Anchoring of Inflation Expectations
Do Inflation Target Formulations Matter?

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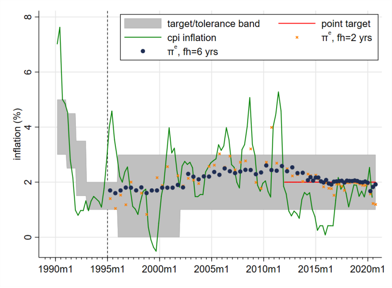
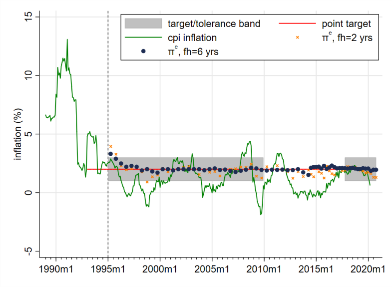
Disclaimer: The views and opinions expressed in the presentation are not necessarily those of the Banque de France or the Eurosystem.

Motivation

- Quantitative formulations for inflation objectives very common $\rightarrow$ *inflation targeting*
- Target formulations differ cross-country, and over time.



(a) New Zealand



(b) Sweden

Note: Green line=YoY CPI inflation. Vertical, dotted line=start date of a stable inflation target, following Roger (2009), with adjustments and extensions. Blue dots=mean point forecast, $h = 6$ to 10 years. Yellow x=mean point forecast, $h = 2$ years.

Motivation

- *MP design:* Do **inflation target formulations** matter for expectation anchoring?
- Economic theory: **conflicting predictions:**

1. Precise CB target problematic due to **time-inconsistency pb** [Stein 1989]
   $\rightarrow$ non-numerical definitions of price stability anchor π^e better
2. Ranges are **more credible** [Demertzis Viegi 2009, Andersson Jonung 2017]
   $\rightarrow$ target ranges/corridors anchor π^e better
3. Ranges provide more **flexibility** [Svensson 1997, Orphanides Wieland 2000]
   $\rightarrow$ point-targets anchor π^e better

$\Rightarrow$ Testable predictions are focus of this paper.

What this paper does

1. Construction of a **novel anchoring measure**
   - based on the cross-sectional distribution of π^e from professional forecasters, h=1,2,...6-10 years (Consensus Economics)
   - consistent with non-linear, asymmetric CB loss fct (Kilian Manganelli 2008)
2. Empirical tests in **panel model** (TWFE)
   - 29 countries
   - 2005q5 - 2020q2
   - distinguishing 4 target formulations:
     - 2.1 no precise numerical target (but quant.def, ex. EA, US*, JP*)
     - 2.2 target range (ex. AU, CH, IL)
     - 2.3 hybrid target (ex. CA, NZ*, MX, CZ*)
     - 2.4 point target (ex. UK*, US*, SE*)

   * Countries that changed the formulation at least once within the sample.

Main findings

- **Point targets**
  - Improve expectations anchoring (*unconditional effect*)
  - Less disanchoring in periods of sustained undershooting and overshooting (*conditional effect*)
- **Hybrid targets** (tolerance bands)
  - No adverse effect on unconditional anchoring.
  - But less effective in limiting shifts in tails of the belief-distribution during periods of sustained deviations from target.
- **Ranking target formulations w.r.t. anchoring properties:**
  1. point target
  2. hybrid target
  3. quant. def. of price stability w/o precise numerical target
  4. target range

