the extent that the wage response to the nominal exchange rate depends on the anchoring regime, the implied elasticity of the marginal cost to the nominal exchange rate (λ_{mc} in the motivating model of section 2) will be dependent on the anchoring regime.

Aggregating across firms, the equilibrium evolution of domestic inflation is determined according to the forward-looking Phillips curve

$$\pi_t = \beta\mathbb{E}_t\pi_{t+1} + \kappa\,(\alpha\eta\hat{y}_t - \hat{a}_t) + \kappa(1-\alpha)\hat{q}_t,$$

[14] Lowercase variables denote logarithms and "hatted" variables denote log-deviations from steady state.
[15] An implicit assumption is that the foreign price level does not respond to movements in the nominal exchange rate.

where $\kappa \equiv \frac{(1-\xi)(1-\xi\beta)}{\xi\left(1+\bar{\theta}\varepsilon_{\mu}\right)}\zeta$ denotes its slope, where $0 < \zeta < 1$ measures real rigidities from domestic roundabout intermediate inputs.[16] The key Phillips curve parameters regulate the aggregate elasticity of prices to changes in aggregate output and the nominal exchange rate and will be calibrated to the Brazilian economy.

5.1.2 Central Bank, expectations' anchoring and the exchange rate The degree of expectations' anchoring is determined by agents' perceptions about monetary policy, and in particular, the central bank inflation target. The central bank sets the short-term nominal rate according to a conventional Taylor rule

$$R_t = \rho_i R_{t-1} + (1-\rho_i)\left[\phi_\pi\left(\pi_t - \pi_t^*\right) + \phi_y \hat{y}_t\right] + \varepsilon_t^R, \tag{5}$$

where $0 \leq \rho \leq 1$ measures the degree of interest rate smoothing, and ϕ_π, ϕ_y denote the responses to inflation and output, respectively. In addition, the interest rate is driven by two exogenous processes. The first corresponds to the time-varying inflation target π_t^* assigned to the central bank, which evolves according to

$$\pi_t^* = \rho_{\pi_*}\pi_{t-1}^* + \varepsilon_t^*. \tag{6}$$

The inflation target changes in response to exogenous idiosyncratic shifts in decisionmakers' preferences, ε_t^*. The second, ε_t^R, is an i.i.d. monetary policy shock.

Monetary shocks and the exchange rate. We assume the monetary policy shock ε_t^R is weakly negatively correlated to the nominal exchange rate' innovation ε_t^e. It can be expressed as

$$\varepsilon_t^R = -\tau_e \varepsilon_t^e + \varepsilon_t^m, \tag{7}$$

where ε_t^m is a i.i.d. innovation and where τ_e is relatively 'small'. This correlation is consistent with empirical evidence. Contractionary monetary surprises are associated to appreciation in the Brazilian currency (Feibert (2022)). Additionally, this negative correlation can be justified with the central bank occasionally deviating from the policy rule in order to prevent the contractionary (expansionary) effects of an exchange rate depreciation (appreciation).[17] As shown below, this provides a simple way to forge a connection between exchange rate movements and the revisions in agents' assessment of the inflation target.

Central bank credibility and anchoring of beliefs. In this simple model, central bank credibility is tied to market participants' *beliefs* about the type of central bank they face. Economic agents know the policy rule (5) and both aggregate demand and supply structural equations defining the economy, but expectations are not fully rational. Agents face three distinct information frictions. First, agents cannot directly infer the inflation target from the policy rule. In fact, they cannot observe separately monetary policy shocks (ε_t^R) and inflation target (π_t^*).

Second, agents have incomplete knowledge about the inflation target process in equation (6). In the "Anchored" regime agents' perceived volatility of ε_t^* coincides with its correct data generating process: agents form estimates for the inflation target under its correct law of motion. In the anchored regime, expectations are consistent with the central bank policy objectives. Conversely, in the "Unanchored" regime the *perceived volatility* of the inflation target (the variance of ε_t^*) is substantially higher than then true value. Beliefs about the central bank reaction

[16] The appendix shows how ζ depends on the input elasticities, together with the elasticity of demand for the final good.
[17] Recall here fluctuations in the exchange rate affect the marginal cost of production.

function are not consistent with actual policy.[18]

Third, agents are not aware of the link between monetary policy innovations and the nominal exchange rate described in equation (7). This assumption of bounded rationality is required because the exchange rate is *fully observed* by market participants. If agents knew the connection (i.e. the parameter τ_e) they would be able to 'factor out' innovations ε_t^e from their estimate of the inflation target. This would sever any connection between exchange rate innovations and long-term expectations in the model.

Given the information available to them, agents use the Kalman filter to revise their estimate of the inflation target, giving

$$\pi^*_{t+1|t} = \rho_{\pi_*}\pi^*_{t|t-1} + \bar{g}^k\left(\tilde{\pi}_t - \pi^*_{t|t-1}\right),$$

where the signal

$$\tilde{\pi}_t = \pi^*_t - \frac{1}{(1-\rho_i)\,\phi_\pi}\varepsilon_t^R,$$

and $\bar{g}^k > 0$, $k \in \{\text{Anchored}, \text{Unanchored}\}$ denotes the Kalman gain, where $\bar{g}^{\text{Unanchored}} >> \bar{g}^{\text{Anchored}}$. As shown in the Appendix, the gain depends both on the relative perceived volatility of the two exogenous processes and the persistence of the inflation target. Changes is the estimated inflation target are driven by temporary monetary policy shocks, exchange rate shocks and by exogenous shifts in the inflation target. In the anchored regime, the perceived volatility of ε_t^* is small and corresponds to actual policy. This results in a small Kalman gain. Conversely, in the unanchored regime the Kalman gain is large, reflecting agents' beliefs that the inflation target is drifting significantly.

The link between monetary policy shocks and exchange rate innovations in equation (7) ties exchange rate variation to revisions in the estimated inflation target, and therefore revisions to long-run inflation expectations. Consider how long-term inflation expectations respond to an unaticipated change in the nominal exchange rate. Beliefs about the inflation target are revised according to

$$\pi^*_{t+1|t} = \left(\rho_{\pi_*} - \bar{g}^k\right)\pi^*_{t|t-1} + \frac{\bar{g}^k\tau_e}{(1-\rho_i)\,\phi_\pi}\varepsilon_t^e. \tag{8}$$

For example, an unexpected devaluation, leads to a positive surprise, $\tilde{\pi}_t - \pi^*_{t|t-1}$, and therefore an upward revision in the inflation target relative to last period prior beliefs. Given the inflation target is highly persistent, this revision affects inflation expectations at every horizon, including the longer ones. In the Unanchored regime these revisions are large, boosting the sensitivity of inflation expectations to new information. This is the main mechanism of shock transmission in the model.

For simplicity, the central bank loss of credibility is an exogenous shift in beliefs, not tied to any specific shock or endogenous outcome. Does this model provide an accurate description of the behavior of medium-term inflation expectations? Carvalho et al. (2023) introduce a model of expectations anchoring based on the idea that firms revise their estimate of the inflation target in response to short-term inflation surprises, driven in large part by cost-push shocks. The model, estimated using US inflation and survey-based *short-term* inflation expectations, predicts very accurately the behavior of *long-run* inflation expectations both for the US economy and other countries spanning the period from the 1970s to 2022. The degree of anchoring is endogenous and depends on the size and persistence of forecast errors. The model detects episodes of unanchoring of expectations in all countries considered. While

[18] In both regimes agents know the parameter ρ_{π_*} in equation (6).

the expectations formation mechanism presented here abstracts from some of these features, its main predictions are quite similar. This supports our view that results about the effects of unanchoring on firms' pricing decisions obtained with this simple model would also obtain under more complex models of expectations formation and unanchoring.

5.2 Calibration and Simulated Regressions

We calibrate the model at a monthly frequency to match selected moments from the Brazilian economy. The parameters and their calibrated values are summarized in Table 10. Crucially, in the simulation we discipline the behavior of inflation expectations in both anchored and unanchored regimes using survey data.

