# Price Setting when Expectations are Unanchored

Daniel Abib
University of Western Ontario

João Ayres
IADB

Marco Bonomo
INSPER

Carlos Carvalho
Kapitalo Investimentos and PUC-Rio

Stefano Eusepi
Brown University

Silvia Matos
IBRE-FGV and EPGE-FGV

Marina Perrupato
UCSD

2024 Bank of Canada Annual Economic Conference

# Motivation: in the Words of Bernanke (2007)

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

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

# Motivation: in the Words of Bernanke (2007)

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

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

First-order implications for policy in our models but...

# Motivation: in the Words of Bernanke (2007)

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

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

First-order implications for policy in our models but...

...What is the impact of expectations unanchoring on observed firms' pricing decisions?

> *..."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."*

# This Paper

Look at Brazilian economy: why?

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

We find

– Significant increase in prices' response to exchange rate "shocks" in the unanchored regime

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

# De-Anchoring and Firm Pricing: Illustration

1. Pricing decision (individual firm). Optimal price under Calvo ($\xi$ 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

2. Inflation expectations. Depend only on *perceived* CB inflation target $\pi^*_{t|t}$ $[\mathbb{E}_t\,(\text{Shocks}_{t+1}) = 0]$)

**Expectations formation**. (Carvalho et al., 2023). Here simple extrapolation, for $j > 0$

$$\mathbb{E}_t \pi_{t+j} = \begin{cases} \pi^*_{t|t} \approx \pi^*_t = 0, & \text{Anchored} \\ \pi^*_{t|t} = \pi^*_{t|t-1} + \bar{g}\left(\pi_t - \pi^*_{t|t-1}\right), \quad \bar{g} >> 0 & \text{Unanchored} \end{cases}$$

$\Longrightarrow$ Shocks to inflation (e.g. from exchange rate movements) affect long-run expectations

# De-Anchoring and Firm Pricing: Illustration

1. Pricing decision (individual firm). Optimal price under Calvo ($\xi$ 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

2. Inflation expectations. Depend only on *perceived* CB inflation target $\pi^*_{t|t}$ [$\mathbb{E}_t\,(\text{Shocks}_{t+1}) = 0$])

**Pricing response to inflation shocks** ($\varepsilon_t$) Given same path for expected real marginal cost

$$p_t^{Unc} - p_t^{Anc} = \frac{\xi\beta}{1-\xi\beta}\left(\pi_t - \pi^*_{t|t-1}\right) = \frac{\xi\beta}{1-\xi\beta}\bar{g} \times \varepsilon_t$$

$\Longrightarrow$ firms with unanchored expectation respond with a larger price change

$\Longrightarrow$ firms with higher gain ($\bar{g}$) and price duration ($\xi$) should respond more

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

1. Long-run Inflation expectations: $\mathbb{E}_t \pi_{t+j}$. Focus Survey Details
   - High frequency (daily) survey: de-anchoring and re-anchoring of expectations (Bonomo et al, 2024)
   - Sample period alternates between "anchored" and "unanchored" regimes

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

1. Long-run Inflation expectations: $\mathbb{E}_t \pi_{t+j}$. Focus Survey Details
    - High frequency (daily) survey: de-anchoring and re-anchoring of expectations (Bonomo et al, 2024)
    - Sample period alternates between "anchored" and "unanchored" regimes
2. 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
    - New BCB survey of firms' forecasts: $\approx 80\%$ of firms look at Focus Survey to form expectations...

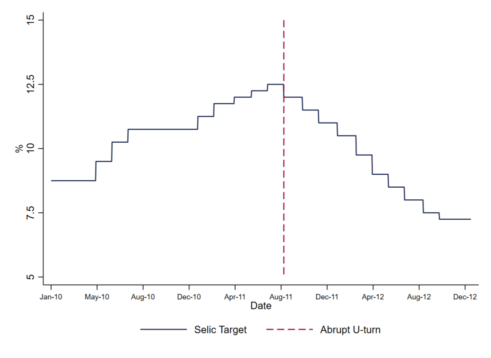
# De-Anchoring and Firm Pricing: Brazilian Data (July 2008 to Dec. 2020)