Related literature

- **Expectations anchoring**
  - **Distribution**: Reis (2021)
  - **Level**: Mehrotra & Yetman 2018, Grishchenko, Mouabbi & Renne 2019
  - **Pass-through**: *short-term to long-term* (Jochmann et al 2010, Pooter et al 2014, Lyziak & Paloviita 2017, Buono & Formai 2018), *realized on long-run* (Levin, Natalucci & Zakrajsek 2004), *long-run break even and news* (Guerkaynak, Levin & Swanson 2012, Beechey, Johannsen & Levin 2011, Bauer 2015, Hachula & Nautz 2018, Speck 2017)
  - → tails of distribution as anchoring criteria.
- **Inflation Targeting**
  - IT helps to anchor expectations, but no effect on realized inflation (Fatas, Mihov & Rose 2007, Crowe 2010, Davis 2014)
  - → significant differences across target formulations
- **Effect of target formulations**
  - Castelnuovo, Nicoletti-Altimari & Rodriguez-Palenzuela 2003: no significant difference between target formulations
    → update and extension
  - Ehrmann 2021: short-run horizon, weaker pass-through in presence of a range or tolerance band
    → longer forecast horizons (beyond MP lag); differences in country and time coverage

Related literature (cont'd)

- **Inflation risk measures in the literature**
  1. density forecasts from macroeconometric models (e.g. Mitchell & Wallis 2011)
  2. (subjective) probability forecasts from surveys (SPF) (Grishchenko, Mouabbi & Renne 2019)
  3. central bank density forecasts for inflation (Knueppel & Schultefrankenfeld 2012)
  4. option-implied inflation prob densities (Kitsul & Wright 2013)

→ inflation risk measures based on **cross-section of point forecasts**

- summary of beliefs across agents, information about CB credibility
- enables to study whole distribution *(skewness)*
- high country coverage & comparability

Data

Data: Anchoring measure

Cross-section of point forecasts (Consensus)

$\rightarrow$ summary 'best predictions'/'beliefs'

- **skew-extended t-distribution**
  - flexible, *asymmetric*, fat tails
  - SMM estimation (ext. robustness) Appendix
- for each country i, quarter t, forecast hor. h =2y, 3y, 4y, 5y, 6y

Anchoring

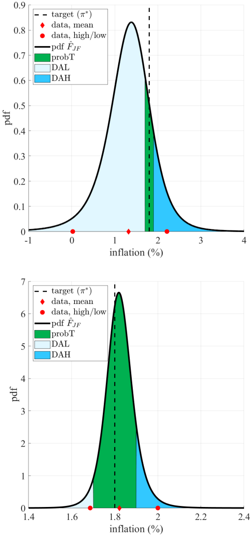
$$probT_{it}^{h} = \int_{\underline{\pi}_i}^{\bar{\pi}_i} dF_{\pi_{it}^{h}}(\pi_{it}^{h})$$

Disanchoring/(a)symmetry

$$DAL_{it}^{h} = \int_{-\infty}^{\underline{\pi}_i} dF_{\pi_{it}^{h}}(\pi_{it}^{h})$$

$$DAH_{it}^{h} = \int_{\bar{\pi}_i}^{\infty} dF_{\pi_{it}^{h}}(\pi_{it}^{h})$$

$\Rightarrow$ theory consistent (Kilian & Manganelli 2008) Model



Note: Euro area, skew $t-$distribution $F_{JF}(\mu, \sigma, a, b)$ for 2 year and 6 year fixed-horizon.

Data: Determinants of expectation anchoring

What are determinants of expectations anchoring?

$$X_{it}^{h} = c + \beta_1 d_t^{fh3} + \beta_2 d_t^{fh4} + \beta_3 d_t^{fh5} + \beta_4 d_t^{fh6} + \delta_1 \sigma_{it}^{\pi 24m} + \delta_2 RQ_{it} + \nu_Y + \nu_i + \varepsilon_{it}$$

where X_{it}^{h} is a generic dependent variable in country i, quarter t and horizon h.