The volatility of monetary policy innovations $\varepsilon_{R,t}$ is set to match the standard deviation of monetary policy surprises inferred from the Focus Survey –see Bonomo et al. Consistent with the data, the volatility of monetary policy surprises is kept the same across anchoring regimes. The Calvo repricing probability is set to the average frequency of price changes during the sample. The measured monthly frequency is about 30% and does not change meaningfully across regimes, validating our modeling choice for price setting.[19] We set the domestic (η) and foreign (α) input shares consistent with data for the Brazilian economy.[20] The degree of firm-level real rigidities, measured by ε_μ is set to deliver an aggregate (Phillips curve) elasticity of domestic inflation to de-trended output consistent with estimates for the Brazilian economy (see Castro, Gouvea, Minella, Santos, and Souza-Sobrinho (2015); Cavalcanti and Vereda (2015); Fasolo, Araújo, Jorge, Kornelius, and Marinho (2024)). The discount rate β delivers the average annual real interest rate of 3.8% observed in the sample period. The autoregressive parameter of the stationary aggregate productivity process to ρ_A matches the persistence in labor productivity as measured by the output to employment ratio.[21] The correlation between monetary policy surprises (ε_t^R) and innovations to the nominal exchange rate (ε_t^e) is set to match the observed negative correlation.[22]

The parameters governing firm-specific productivity processes do not affect the aggregate evolution of the economy. The innovations' variance is set to match the average size of price changes in the sample. The autocorrelation parameter roughly matches the estimated negative conditional correlation between firms's prices upon resetting and the price change when they last re-set their prices ($\Delta_{\tau_i} p_{it-\tau_{it}}$) – see Table 3.

The remaining parameters are chosen to match ten statistical moments of Brazilian macroeconomic indicators over the period from July 2008 to December 2020. For the purpose of the calibration, model-generated statistics are an average over 200 replications, where each simulation has the same length as the data sample, and where the timing of anchored and unanchored regimes are lined up as in the actual data. We discipline the behavior of inflation expectations in both anchored and unanchored regimes using survey data. In particular, we look at the volatility of relatively long-term inflation expectations from BCB's Focus Survey: specifically, 12-month inflation between 36 and 48 months ahead (four years ahead). The inflation rate is based on the consumer price index that Brazil uses to implement its inflation targeting regime, the IPCA, published by the Brazilian Institute of Geography and Statistics (IBGE). The interest rate corresponds to the policy rate set by BCB (Selic). As measures of real de-trended output and nominal exchange rate, we use the Hodrick-Prescott filtered cyclical component of their monthly series.[23] Real output is obtained from the Central Bank Economic Activity Index (IBC-Br), and the

[19] See section 3.2

[20] Details on these measures can be found in Appendix D.

[21] Labor productivity is measured using quarterly data from FRED. We choose the monthly autocorrelation coefficient to be consistent with a quarterly estimate obtained from the first-order autocorrelation of the Hodrick-Prescott de-trended series with the standard smoothing parameter of 1600.

[22] Innovations to the nominal exchange rate process are obtained from the residuals from fitting a first-order autoregressive process to the Hodrick-Prescott de-trended nominal exchange rate.

[23] We set the smoothing parameter to 14,400.

Table 10: **Model calibration**

Parameters	**Description**		**Parameters**	**Description**	
$1-\alpha$	import elasticity	0.150	ρ_{π^*}	π_t^* shock	0.951
β	discount rate	0.997	σ_R	vol. mp shock	0.140
$1-\xi$	freq. Δp^i	0.300	ρ_e	persistence e_t	0.890
$1-\eta$	interm. inputs	0.220	ρ_a	persistence a_t	0.900
ϕ_π	TR: $\pi_t - \pi_t^*$	1.600	ρ_{a_i}	persistence a_{it}	0.920
ϕ_y	TR: y_t	0.003	σ_e	vol. e_t shock	3.975
ρ_i	TR: R_{t-1}	0.803	σ_a	vol. a_t shock	0.306
$\hat{g}^{\text{Unanchored}}$	Kalman gain	0.300	σ_{a_i}	vol. a_{it} shock	18.35
$\hat{g}^{\text{Anchored}}$	Kalman gain	0.014	$\text{Corr}(\varepsilon_t^R, \varepsilon_t^e)$	corr.	-0.127

Moments	**Model**	**Data**
$\sigma(\pi_t)$	0.313	0.300
$\sigma(R_t)$	0.299	0.260
$\sigma(e_t)$	8.784	8.720
$\sigma(\hat{y}_t)$	2.427	2.400
$\sigma(\mathbb{E}^{Anc}\pi)$:	0.157	0.160
$\sigma(\mathbb{E}^{Unanc}\pi)$:	0.363	0.360
$\rho(\pi_t, \pi_{t-1})$:	0.649	0.570
$\rho(R_t, R_{t-1})$:	0.882	0.950
$\rho(\hat{y}_t, \hat{y}_{t-1})$:	0.695	0.820
$\rho(e_t, e_{t-1})$:	0.867	0.890
$\mathbb{E}(\lvert\Delta p_t^i\rvert)$:	6.243	6.000

Note: The table shows the calibrated parameters used in our simulation, and the statistical moments for key variables implied by the calibration. The model-implied moments are compared with corresponding moments from the data.

nominal exchange rate is the monthly average BRL/USD foreign exchange rate.

As shown in Table 10, in the unanchored regime medium-term inflation expectations are roughly two times as volatile as in the anchored regime. Despite its extreme simplicity, the model can match reasonably well all of the moments targeted using empirically plausible parameters for the monetary policy rule and the elasticity of the production function to factor inputs.[24]

In order to interpret the empirical evidence presented in Section 4 through the lens of the model, we perform the same regression analysis on simulated data from our simple economy. We simulate 1000 artificial economies over a number of periods (156 months) that matches the size of our data sample used to estimate our panel regressions. As for the calibration, the simulated data reflect the same timing of regime switching as in our sample. From these simulated economies, we draw the paths of individual prices for 5800 firms. In each period, 30% of randomly selected firms change their prices, while the remaining fraction leaves prices unchanged, as observed in the data.

Table 11 shows the results we obtain when running the analogous regressions we apply to actual data on the artificial data generated from the model. In columns (3)-(4) we report the estimated coefficients on the data. To facilitate comparison with model simulations, these estimates include individual and time fixed effects but do not include all controls used in the baseline regression. The estimated coefficients remain consistent with our main conclusion that in the unanchored regime price respond 50% more to changes in the exchange rate. Columns (1)-(2) report mean estimates across model simulations. While not targeted in the calibration, the baseline pass-through coefficient (first line) is in line with empirical estimates. Most importantly, the simulated regressions deliver an increase in the price response to changes in the exchange rate in the unanchored regime that is quantitatively in line with the data (the coefficient in the second line). In our artificial economy the sole driving force behind the difference in the estimated price responses is the different behavior of inflation expectations over anchored and

[24]Note, the model does not match all moments perfectly because we bound the parameters according to economically plausible priors. See Appendix XX for details.

unanchored regimes. The result gives us confidence that our empirical findings are consistent with the economic mechanism presented in the paper. Implementing monetary policy regimes that maintain inflation expectations anchored to central bank long-run goals is therefore key to maintain overall price stability.

Table 11: Regressions with artificial microdata

	Model-generated data		**PPI data**	
Dependent variable: $\Delta_{\tau_i} p_{it}$	**(1)**	**(2)**	**(3)**	**(4)**
$\Delta_{\tau_i} e_t$	0.060	0.075	0.0586	0.0653
$\Delta_{\tau_i} e_t \times \mathbb{1}_t^{Unanch}$	0.024	0.025	0.0351	0.0286
$\Delta_{\tau_i} e_{t-\tau_{it}}$		0.021		0.0244
$\Delta_{\tau_i} e_{t-\tau_{it}} \times \mathbb{1}_t^{Unanch}$		0.003		0.0386
$\Delta_{\tau_i} p_{it-\tau_{it}}$	-0.119	-0.120	-0.109	-0.112
N	174,357	174,357	178,442	172,850
Individual Fixed Effects	No	No	Yes	Yes
Time-Fixed Effects	Yes	Yes	Yes	Yes
Items/Sectors Controls	No	No	No	No

Note: All coefficients estimated with actual PPI data are statistically significant at the 1% levels, or lower.

6 Conclusion

This paper demonstrates that unanchored inflation expectations significantly influence firm pricing decisions, amplifying the pass-through of exchange rate shocks. Using a unique natural experiment in Brazil, we provide both empirical evidence and theoretical validation of these dynamics. The findings offer insights for policymakers aiming to enhance the credibility of monetary policy and maintain price stability.

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Appendix

A Data

A.1 PPI Data treatment

We work at the monthly frequency. Hence, for items that are surveyed more than once per month, we choose to keep the last price quote of the items in each month. We assign missing values to outliers. We define as outliers all prices that are higher than 10 times or lower than 0.1 times the preceding price in the item's quote line. This aims at eliminating common typing errors. We further refine our sample by eliminating items with too many or too many consecutive missing prices. We drop items with more than 30% of missing prices, as well as items with more than 12 consecutive missing observations. Moreover, for each item and in each month, we assign missing values to price quotes that are above the 99.5^{th} and below the 0.5^{th} percentiles. The final sample has 14.164 items and 883.782 price quotes.

B Additional Results

B.1 Specification with exchange rate change over previous price spell

Inspired by Gopinath et al. (2010) and Gopinath and Itskhoki (2010), we estimate an alternative specification that includes the change in the exchange rate in the previous price spell and its interaction with the unanchoring dummy. Including the change in the exchange rate during the previous price spell can account for incomplete pass-through due to real rigidities in the sense of Ball and Romer (1990).