1. Long-run Inflation expectations: $\mathbb{E}_t \pi_{t+j}$. Focus Survey Details
   - High frequency (daily) survey: de-anchoring and re-anchoring of expectations (Bonomo et al, 2024)
   - Sample period alternates between "anchored" and "unanchored" regimes
2. 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
   - New BCB survey of firms' forecasts: $\approx 80\%$ of firms look at Focus Survey to form expectations...
3. The shock: $\varepsilon_t$. Exchange rate. Need *sizable* and *observable* "shock"
   - Follow international literature (Gopinath and Itskhoki, 2010)
   - Viewed as exogenous shifts to firms' costs: instrumental variable approach

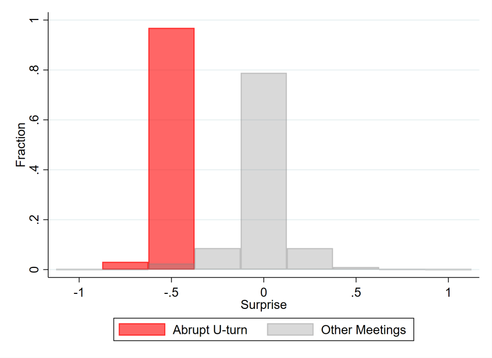
# Monetary Policy U-Turn

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

(a) *Policy reversal*




(b) *Large market surprise*




Bonomo et al (2024): ⇒ de-anchoring of long-term inflation expectations Details

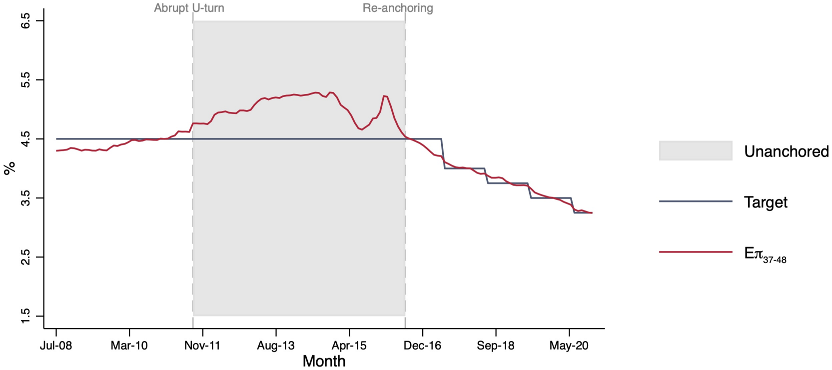
# Long-Run Inflation Expectations in the Unanchored Regime

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

$\Longrightarrow$ Long-run inflation expectations respond to economic shocks: $\pi^*_{t|t} = \pi^*_{t|t-1} + \bar{g} \times \varepsilon_t, \quad \bar{g} >> 0$

# The Regimes




Re-anchoring: President Rouseff removed from office in May 2016;

⇒ Re-anchoring process completed in August 2016 (Carvalho and Nechio, 2023)

# De-Anchoring and Firm Pricing: Empirical Strategy

Baseline regression:

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

$\tau_{it}$: 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: [see below]

$\epsilon_{it}$: error term.

# Exogenous 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

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

where $\Delta S_t \equiv \frac{\left(\sum_{k=1}^{7} \Delta s_{k,t}\right)}{7}$: 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: Baseline Results