Allowing for lagged exchange-rate movements does not weaken the regime result: pass-through is higher in unanchored periods for both current- and previous-spell exchange-rate changes. Table 12 includes both current and lagged exchange rate changes. Column 1 shows that price changes from current exchange rate variation is roughly four times larger than from the previous spell. A 10% depreciation during current spell leads to a 0.42% increase in prices, while the same shock occurring in the previous spell yields a revision in prices of 0.12%. When we allow for regime-specific effects (Column 2), pass-through from lagged exchange rate changes becomes negligible during anchored periods, but rises to 0.28% when expectations are unanchored. Similarly, the impact of current depreciations increases from 0.13% in anchored regimes to 0.70% when expectations are unanchored. A more saturated specification (Column 3) confirms this pattern. These findings further underscore the role of expectations: not only do firms respond more to contemporaneous exchange rate shocks when expectations are unanchored, but they are also more likely to incorporate past movements into pricing decisions.

Table 12: Price responses to current and lagged exchange-rate changes

	$\Delta_{\tau_i} e_t$ **- Nominal Exchange Rate**		
Dependent variable: $\Delta_{\tau_i} p_{it}$	(1)	(2)	(3)
$\Delta_{\tau_i} e_t$	0.0420***	0.0128**	0.00588
	(0.00430)	(0.00650)	(0.00672)
$\Delta_{\tau_i} e_{t-\tau_{it}}$	0.0120***	-0.000287	0.00237
	(0.00348)	(0.00468)	(0.00466)
$\Delta_{\tau_i} e_t \times \mathbb{1}_t^{Unanch}$		0.0618***	0.0520***
		(0.00896)	(0.00910)
$\Delta_{\tau_i} e_{t-\tau_{it}} \times \mathbb{1}_t^{Unanch}$		0.0277***	0.0391***
		(0.00676)	(0.00669)
$\Delta_{\tau_i} p_{it-\tau_{it}}$			-0.123***
			(0.00539)
τ_{it}			0.000693***
			(0.0000888)
$\Delta_{\tau_i} Real\ ULC_t$			0.00837
			(0.00578)
$\Delta_{\tau_i} Real\ Sectoral\ cost_t$			0.00173
			(0.0107)
$Sectoral\ inventory_t$			-0.00366***
			(0.000367)
$Sectoral\ demand_t$			0.00366***
			(0.000366)
$Constant$	0.00887***	0.00886***	0.00896***
	(0.00309)	(0.00309)	(0.00327)
N	178973	178973	172850
Adjusted R^2	0.0465	0.0469	0.0638
Individual Fixed Effects	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes
Items/Sectors Controls	No	No	Yes

Note: Heteroskedasticity-robust standard errors in parentheses. Coefficients followed by ***,**, or * are statistically significant at the 1%, 5%, or 10% levels, respectively.

B.2 Degree of Unanchoring Regression

As an alternative to the binary regime classification, we also study how price-setting responses vary with the degree of unanchoring. We construct a continuous measure

$$Unanch_t \;=\; \mathbb{E}_t[\pi_{t+s}] \;-\; \pi^T_{t+s},$$

where expectations refer to inflation expectations 37–48 months ahead from Focus Survey, and π^T_{t+s} is the corresponding inflation target. Figure 2 illustrates that this measure rises sharply in the mid-2010s and peaks during the same episodes classified as unanchored in our baseline regime definition.

Table 13 re-estimates our baseline specification replacing the regime dummy with the continuous $Unanch_t$ interacted with the exchange-rate change. Column 1 replicates the baseline estimate without the interaction. Columns 2 and 3 show that the sensitivity of price changes to exchange rate movements increases with the degree of unanchoring: the interaction term $\Delta_{\tau_i} e_t \times Unanch_t$ is positive and statistically significant both without and with controls. Quantitatively, in Column 2 a 10% depreciation is associated with a 0.20% price increase when $Unanch_t = 0$ (expectations at target), and the implied response rises by about 0.11 p.p. for each one-unit increase in $Unanch_t$. In Column 3, after adding controls, the same pattern remains: the anchored-at-target response is about 0.11% for a 10% depreciation, and it increases by roughly 0.07 p.p. per unit of $Unanch_t$.

This exercise complements the binary-regime results by showing that the increase in price responses is not limited to a discrete regime switch. Instead, the exchange-rate sensitivity of price adjustments rises smoothly with the extent to which long-term inflation expectations deviate from the target.

Figure 2: **Anchored/unanchored regimes and degree of unanchoring**

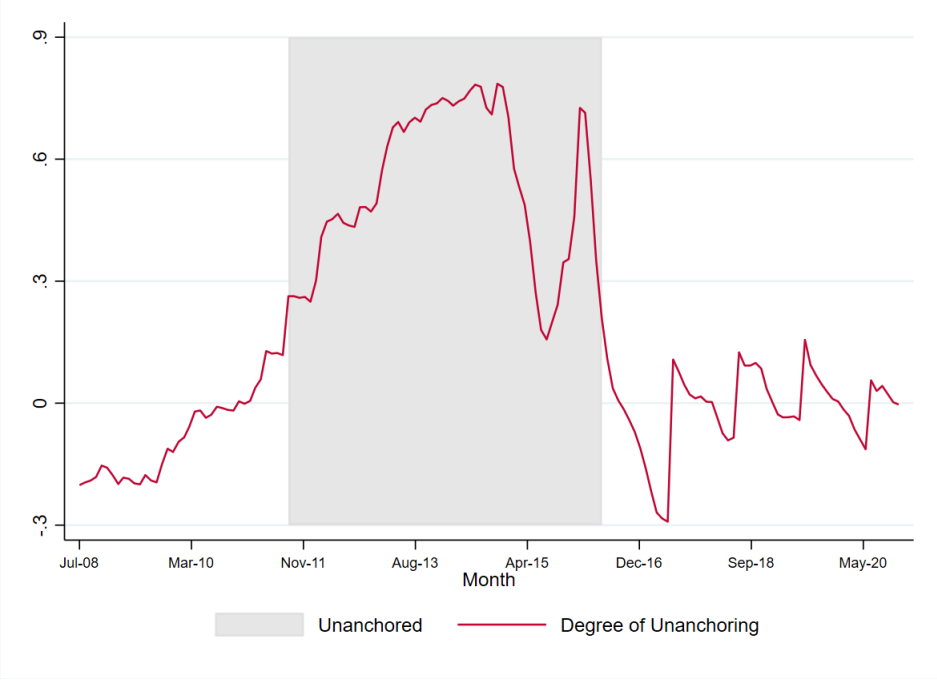


Table 13: Degree of Unanchoring Regression

	$\Delta_{\tau_i} e_t$ - **Nominal Exchange Rate**		
Dependent variable: $\Delta_{\tau_i} p_{it}$	(1)	(2)	(3)
$\Delta_{\tau_i} e_t$	0.0410***	0.0195***	0.0110**
	(0.00393)	(0.00521)	(0.00547)
$\Delta_{\tau_i} e_t \times Unanch_t$		0.109***	0.0714***
		(0.0149)	(0.0159)
$\Delta_{\tau_i} p_{it-\tau_{it}}$			-0.122***
			(0.00521)
τ_{it}			0.000617***
			(0.0000850)
$\Delta_{\tau_i} Real\ ULC_t$			0.0156***
			(0.00573)
$\Delta_{\tau_i} Real\ Sectoral\ cost_t$			0.0142
			(0.0104)
$Sectoral\ inventory_t$			-0.00352***
			(0.000365)
$Sectoral\ demand_t$			0.00414***
			(0.000369)
$Constant$	0.0435***	0.0427***	0.0335***
	(0.00245)	(0.00245)	(0.00248)
N	192502	192502	178442
Adjusted R^2	0.0492	0.0496	0.0644
Individual Fixed Effects	Yes	Yes	Yes
Time-Fixed Effects	Yes	Yes	Yes
Items/Sectors Controls	No	No	Yes

Note: Heteroskedasticity-robust standard errors in parentheses. Coefficients followed by ***,**, or * are statistically significant at the 1%, 5%, or 10% levels, respectively.

C Model Details

C.1 Households

Maximize the utility function

$$U = \mathbb{E}_0 \left\{ \sum_{t=0}^{\infty} \beta^t \left[\log\left(C_t\right) - \varphi \frac{L_t^{1+\delta}}{1+\delta} \right] \right\}$$

where $\varphi > 0, \delta \geq 0$ and where the consumption aggregator is in the Kimball form

$$\int_0^1 G\left(\frac{C_{i,t}}{C_t}\right) di = 1.$$

Individual consumption demand is given by

$$C_{i,t} = C_t G'^{-1}\left(G'\left(1\right)\frac{P_{i,t}}{P_t}\right)$$

where demand elasticity is given by

$$\theta(x) = -\frac{G'(x)}{xG''(x)} > 0, \qquad G(1) = 1.$$

The aggregate price level is defined by

$$\int_0^1 G\left(G'^{-1}\left(\frac{p_t(i)}{P_t}G'\left(1\right)\right)\right) di = 1.$$

. The household budget constraint is

$$R_t^{-1} B_t + P_t C_t = B_{t-1} + W_t L_t + \Gamma_t - T_t$$

where B_t denotes short-term government bonds in zero net supply, R_t is the policy rate, W_t is the wage, Γ_t, T_t are profits and taxes respectively. The government has a balanced budget with zero spending. Linearized first order conditions give

$$\hat{\lambda}_t = -\sigma \hat{c}_t,$$

where variables with the hat are expressed in log-deviations from their steady state. The variable $\hat{\lambda}_t$ is the marginal utility of income where in the second step we use goods market clearing conditions,

$$\hat{\lambda}_t - R_t = \mathbb{E}_t\left(\hat{\lambda}_{t+1} - \pi_{t+1}\right)$$

where π_t is the inflation rate. Labor supply is

$$\delta \hat{L}_t = \hat{w}_t - \sigma \hat{c}_t.$$

C.2 Firms

Intermediate product firms produce using labor hired in competitive markets and both domestic and foreign intermediate inputs. The cost of producing is

$$Q_{i,t} = \frac{W_t L_{i,t}}{P_t} + \frac{e_t M_{i,t}}{P_t} + I_{i,t}$$

where e_t denotes the nominal exchange rate and M_t the foreign intermediate input. The domestic inputs are labor, $L_{i,t}$, and $I_{i,t}$. The latter is a Kimball aggregator of all domestically produced goods,

$$\int_0^1 G\left(\frac{I_{i,i',t}}{I_{i,t}}\right) di' = 1.$$

$$I_{i,t} = \left[\int_0^1 I_{i,i',t}^{(\theta-1)/\theta} di\right]^{\theta/(\theta-1)},$$

inducing demand

$$I_{i,i',t} = I_{i,t} G'^{-1}\left(G'(1)\frac{P_{i',t}}{P_t}\right).$$

Firm minimize cost subject to the production function

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

where $A_{i,t}$ denotes firm-specific productivity. This process is made of an aggregate component we define below. The cost-minimization problem yields first order conditions (foc):

$$\frac{W_t}{P_t} - mc_{i,t}\alpha\eta A_{i,t} L_{i,t}^{\eta-1} I_{i,t}^{1-\eta}\left(L_{i,t}^{\eta} I_{i,t}^{1-\eta}\right)^{\alpha-1} M_{i,t}^{(1-\alpha)} = 0$$

$$\frac{e_t}{P_t} - mc_{i,t}(1-\alpha) A_{i,t}\left(L_{i,t}^{\eta} I_{i,t}^{1-\eta}\right)^{\alpha} M_{i,t}^{-\alpha} = 0$$

$$1 - mc_{i,t}\alpha(1-\eta) A_{i,t} L_{i,t}^{\eta} I_{i,t}^{-\eta}\left(L_{i,t}^{\eta} I_{i,t}^{1-\eta}\right)^{\alpha-1} M_t^{(1-\alpha)} = 0.$$

From these we determine labor demand and the marginal cost as a function of input prices. Combining the above first order conditions we get

$$mc_{i,t} = \frac{W_t}{P_t}\frac{1}{\alpha\eta A_{i,t}\left(\frac{L_{i,t}}{I_{i,t}}\right)^{-\alpha(1-\eta)}\left(\frac{W_t}{P_t}\frac{P_t}{e_t}\frac{(1-\alpha)}{\alpha\eta}\right)^{1-\alpha}}$$

where

$$\frac{W_t}{P_t} = \frac{\eta}{1-\eta}\left(\frac{I_{i,t}}{L_{i,t}}\right)$$

and finally

$$mc_{i,t} = A_{i,t}^{-1}\left(\frac{W_t}{P_t}\right)^{\alpha\eta}\left(\frac{e_t}{P_t}\right)^{1-\alpha}\left[\alpha\eta\left(\frac{1-\eta}{\eta}\right)^{\eta(1-\alpha)}\left(\frac{(1-\alpha)}{\alpha\eta}\right)^{1-\alpha}\right]^{-1}.$$

In log-linear terms we get

$$\hat{mc}_{i,t} = \alpha\eta\hat{w}_t + (1-\alpha)\,\hat{q}_t - a_{i,t}$$

where $\hat{q}_t$ denotes the real exchange rate. The exogenous productivity shock evolves according to

$$a_{i,t} = \hat{a}_t + \hat{a}_{i,t}$$

$$\hat{a}_{i,t} = \rho_a\hat{a}_{i,t-1} + \varepsilon_t^{a,i}$$

$$\hat{a}_t = \rho_A\hat{a}_{t-1} + \varepsilon_t^{A}$$

so that we can express

$$\hat{mc}_{i,t} = \alpha\eta\hat{w}_t + (1-\alpha)\,\hat{q}_t - \hat{a}_t - \hat{a}_{i,t}$$

$$= \hat{mc}_t - \hat{a}_{i,t}$$

where the aggregate marginal cost is

$$\hat{mc}_t = \alpha\hat{w}_t + (1-\alpha)\,\hat{q}_t - \hat{a}_t$$

and the wage can be expressed as

$$\hat{w}_t = \int \hat{I}_{i,t} - \int \hat{L}_{i,t}$$

$$= \hat{I}_t - \hat{L}_t.$$

Furthermore, express

$$\frac{W_t}{P_t}L_{i,t} = mc_{i,t}\alpha\eta A_{i,t}L_{i,t}^{\eta}I_{i,t}^{1-\eta}\left(\frac{M_{i,t}}{L_{i,t}^{\eta}I_{i,t}^{1-\eta}}\right)^{1-\alpha}$$

$$= mc_{i,t}\alpha\eta Y_{i,t}.$$

In log-linear terms we obtain,

$$\hat{w}_t + \hat{L}_{i,t} = \hat{mc}_{i,t} + \hat{y}_{i,t}.$$

Aggregating and substituting for the marginal cost we get

$$\begin{aligned}\int \hat{w}_t + \int \hat{L}_{i,t} &= \int m\hat{c}_{i,t} + \int \hat{y}_{i,t} \\ \hat{w}_t + \hat{L}_t &= m\hat{c}_t + \hat{y}_t \\ \hat{L}_t &= -(1-\alpha\eta)\,\hat{w}_t + (1-\alpha)\,\hat{q}_t - \hat{a}_t + \hat{y}_t.\end{aligned}$$

Using the aggregate labor supply

$$\delta \hat{L}_t = \hat{w}_t - \sigma \hat{c}_t$$

and substitute labor demand above to get

$$\hat{w}_t = \frac{\delta}{\delta(1-\alpha\eta)+1}\left[(1-\alpha)\hat{q}_t + \hat{y}_{i,t} - \hat{a}_t\right] + \frac{\sigma}{\delta(1-\alpha\eta)+1}\hat{c}_t.$$

We can then substitute for the wage in the aggregate marginal cost to get

$$m\hat{c}_{i,t} = -\hat{a}_{i,t} + \left(1 + \frac{\alpha\eta\delta}{\delta(1-\alpha\eta)+1}\right)\left((1-\alpha)\hat{q}_t - \hat{a}_t\right) + \frac{\alpha\eta}{\delta(1-\alpha\eta)+1}\left(\delta\hat{y}_t + \sigma\hat{c}_t\right).$$

Consider the equilibrium in goods markets. In log-linear terms

$$\hat{y}_t = \frac{I}{y}\hat{I}_t + \left(1 - \frac{I}{y}\right)\hat{c}_t.$$

We use the steady state relationships

$$\begin{aligned}mc &= \frac{\bar{\theta}-1}{\bar{\theta}}; \qquad \bar{\theta} = \theta(1) \\ w &= mc \times \alpha\eta\frac{Y}{L} \\ w &= \frac{\eta}{1-\eta}\frac{I}{L} \\ w &= \alpha\eta \times mc\frac{y}{I} \times \frac{I}{L}\end{aligned}$$

to obtain

$$\frac{I}{y} = \psi = \alpha\frac{\theta-1}{\theta}(1-\eta).$$

We can then use the above relationships to express

$$\hat{w}_t + \hat{L}_t = \hat{I}_t = m\hat{c}_t + \hat{y}_t.$$

We can the re-write the resource constraint as

$$\begin{aligned}\hat{y}_t &= \psi \hat{I}_t + (1-\psi)\,\hat{c}_t \\ \hat{y}_t &= \frac{\psi}{1-\psi} \hat{mc}_t + \hat{c}_t.\end{aligned}$$