| | $\Delta_{\tau_i} e_t$ - **Nominal Exchange Rate** | | | $\Delta_{\tau_i} e_t$ - **Instrumented FX** | | |
|---|---|---|---|---|---|---|
| **Dependent variable:** $\Delta_{\tau_i} p_{it}$ | (1) | (2) | (3) | (4) | (5) | (6) |
| $\Delta_{\tau_i} e_t$ | 0.0410*** | 0.0225*** | 0.00822 | 0.0855*** | 0.0684*** | 0.0566*** |
| | (0.00393) | (0.00545) | (0.00568) | (0.00596) | (0.00812) | (0.00886) |
| $\Delta_{\tau_i} e_t \times \mathbb{1}_t^{Unanch}$ | | 0.0460*** | 0.0322*** | | 0.0431*** | 0.0243** |
| | | (0.00805) | (0.00844) | | (0.0115) | (0.0120) |
| $\Delta_{\tau_i} p_{it-\tau_{it}}$ | | | -0.122*** | | | -0.123*** |
| | | | (0.00521) | | | (0.00520) |
| $\tau_{it}$ | | | 0.000359*** | | | 0.000244** |
| | | | (0.0000974) | | | (0.000101) |
| $\Delta_{\tau_i} ULC_t$ | | | 0.0289*** | | | 0.0160*** |
| | | | (0.00608) | | | (0.00618) |
| $\Delta_{\tau_i} Sectoral\ cost_t$ | | | 0.0347*** | | | 0.0282*** |
| | | | (0.0104) | | | (0.0103) |
| $Sectoral\ \ inventory_t$ | | | -0.000177*** | | | -0.000178*** |
| | | | (0.0000184) | | | (0.0000184) |
| $Sectoral\ \ demand_t$ | | | 0.000325*** | | | 0.000327*** |
| | | | (0.0000288) | | | (0.0000288) |
| $Constant$ | 0.0435*** | 0.0428*** | 0.00214 | 0.0445*** | 0.0441*** | 0.00428 |
| | (0.00245) | (0.00245) | (0.00380) | (0.00245) | (0.00246) | (0.00381) |
| N | 192502 | 192502 | 178442 | 192502 | 192502 | 178442 |
| Adjusted $R^2$ | 0.049 | 0.049 | 0.065 | 0.0501 | 0.0502 | 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 |

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

**Real rigidities (Gopinath et al., 2010)?**

a. Lagged FX change Details

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

**Different behavior across regimes?** Exchange rate

b. Non-linear FX effect Details

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

c. Asymmetric FX effect Details:

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

# De-Anchoring and Firm Pricing: Robustness II (Inflation)

**Larger price adjustments because inflation is higher?**

d. Control for 12-months inflation Details

$$\Delta_{\tau_i} p_{it} = \alpha_i + \gamma_t + \beta_1 \Delta_{\tau_i} e_t + \beta_2 \Delta_{\tau_i} e_t \times \mathbb{1}_t{}^{Unanch} + \beta_3 \Delta_{\tau_i} e_t \times \pi_{t-1}^{12m} + \text{controls} + \epsilon_{it}$$

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

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

e. Degree of anchoring Details

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

# Model

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

# Firms' Pricing Decision

- Firm $(i)$ resetting the price

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

where aggregate marginal cost Details

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

- 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.
  - 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:

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

- Learning about $\pi_t^*$:
  1. Agents cannot separately identify $\varepsilon_t^R$ and $\pi_t^*$
  2. Signal extraction problem: Kalman filter
- Monetary policy shock: $\varepsilon_t^R = -\tau_e \varepsilon_t^e + \varepsilon_t^m$, $\tau$ "small" $\rightarrow$ accommodate exchange rate depreciation
- Bounded rationality: agents are 'know the model' but assume $\text{Cov}(\varepsilon_t^R, \varepsilon_t^e) = 0$

# Central Bank and Expectation (Un)Anchoring

- Monetary shocks and anchoring

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

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

- Kalman gain: $\bar{g} > 0$

1. $\bar{g}^{\text{Anchored}}$ (small): reflects correct signal-to-noise ratio from DGP of $\pi_t^*$ and $\varepsilon_{R,t}$
2. $\bar{g}^{\text{Unanchored}} >> \bar{g}^{\text{Anchored}}$: higher perceived volatility in the inflation target

- Exchange rate and anchoring: link between $\varepsilon_t^e$ to long-run inflation expectations

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

# Model Calibration

- Model calibrated to Brazilian economy. Details
  - Key target: *relative expectations' vol across regimes*.
  - Price response to exchange rate is untargeted
- We simulate the model, sample a panel of 5800 firms over 156 months (sample period)
- Assume windows of anchored/unanchored/anchored expectations as in the data, and run pass-through regressions analogous to empirical specifications.
- Monte Carlo experiment: perform $1000$ replications and look at the mean regression outcomes.