The firm decision under Calvo is then

$$\mathbb{E}_t \sum_{T=t}^{\infty} \xi^{T-t} \Theta_{t,T} \left[Y_{i,t} \left(P_{i,t} - P_T mc_{i,T} \right) \right],$$

where ξ is the probability of not re-setting the price, subject to the demand constraint from both firms and households

$$\begin{aligned}Y_{i,t} &= C_{i,t} + \int_0^1 I_{i',i,t} di' \quad \forall i \\ Y_{i,t} &= Y_t G'^{-1} \left(G'(1) \frac{P_{i,t}}{P_t} \right).\end{aligned}$$

The first order conditions yield

$$\mathbb{E}_t \sum_{T=t}^{\infty} \xi^{T-t} \Theta_{t,T} Y_{i,T} \frac{P_T}{P_{i,t}} \left(\theta \left(\frac{Y_{i,T}}{Y_T} \right) - 1 \right) \left[\frac{P_{i,t}}{P_T} - \mu \left(\frac{Y_{i,T}}{Y_T} \right) mc_{i,T} \right] = 0$$

and in log-linear terms

$$\begin{aligned}\tilde{p}^r_{i,t} &= \mathbb{E}_t \sum_{T=t}^{\infty} (\xi\beta)^{T-t} \left[\frac{1-\xi\beta}{1+\bar{\theta}\epsilon_\mu} \left(\hat{mc}_T - a_{i,T} \right) + \xi\beta\pi_{T+1} \right] \\ &= -\frac{1-\xi\beta}{(1-\xi\beta\rho_a)\left(1+\bar{\theta}\epsilon_\mu\right)} a_{i,t} + \mathbb{E}_t \sum_{T=t}^{\infty} (\xi\beta)^{T-t} \left[\frac{1-\xi\beta}{1+\bar{\theta}\epsilon_\mu} \hat{mc}_T + \xi\beta\pi_{T+1} \right] \\ \hat{p}^r_{i,t} &= \tilde{p}^r_t + \hat{p}_t - \frac{1-\xi\beta}{(1-\xi\beta\rho_a)\left(1+\bar{\theta}\epsilon_\mu\right)} a_{i,t}\end{aligned}$$

where the (relative) reset price is $\tilde{p}^r_t = \hat{p}^r_t - \hat{p}_t$. Using the log-linearized price index we get

$$\tilde{p}^r_t = \frac{\xi}{1-\xi} \pi_t$$

and aggregating and quasi-differencing we get the familiar Phillips curve gives the familiar

$$\pi_t = \frac{(1-\xi)(1-\xi\beta)}{\xi\left(1+\bar{\theta}\epsilon_\mu\right)} \hat{mc}_t + \beta \mathbb{E}_t \pi_{t+1}.$$

Last we define the nominal exchange rate and firms's individual prices as follows. First, the real exchange rate is defined as

$$\hat{q}_t = \hat{e}_t + \hat{p}^f_t - \hat{p}_t$$

where $\hat{e}_t$ is the nominal exchange rate, $\hat{p}_t^f$ is the log of prices of foreign goods and $\hat{p}_t$ is the log price of domestic goods. Normalizing the price of foreign goods to $\hat{p}_t^f = 0$ and assuming the nominal exchange rate evolves according to an AR(1) process

$$\hat{e}_t = \rho_e \hat{e}_t + \varepsilon_t^e$$

the model is closed by the evolution of the nominal exchange rate and prices

$$\hat{p}_t = \pi_t + \hat{p}_{t-1}.$$

$$\hat{p}_t = \pi_t + \hat{p}_{t-1}$$

$$\hat{q}_t = \hat{e}_t - \hat{p}_t.$$

C.3 The slope of the Phillips curve

Recall the marginal cost can be expressed as

$$\begin{aligned} mc_t &= \left(\frac{\delta+1}{\delta(1-\alpha\eta)+1}\right)((1-\alpha)\hat{q}_t - \hat{a}_t) + \frac{\alpha\eta}{\delta(1-\alpha\eta)+1}(\delta\hat{y}_t + \sigma\hat{c}_t) \\ &= ((1-\alpha)\hat{q}_t - \hat{a}_t) + \alpha\eta\sigma\hat{c}_t \end{aligned}$$

where in the last row we assume infinite labor supply elasticity: $\delta = 0$. Now substitute

$$\hat{y}_t = \frac{\psi}{1-\psi}\hat{mc}_t + \hat{c}_t$$

to get

$$\begin{aligned} mc_t &= ((1-\alpha)\hat{q}_t - \hat{a}_t) + \alpha\eta\sigma\left(\hat{y}_t - \frac{\psi}{1-\psi}\hat{mc}_t\right) \\ &= \frac{(1-\alpha)\hat{q}_t - \hat{a}_t}{1+\alpha\eta\sigma\frac{\psi}{1-\psi}} + \frac{\alpha\eta}{1+\alpha\eta\frac{\psi}{1-\psi}}\hat{y}_t \end{aligned}$$

So the Phillips curve becomes

$$\pi_t = \frac{(1-\xi)(1-\xi\beta)}{\xi\left(1+\bar{\theta}\epsilon_\mu\right)}\zeta\left[(1-\alpha)\hat{q}_t - \hat{a}_t + \alpha\eta\hat{y}_t\right] + \beta\mathbb{E}_t\pi_{t+1}$$

where

$$\zeta = \frac{1}{1+\alpha\eta\frac{\psi}{1-\psi}}$$

captures the degree of real rigidities associated to intermediate inputs.

C.4 Monetary policy

Central bank follows the usual Taylor rule

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

where π_t^* is a low frequency drift in policy objectives. The 'monetary policy shock' ε_t^R is 'weakly' correlated with the innovation in the exchange rate, reflecting the central bank accommodating exchnage rate changes, so that

$$\sigma^R \varepsilon_t^R = \sigma^m \varepsilon_t^m - \tau_e \sigma^e \varepsilon_t^e$$

where and ε_t^m is an independent normally distributed monetary policy shock.

C.5 Imperfect information and anchoring

Agents cannot separately identify ε_t^R and π_t^* . Importantly, agents are boundedly rational in one dimension: they ignore the correlation between the exchange rate innovation and the monetary policy surprises. The assumption links exchange rate innovation to long-term inflation expectations' revisions. Since the innovation to the exchange rate is perfectly observed, it the agents know of the link between monetary policy and exchange rate innovations, then their estimate of the inflation target would be independent of the exchange rate.

Agent use the Kalman filter to estimate the current π_t^*. Write the agents' estimates of the unobserved processes is

$$\begin{aligned} \pi_{t|t}^* &= \pi_{t|t-1}^* + \bar{g}\left(\tilde{\pi}_t - \pi_{t|t-1}^*\right) \\ \varepsilon_{t|t}^R &= -\frac{(1-\bar{g})}{\sigma^R}\left(\tilde{\pi}_t - \pi_{t|t-1}^*\right) \end{aligned}$$

where

$$\begin{aligned} \sigma^R &= \sqrt{\left(\sigma^m\right)^2 + \left(\tau_e \sigma^e\right)^2} \\ \tilde{\pi}_t &= \pi_t^* - \frac{1}{(1-\rho)\,\phi_\pi} \sigma^R \varepsilon_t^R. \end{aligned}$$

The Kalman gain is obtained as

$$\bar{g} = \frac{-\left(1-\rho_{\pi^*}^2\right) + \sqrt{\left(1-\rho_{\pi^*}^2\right)^2 + 4\rho_{\pi^*}^2 s_n^2}}{2\rho_{\pi^*}^2}$$

where

$$s_n \quad = \quad (1-\rho)\,\phi_\pi \frac{\sigma^{\pi^*}}{\sigma^R}$$

defines the signal-to-noise ration that agents face. In the anchored regime agents signal-to- ratio is model consistent. In the unanchored regime the *perceived* volatility of the inflation target increases to $\tilde{\sigma}^{\pi^*} > \sigma^{\pi^*}$ so that $\bar{g}^{\text{unc}} > \bar{g}^{\text{anc}}$.

In both regimes, the forecast is then

$$\pi^*_{t+1|t} \quad = \quad \rho_{\pi_*}\pi^*_{t|t}$$

Importantly, we can re-write the policy rule in terms of the estimated unobserved processes, that

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

C.6 Summary of Equations

$$\hat{c}_t = E_t\hat{c}_{t+1} - \mathbb{E}_t\left(R_t - \pi_{t+1}\right) \tag{9}$$

$$\hat{mc}_t = \frac{(1-\alpha)\hat{q}_t - \hat{a}_t}{1+\alpha\eta\sigma\frac{\psi}{1-\psi}} + \frac{\alpha\eta}{1+\alpha\eta\frac{\psi}{1-\psi}}\hat{y}_t \tag{10}$$

$$\hat{y}_t = \frac{\psi}{1-\psi}\hat{mc}_t + \hat{c}_t \tag{11}$$

$$\pi_t = \frac{(1-\xi)(1-\xi\beta)}{\xi\left(1+\bar{\theta}\epsilon_\mu\right)}\zeta\left[(1-\alpha)\hat{q}_t - \hat{a}_t + \alpha\eta\hat{y}_t\right] + \beta\mathbb{E}_t\pi_{t+1} \tag{12}$$

$$\tilde{p}^r_t = \frac{(1-\xi)(1-\xi\beta)}{\left(1+\bar{\theta}\epsilon_\mu\right)}\hat{mc}_t + \xi\beta\hat{E}_t\pi_{t+1} + \xi\beta\hat{E}_t\tilde{p}^r_{t+1} \tag{13}$$

$$R_t = \rho R_{t-1} + (1-\rho)\left[\phi_\pi\left(\pi_t - \pi^*_{t|t}\right) + \phi_y\hat{y}_t\right] + \sigma^R\varepsilon^R_{t|t} \tag{14}$$

$$\pi^*_{t+1|t} = \rho_{\pi_*}\pi^*_{t|t} \tag{15}$$

$$\varepsilon^R_{t+1|t} = 0 \tag{16}$$

$$\hat{e}_t = \rho_e\hat{e}_{t-1} + \varepsilon^e_t \tag{17}$$

$$\pi^*_t = \rho_{\pi_*}\pi^*_{t-1} + \sigma^{\pi^*}\varepsilon^*_t \tag{18}$$

$$\pi^*_{t|t} = \pi^*_{t|t-1} + \bar{g}\left(\tilde{\pi}_t - \pi^*_{t|t-1}\right) \tag{19}$$

$$\tilde{\pi}_t = \pi_t^* - \frac{1}{(1-\rho)\,\phi_\pi}\sigma^R \varepsilon_t^R \tag{20}$$

$$\varepsilon_{t|t}^R = -\frac{(1-\bar{g})}{\sigma^R}\left(\tilde{\pi}_t - \pi_{t|t-1}^*\right) \tag{21}$$

$$\hat{p}_t = \pi_t + \hat{p}_{t-1} \tag{22}$$

$$\hat{q}_t = \hat{e}_t - \hat{p}_t \tag{23}$$

$$\hat{a}_t = \rho_A \hat{a}_{t-1} + \varepsilon_t^A \tag{24}$$

$$\hat{p}_{i,t}^r = \tilde{p}_t^r + \hat{p}_t - \frac{1-\xi\beta}{(1-\xi\beta\rho_a)\left(1+\bar{\theta}\epsilon_\mu\right)} a_{i,t} \tag{25}$$

$$\hat{a}_{i,t} = \rho_a \hat{a}_{i,t-1} + \varepsilon_t^{a,i} \tag{26}$$

We have 18 equations in 18 variables: 1-2. $\zeta_{t+1|t} = \left(\pi_{t+1|t}^*, \varepsilon_{t+1|t}^m\right)'$; 3. $\hat{c}_t$; 4. R_t; 5. $\hat{mc}_t$; 6. $\hat{e}_t$; 7. $\hat{y}_t$; 8. π_t; 9. $\hat{p}_t^r$; 10. $\hat{p}_t$; 11. $\hat{q}_t$; 12. $\hat{\pi}_t^*$; 13. $\hat{\pi}_{t|t}^*$; 14. $\tilde{\pi}_t$; 15. $\varepsilon_{m,t|t}$; 16. $\hat{a}_t$; 17. $\hat{a}_{i,t}$; 18. $\hat{p}_{i,t}^r$.

C.7 Model solution (aggregate economy)

Define the state space as

$$A \begin{bmatrix} z_{t+1}^J \\ z_{t+1}^S \\ \zeta_{t+1|t} \end{bmatrix} = B \begin{bmatrix} z_t^J \\ z_t^S \\ \zeta_{t|t} \end{bmatrix} + C\varepsilon_t$$

where

$$z_t^J = \begin{bmatrix} \hat{c}_t \\ \hat{p}_t^r \\ \hat{y}_t \\ \pi_t \\ \hat{q}_t \\ \hat{mc}_t \end{bmatrix}$$

are jump variables

$$z_t^S = \begin{bmatrix} R_{t-1} \\ \hat{p}_{t-1} \\ \hat{e}_{t-1} \\ \hat{a}_{t-1} \end{bmatrix}$$

and the innovations that are observed

$$\varepsilon_t = \begin{bmatrix} \varepsilon_t^A \\ \varepsilon_t^e \end{bmatrix}$$

are predetermined observable (to the agents) variables and ζ_t are the unobserved variables. The solution yields

$$\begin{aligned} z_t^J &= D\begin{bmatrix} z_t^S \\ \zeta_{t|t} \end{bmatrix} + F\varepsilon_t \\ \begin{bmatrix} z_{t+1}^S \\ \zeta_{t+1|t} \end{bmatrix} &= G\begin{bmatrix} z_t^S \\ \zeta_{t|t} \end{bmatrix} + H\varepsilon_t. \end{aligned}$$

To this we add the evolution of the estimate

$$\zeta_{t|t} = \begin{bmatrix} \pi_{t|t}^* \\ \varepsilon_{m,t|t} \end{bmatrix}.$$

We can then express:

$$\begin{bmatrix} \zeta_{t|t} \\ \pi_t^* \end{bmatrix} = N\begin{bmatrix} \zeta_{t|t-1} \\ \pi_{t-1}^* \end{bmatrix} + O\begin{bmatrix} \epsilon_{R,t} \\ \varepsilon_t^* \\ \varepsilon_t^e \end{bmatrix}$$

$$\begin{aligned} z_t^J &= D\begin{bmatrix} z_t^S \\ \zeta_{t|t} \end{bmatrix} + F\varepsilon_t \\ \begin{bmatrix} z_{t+1}^S \\ \zeta_{t+1|t} \end{bmatrix} &= G\begin{bmatrix} z_t^S \\ \zeta_{t|t} \end{bmatrix} + H\varepsilon_t. \end{aligned}$$

In addition to simulating these variables we need to compute agents' inflation expectations at differnt horizons. We then add

$$\begin{aligned} E_t z_{t+1}^J &= DE_t\begin{bmatrix} z_{t+1}^S \\ \zeta_{t+1|t} \end{bmatrix} \\ E_t z_{t+n}^J &= DG^{n-1}\begin{bmatrix} z_{t+1}^S \\ \zeta_{t+1|t} \end{bmatrix}. \end{aligned}$$

Now, to compute the average yearly inflation three years out we need

$$\frac{1}{12}\sum_{i=25}^{36} E_t z_{t+i}^J = \frac{1}{12}D\left(\sum_{i=25}^{36} G^{i-1}\right)\begin{bmatrix} z_{t+1}^S \\ \zeta_{t+1|t} \end{bmatrix}.$$

We can use

$$\begin{aligned} \sum_{i=25}^{36} G^{i-1} &= \frac{1}{12}(I-G)^{-1}\left(I-G^{36}\right) - \frac{1}{12}(I-G)^{-1}\left(I-G^{24}\right) \\ &= \frac{1}{12}(I-G)^{-1}\left(G^{24}-G^{36}\right) \\ &= \frac{1}{12}(I-G)^{-1}\left(I-G^{12}\right)G^{24}. \end{aligned}$$

In the new version we have

$$\begin{aligned}\sum_{i=37}^{48} G^{i-1} &= \frac{1}{12}(I-G)^{-1}\left(I-G^{48}\right)-\frac{1}{12}(I-G)^{-1}\left(I-G^{36}\right)\\ &= \frac{1}{12}(I-G)^{-1}\left(G^{36}-G^{48}\right)\\ &= \frac{1}{12}(I-G)^{-1}\left(I-G^{12}\right)G^{36}.\end{aligned}$$

Given the solution from the aggregate economy it is then straightforward to simulate individual price decision using

$$\hat{p}^r_{i,t} = \tilde{p}^r_t + \hat{p}_t - \frac{1-\xi\beta}{1-\xi\beta\rho_a}a_{i,t}.$$

D Calibration Details

The foreign input share $(1 - \alpha)$ is obtained from the 2015 Brazilian Input–Output Table published by IBGE. Specifically, we sum across all manufacturing sectors the total value of imported intermediate consumption and divide this by total intermediate consumption. This yields a foreign input share of 16.4%.

The domestic input share, excluding labor, is calculated using data from IBGE's Pesquisa Industrial Anual (PIA) for 2015. We first subtract labor expenses from total intermediate consumption to obtain total spending on intermediate inputs. We then divide this value by total intermediate consumption to obtain the domestic input share (η) of 78%.