# Pass-Through Regressions with Model-Generated Data

| | Model-generated data | | PPI data | |
|---|---|---|---|---|
| **Dependent variable:** $\Delta_{\tau_i} p_{it}$ | **(1)** | **(2)** | **(3)** | **(4)** |
| $\Delta_{\tau_i} e_t$ | 0.048 | 0.058 | 0.0586*** | 0.0653*** |
| $\Delta_{\tau_i} e_t \times \mathbb{1}_t^{Unanch}$ | 0.021 | 0.022 | 0.0351*** | 0.0286*** |
| $\Delta_{\tau_i} e_{t-\tau_{it}}$ | | 0.012 | | 0.0244*** |
| $\Delta_{\tau_i} e_{t-\tau_{it}} \times \mathbb{1}_t^{Unanch}$ | | 0.002 | | 0.0386*** |
| $\Delta_{\tau_i} p_{it-\tau_{it}}$ | -0.138 | -0.139 | -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.

Back

# PPI Microdata

- Survey of firms from agriculture, mining, and manufacturing.
  - Sector (CNAE 3.0): set of products in the same sector. E.g. Textile products.
  - Product (CNAE 2.0): set of items classified as being from the same product. Level at which weights are available. E.g. Cotton fabrics.
  - Item: most disaggregated level, individual prices; includes company, model, size, brand, packaging, city etc.
- 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.

Back

# Daily Data: monetary policy caused unanchoring


Back

# 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 |

Back

# 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 |

Back

# 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 |

Back

# Sensitivity of inflation expectations to interest rate surprises

| Dependent variable | One day after policy meetings $\Delta E_i\left[\pi_{13-24} - \pi^T_{13-24}\right]$ | $\Delta E_i\left[\pi_{25-36} - \pi^T_{25-36}\right]$ | $\Delta E_i\left[\pi_{37-48} - \pi^T_{37-48}\right]$ |
|---|---|---|---|
| *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 |

Back

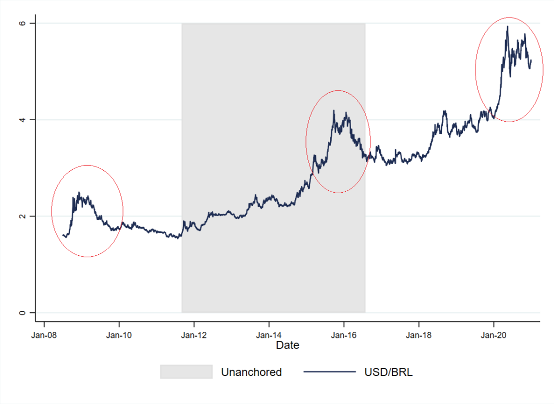
# Pass-through regression with lagged FX change

| | $\Delta_{\tau_i} e_t$ - **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 |

Back

# Exchange rate: Unanchoring or non-linearity?

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




Back

# 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 |

Back

# 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 |

Back

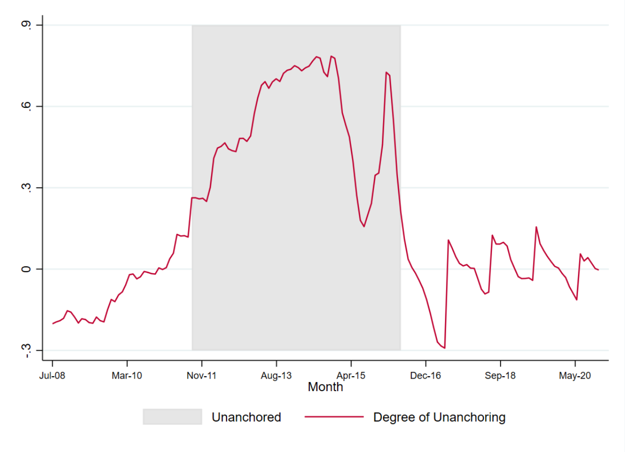
# Unanchoring or higher 12m inflation?