E Results for Expectation Changes and FX

E.1 Changes over expectation spells

Tables 14 and 15 relate changes in inflation expectations over an expectations spell to exchange-rate movements in the same horizon, separately for anchored and unanchored regimes. In anchored periods, coefficients are small and generally negative across horizons, implying economically negligible downward revisions; the negative sign is also consistent with a mean-reverting component of expectations over the spell. When expectations are unanchored, the corresponding effects are positive and statistically significant for most horizons, with higher magnitudes, implying upward revisions in expected inflation following depreciations. Results are qualitatively similar when using the AR(1) nominal exchange residuals (Table 14) or the cumulative change in the exchange rate (Table 15).

Table 14: Inflation expectation changes over the spell and FX shocks (AR(1) residual): anchored vs unanchored

	1y	2y	3y	4y	12–24	24–36	36–48
Anchored effect	-0.00318	-0.00316**	-0.00237**	-0.00870***	-0.00395*	-0.00282**	-0.00389**
	(0.00430)	(0.00132)	(0.00118)	(0.00309)	(0.00210)	(0.00109)	(0.00183)
Unanchored effect	0.0327***	0.0118**	0.00645*	0.00575	0.0217***	0.0108**	0.00995**
	(0.0101)	(0.00534)	(0.00382)	(0.00524)	(0.00705)	(0.00497)	(0.00485)
N	237,980	207,338	188,370	142,073	206,604	187,949	142,060
Adjusted R^2	-0.000186	-0.000252	-0.000299	-0.000438	-0.000157	-0.000215	-0.000354

Standard errors in parentheses. Significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Unanchored effect equals anchored coefficient plus the interaction term.

Table 15: Inflation expectation and FX changes over the spell: anchored vs unanchored

	1y	2y	3y	4y	12–24	24–36	36–48
Anchored effect	-0.00850*	-0.00477***	-0.00408***	-0.0142***	-0.00502*	-0.00378***	-0.00689***
	(0.00513)	(0.00143)	(0.00145)	(0.00456)	(0.00256)	(0.00134)	(0.00249)
Unanchored effect	0.0311***	0.0108**	0.00682**	0.00692	0.0200***	0.0103**	0.00945**
	(0.00941)	(0.00457)	(0.00337)	(0.00488)	(0.00608)	(0.00421)	(0.00434)
N	237,980	207,338	188,370	142,073	206,604	187,949	142,060
Adjusted R^2	-0.000161	-0.000203	-0.000222	-0.000109	-0.000134	-0.000163	-0.000230

Standard errors in parentheses. Significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Unanchored effect equals anchored coefficient plus the interaction term.

E.2 Changes between Focus contest dates

Tables 16 and 17 report regressions of inflation-expectation revisions computed between Focus survey *contest dates* on exchange-rate changes, split by anchoring regime. Surveyed institutions have stronger incentives to update their forecasts in Focus platform around those day[25]. In anchored periods, estimates are generally close to zero and imprecisely estimated across horizons, with large standard errors and few statistically significant coefficients (the main exception is a positive estimate at the 24–36 month horizon in the FX-shock specification, significant at the 10% level). In unanchored periods, coefficients are positive across all horizons and statistically significant for the longer horizons (notably 3y, 4y, and 36–48), indicating that depreciations between reference dates are associated with upward revisions in expected inflation. Results are similar when using AR(1) FX-shock residuals (Table 16) or the cumulative exchange-rate change (Table 17).

Table 16: Expectations changes between Focus contest dates and FX shocks (AR residual): anchored vs unanchored

	1y	2y	3y	4y	12–24	24–36	36–48
Anchored effect	-0.0527	0.118	0.0755	0.0357	0.0271	0.141*	0.0530
	(0.259)	(0.0821)	(0.0749)	(0.0651)	(0.195)	(0.0845)	(0.0664)
Unanchored effect	0.383	0.472	0.425**	0.392**	0.268	0.393	0.437**
	(0.743)	(0.304)	(0.202)	(0.165)	(0.669)	(0.263)	(0.189)
N	10835	9410	8570	6407	9360	8536	6405
Adjusted R^2	-0.00870	-0.00645	-0.00430	-0.00853	-0.00883	-0.00630	-0.00623

Standard errors in parentheses. Significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Unanchored effect equals anchored coefficient plus the interaction term.

Table 17: Expectations changes between Focus contest dates and FX changes: anchored vs unanchored

	1y	2y	3y	4y	12–24	24–36	36–48
Anchored effect	-0.0712	0.104	0.0639	0.0283	0.0188	0.128	0.0458
	(0.252)	(0.0783)	(0.0714)	(0.0629)	(0.189)	(0.0804)	(0.0636)
Unanchored effect	0.396	0.477	0.430**	0.393**	0.265	0.397	0.438**
	(0.735)	(0.295)	(0.197)	(0.162)	(0.665)	(0.255)	(0.186)
N	10835	9410	8570	6407	9360	8536	6405
Adjusted R^2	-0.00851	-0.00629	-0.00408	-0.00838	-0.00883	-0.00621	-0.00605

Standard errors in parentheses. Significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Unanchored effect equals anchored coefficient plus the interaction term.

[25] Accredited institutions can update their forecasts at any time through the BCB's "Market Expectation System," and the BCB compiles these forecasts every working day. Forecast updates are not mandatory, but the BCB provides incentives for participating institutions to update frequently. One example is the "contest dates", these are days on which forecasts are collected to be compared to realized outcomes upon release, and it then publishes a ranking with the five most accurate forecasting institutions based on absolute forecast error. Second, every Monday the BCB publishes the "Focus Market Readout" summarizing forecasts, restricting the sample to forecasts updated within the previous 30 days. Finally, institutions that do not update their forecasts within six months are excluded from the survey and must file a formal request to resume participation. These features imply stronger incentives for surveyed institutions to update their Focus forecasts around the contest (reference) dates used to define the expectation changes in this appendix (**?**).

F Product codes, description and matching codes

Table 18: **Input-Output Matrix: sector codes and description**

Code	Input-Output Matrix Description
1091	Slaughter and meat products, including dairy and fish products
1092	Manufacture and cane sugar refining products
1093	Manufacture of other food products
1100	Manufacture of beverages
1200	Manufacture of tobacco products
1300	Manufacture of textiles products
1400	Manufacture of wearing apparel and accessories
1500	Manufacture of footwear and leather products
1600	Manufacture of wood products
1700	Manufacture of pulp, paper and paper products
1800	Printing and reproduction of recorded media
1991	Manufacture of coke and refined petroleum products
1992	Manufacture of biofuel products
2091	Manufacture of organic and inorganic chemicals, resins and elastomers
2092	Manufacture of Pesticides, Disinfectants, Various Paints and Chemicals
2093	Manufacture of cleaning products, cosmetics/perfumery and personal hygiene
2100	Manufacture of basic pharmaceutical products and pharmaceutical
2200	Manufacture of rubber and plastic products
2300	Manufacture of non-metallic mineral products
2491	Manufacture of pig iron/ferroalloys, steel and seamless steel tubes
2492	Metallurgy of non-ferrous metals and metal smelting
2500	Manufacture of fabricated metal products, except machinery and equipment
2600	Manufacture of computer, electronic and optical products
2700	Manufacture of electrical equipment
2800	Manufacture of machinery and equipment n.e.c.
2991	Manufacture of automobiles, trucks and buses, except their components parts
2992	Manufacture of parts and accessories for motor vehicles
3000	Manufacture of other transport equipment, except motor vehicles
3180	Manufacture of furniture; other manufacturing
3300	Repair and installation of machinery and equipment

Source: Brazilian Institute of Geography and Statistics (IBGE).

Table 19: **Survey of Industry Conditions: sector codes and description**

Code	Survey Description
101	Slaughter and meat products, including dairy and fish products
104	Manufacture of vegetable and animal fats and oils
105	Manufacture of dairy products
106	Milling, manufacture of starchy products and animal feed
107	Manufacture and cane sugar refining products
100A	Manufacture of other food products
111	Manufacture of alcoholic beverages
112	Manufacture of non-alcoholic beverages
12	Manufacture of tobacco products
13	Manufacture of textiles products
14	Manufacture of wearing apparel and accessories
150A	Manufacture of leather
150B	Manufacture of footwear
16	Manufacture of wood products
171	Manufacture of pulp and pulp for papermaking
172	Manufacture of paper and cardboard
173	Manufacture of paper packaging
174	Manufacture of various paper products
18	Printing and reproduction of recorded media
190A	Manufacture of coke and refined petroleum products
190B	Manufacture of biofuel products
201	Manufacture of inorganic chemicals
202	Manufacture of organic chemicals
203	Manufacture of resins and elastomers
205	Manufacture of Pesticides and Disinfectants,
207	Manufacture of paints, varnishes, enamels, lacquers and related products
200A	Other unspecified chemicals
20B	Manufacture of soaps, detergents, cleaning products, cosmetics, perfumery products
21	Manufacture of pharmaceuticals
22A	Manufacture of rubber products
22B	Manufacture of plastic products
231	Manufacture of glass and glass products
232	Manufacture of cement
233	Manufacture of concrete, cement, fiber cement, plaster and similar materials
234	Manufacture of ceramic products
239	Stone rigging and manufacture of other non-metallic mineral products
244	Metallurgy of non-ferrous metals
240A	Steel industry
240B	Other basic metallurgy products
251	Manufacture of metal structures and heavy boiler works
253	Forging, stamping, powder metallurgy and metalworking services
254	Manufacture of Cutlery, Hand Tools and General Hardware
250A	Manufacture of other fabricated metal products
262	Manufacture of computer equipment and peripherals
263	Manufacture of communication equipment
264	Manufacture of audio and video reception, reproduction, recording and amplification apparatus
260A	Others - electronic material, communication, information technology and optical devices and equipment
271	Manufacture of generators, transformers and electric motors
273	Manufacture of equipment for distribution networks and electricity contro
275	Manufacture of home appliance
270A	Manufacture of other electrical equipment and appliances
281	Manufacture of engines, pumps, compressors and transmission equipment
282	Manufacture of machinery and equipment n.e.c.
283	Manufacture of electrical equipment
285	Manufacture of machinery and equipment for use in mineral extraction and construction
280A	Manufactured of other machines and equipment
291	Manufacture of automobiles, vans and utilities
292	Manufacture of trucks and buses
294	Manufacture of parts and accessories for motor vehicles
290A	Manufacture of other motor vehicles
301	Boat Building
304	Aircraft manufacturing
300A	Manufacture of other transport equipment, except motor vehicles
31	Manufacture of Furniture and Related Products
32	Manufacture of other manufacturing products

Source: Survey of Industrial Conditions - IBRE-FGV.

Table 20: **List of codes correspondence: CNAE - PPI; Survey of Industry Conditions (S) and Input-Output Matrix (IOM)**

CNAE	S	IOM	CNAE	S	IOM	CNAE	S	IOM	CNAE	S	IOM
10101	101	1091	15303	150B	1500	21202	21	2100	26204	262	2600
10102	101	1091	15304	150B	1500	22101	22A	2200	26301	263	2600
10103	101	1091	15401	150B	1500	22102	22A	2200	26302	263	2600
10104	101	1091	16101	16	1600	22103	22A	2200	26303	263	2600
10105	101	1091	16201	16	1600	22104	22A	2200	26304	263	2600
10201	101	1091	16202	16	1600	22105	22A	2200	26305	263	2600
10301	100A	1093	16203	16	1600	22106	22A	2200	26401	264	2600
10302	100A	1093	16204	16	1600	22201	22B	2200	26402	264	2600
10303	100A	1093	16205	16	1600	22202	22B	2200	26403	264	2600
10304	100A	1093	16206	16	1600	22203	22B	2200	26501	260A	2600
10305	100A	1093	17101	171	1700	22204	22B	2200	27101	271	2700
10306	100A	1093	17201	172	1800	22205	22B	2200	27102	271	2700
10401	104	1093	17202	172	1700	22206	22B	2200	27103	271	2700
10402	104	1093	17203	172	1700	22207	22B	2200	27104	271	2700
10403	104	1093	17301	173	1700	22208	22B	2200	27201	270A	2700
10404	104	1093	17302	173	1700	22209	22B	2200	27301	273	2700
10405	104	1093	17303	173	1700	22210	22B	2200	27302	273	2700
10406	104	1093	17401	174	1700	22211	22B	2200	27303	273	2700
10501	105	1091	17402	174	1700	22212	22B	2200	27401	270A	2700
10502	105	1091	17403	174	1700	22213	22B	2200	27501	275	2700
10503	105	1091	17404	174	1700	23101	231	2300	27502	275	2700
10504	105	1091	19201	190A	1991	23102	231	2300	27503	275	2700
10505	105	1091	19202	190A	1991	23103	231	2300	27504	275	2700
10506	105	1091	19203	190A	1991	23104	231	2300	27505	275	2700
10507	105	1091	19204	190A	1991	23201	232	2300	27901	270A	2700
10508	105	1091	19205	190A	1991	23301	233	2300	28101	281	2800
10509	105	1091	19206	190A	1991	23302	233	2300	28102	281	2800
10601	106	1093	19207	190A	1991	23303	233	2300	28103	281	2800
10602	106	1093	19208	190A	1991	23304	233	2300	28104	281	2800
10603	106	1093	19301	190B	1992	23401	234	2300	28105	281	2800
10604	106	1093	19302	190B	1992	23402	234	2300	28106	281	2800
10605	106	1093	19303	190B	1992	23403	234	2300	28107	281	2800
10606	106	1093	20101	201	2091	23404	234	2300	28201	282	2800
10701	107	1092	20102	201	2091	23405	234	2300	28202	282	2800
10702	107	1092	20103	201	2091	23901	239	2300	28203	282	2800
10703	107	1092	20104	201	2091	23902	239	2300	28204	282	2800
10801	100A	1093	20105	201	2091	23903	239	2300	28205	282	2800
10802	100A	1093	20106	201	2091	23904	239	2300	28206	282	2800
10901	100A	1093	20107	201	2091	24101	240B	2491	28207	282	2800
10902	100A	1093	20108	201	2091	24102	240B	2491	28301	283	2800
10903	100A	1093	20109	201	2091	24201	240A	2491	28302	283	2800
10904	100A	1093	20110	201	2091	24202	240A	2491	28303	283	2800
10905	100A	1093	20201	202	2091	24203	240A	2491	28304	283	2800
10906	100A	1093	20202	202	2091	24204	240A	2491	28401	280A	2800
10907	100A	1093	20203	202	2091	24205	240A	2491	28501	285	2800
10908	100A	1093	20204	202	2091	24206	240A	2491	28502	285	2800
11101	111	1100	20205	202	2091	24207	240A	2491	28503	285	2800
11102	111	1100	20206	202	2091	24208	240A	2491	28601	280A	2800
11103	111	1100	20207	202	2091	24209	240A	2491	28602	280A	2800
11104	111	1100	20301	203	2091	24210	240A	2491	28603	280A	2800
11201	112	1100	20302	203	2091	24211	240A	2491	29101	291	2991
11202	112	1100	20303	203	2091	24301	240B	2491	29102	291	2991
11203	112	1100	20304	203	2091	24302	240B	2491	29103	291	2991
12101	12	1200	20305	203	2091	24401	244	2492	29201	292	2991
12201	12	1200	20306	203	2091	24402	244	2492	29202	292	2991
13101	13	1300	20307	203	2091	24403	244	2492	29203	292	2991
13102	13	1300	20401	200A	2091	24404	244	2492	29204	292	2991
13201	13	1300	20501	205	2092	24405	244	2492	29301	292	2991
13202	13	1300	20502	205	2092	24406	244	2492	29302	292	2991
13301	13	1300	20503	205	2092	24407	244	2492	29401	294	2992
13501	13	1300	20504	205	2092	24408	244	2492	29402	294	2992
13502	13	1300	20505	205	2092	24501	251	2492	29403	294	2992
13503	13	1300	20601	20B	2093	25101	251	2500	29404	294	2992
13504	13	1300	20602	20B	2093	25102	251	2500	29405	294	2992
14101	14	1400	20603	20B	2093	25201	251	2500	29406	294	2992
14102	14	1400	20604	20B	2093	25301	253	2500	30901	290A	3000
14103	14	1400	20605	20B	2093	25401	254	2500	30902	290A	3000
14104	14	1400	20606	20B	2093	25402	254	2500	30903	290A	3000
14105	14	1400	20701	207	2093	25403	254	2500	31101	31	3180
14106	14	1400	20702	207	2093	25901	250A	2500	31102	31	3180
14107	14	1400	20703	207	2093	25902	250A	2500	31103	31	3180
14108	14	1400	20704	207	2093	25903	250A	2500	31104	31	3180
14201	14	1400	20901	200A	2092	25904	250A	2500	31105	31	3180
15101	150A	1500	20902	200A	2092	25905	250A	2500	31106	31	3180
15102	150A	1500	20903	200A	2092	26101	262	2600	31107	31	3180
15201	150A	1500	20904	200A	2092	26201	262	2600	31108	31	3180
15301	150B	1500	20905	200A	2092	26202	262	2600			
15302	150B	1500	21201	21	2100	26203	262	2600			

The PPI code (CNAE) in the survey has 9-digits, but for all products from the Manufacturing Industries the four initial code is the same: 2022. For instance, for the CNAE 10101 the complete code is 202210101. Sources: IBRE-FGV and Brazilian Institute of Geography and Statistics (IBGE).