| | $\Delta_{\tau_i} e_t$ - **Nominal Exchange Rate** | | | | | $\Delta_{\tau_i} e_t$ - **Instrumented FX** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
| $\Delta_{\tau_i} e_t$ | 0.0410*** | 0.0225*** | -0.0142 | -0.000444 | -0.0284** | 0.0855*** | 0.0684*** | 0.00945 | 0.0129 | -0.0123 |
| | (0.00393) | (0.00545) | (0.0105) | (0.0116) | (0.0122) | (0.00596) | (0.00812) | (0.0166) | (0.0179) | (0.0192) |
| $\Delta_{\tau_i} e_t \times \mathbb{1}_t^{Unanch}$ | | 0.0460*** | | 0.0283** | 0.00358 | | 0.0431*** | | 0.00684 | -0.0211 |
| | | (0.00805) | | (0.0120) | (0.0128) | | (0.0115) | | (0.0157) | (0.0168) |
| $\Delta_{\tau_i} e_t \times \pi_{t-1}^{12m}$ | | | 0.00891*** | 0.00485** | 0.00763*** | | | 0.0125*** | 0.0115*** | 0.0140*** |
| | | | (0.00154) | (0.00230) | (0.00242) | | | (0.00255) | (0.00348) | (0.00371) |
| N | 192502 | 192502 | 192502 | 192502 | 178442 | 192502 | 192502 | 192502 | 192502 | 178442 |
| Adjusted $R^2$ | 0.0492 | 0.0495 | 0.0495 | 0.0495 | 0.0646 | 0.0501 | 0.0502 | 0.0502 | 0.0502 | 0.0651 |
| 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 |

Back

# A measure of the degree of unanchoring

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




Back

# 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 |

Back

# 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:

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

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

Back

# Calibration Results

| Parameters | Description | | Parameters | Description | |
|---|---|---|---|---|---|
| $1-\alpha$ | import elasticity | 0.050 | $\rho_{\pi^*}$ | $\pi_t^*$ shock | 0.951 |
| $\beta$ | discount rate | 0.995 | $\sigma_R$ | vol. mp shock | 0.141 |
| $1-\xi$ | freq. $\Delta p^i$ | 0.200 | $\rho_e$ | persistence $e_t$ | 0.890 |
| $1-\eta$ | interm. inputs | 0.200 | $\rho_a$ | persistence $a_t$ | 0.516 |
| $\phi_\pi$ | TR: $\pi_t - \pi_t^*$ | 1.284 | $\rho_{a_i}$ | persistence $a_{it}$ | 0.950 |
| $\phi_y$ | TR: $y_t$ | 0.005 | $\sigma_e$ | vol. $e_t$ shock | 3.893 |
| $\rho_i$ | TR: $R_{t-1}$ | 0.875 | $\sigma_a$ | vol. $a_t$ shock | 0.640 |
| $\hat{g}^{\text{Unanchored}}$ | Kalman gain | 0.127 | $\sigma_{a_i}$ | vol. $a_{it}$ shock | 4.481 |
| $\hat{g}^{\text{Anchored}}$ | Kalman gain | 0.008 | $\text{Corr}(\varepsilon_t^R, \varepsilon_t^e)$ | corr. | -0.097 |

| Moments | Model | Data |
|---|---|---|
| $\sigma(\pi_t)$ | 0.421 | 0.300 |
| $\sigma(R_t)$ | 0.203 | 0.260 |
| $\sigma(e_t)$ | 8.603 | 8.720 |
| $\sigma(\hat{y}_t)$ | 2.385 | 2.400 |
| $\sigma(\mathbb{E}^{Anc}\pi)$: | 0.162 | 0.160 |
| $\sigma(\mathbb{E}^{Unanc}\pi)$: | 0.367 | 0.360 |
| $\rho(\pi_t, \pi_{t-1})$: | 0.696 | 0.570 |
| $\rho(R_t, R_{t-1})$: | 0.810 | 0.950 |
| $\rho(\hat{y}_t, \hat{y}_{t-1})$: | 0.663 | 0.820 |
| $\rho(e_t, e_{t-1})$: | 0.867 | 0.867 |
| $\mathbb{E}(\lvert\Delta p_t^i\rvert)$: | 6.179 | 6.000 |

*: fixed

Back