- dummy forecast horizon: $d_t^{fh3}, ..., d_t^{fh6}$
- regulatory quality (Worldbank WGI): $RQ_{i,t}$
- condition on volatility of realized inflation, rolling-window (24m): $\sigma_{it}^{\pi 24m}$
- year dummies (ν_Y)
- country FE (ν_i)
- ref. group (const): cross-country avg., 2y horizon

Data: Determinants of expectation anchoring

Tab. 2: Determinants of inflation risk measures

	(1) distAbs	(2) stdev	(3) skewness ratio	(4) probT	(5) DAL	(6) DAH
sd infl. (24m)	0.374***	0.180***	0.00103	-0.000374	-0.0497***	0.0501***
	(0.0130)	(0.00619)	(0.00710)	(0.00536)	(0.00821)	(0.00802)
Regulatory quality	-0.169***	-0.0747***	-0.0270***	0.130***	0.0888***	-0.219***
	(0.0125)	(0.00598)	(0.00688)	(0.00518)	(0.00794)	(0.00776)
d^{fh3}	-0.127***	0.0159	0.0159	0.0469***	-0.0538***	0.00693
	(0.0224)	(0.0107)	(0.0122)	(0.00925)	(0.0142)	(0.0138)
d^{fh4}	-0.170***	0.0276***	0.0318***	0.0685***	-0.0737***	0.00517
	(0.0224)	(0.0107)	(0.0123)	(0.00925)	(0.0142)	(0.0138)
d^{fh5}	-0.198***	0.0182*	0.0550***	0.0964***	-0.0887***	-0.00775
	(0.0224)	(0.0107)	(0.0123)	(0.00925)	(0.0142)	(0.0138)
d^{fh6}	-0.215***	0.00658	0.0737***	0.115***	-0.0962***	-0.0190
	(0.0224)	(0.0107)	(0.0123)	(0.00926)	(0.0142)	(0.0139)
Constant	0.427***	0.290***	0.0270	0.00915	0.302***	0.689***
	(0.0447)	(0.0214)	(0.0245)	(0.0185)	(0.0283)	(0.0277)
adj. R-squared	0.28	0.27	0.04	0.18	0.09	0.23
N.Obs	4483	4483	4435	4483	4483	4483
year dummies	Yes	Yes	Yes	Yes	Yes	Yes

Notes. Pooled OLS, standard errors in parentheses. ***/**/*/ denote statistical significance at the 1%/5%/10% level.

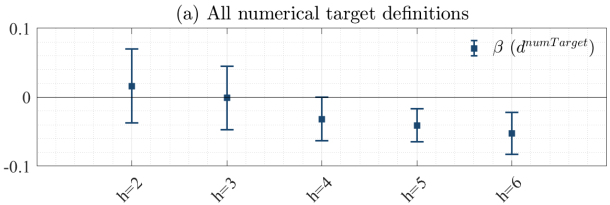
Empirical results

Results (1a): Are numerical targets always better?

$$probT_{it}^{h} = c + \beta d_{it}^{numTarget} + \delta_1 \sigma_{it}^{\pi 24m} + \delta_2 RQ_{it} + \nu_i + \nu_Y + \varepsilon_{it}.$$

$d_{it}^{numTarget}$: all numerically defined inflation targets

Anchoring effects of numerically defined inflation targets (effects on *probT*)



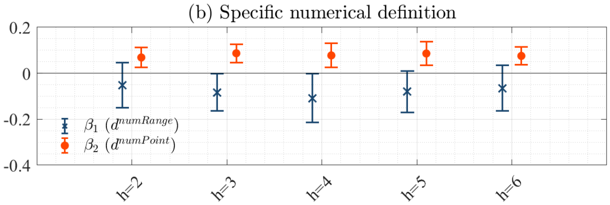
Notes: Point estimates and 90% confidence intervals based on Driscoll and Kraay (1998) standard errors. All equations are estimated separately for each forecast horizon from $h = 2$ to $h = 6$ years based on a fixed-horizon approximation. The reference group of countries are US$<$ 2012m3, euro area, and Japan$<$ 2012m2.

Results (1b): Are numerical targets always better?

$$probT_{it}^{h} = c + \beta_1 d_{it}^{numRange} + \beta_2 d_{it}^{numPoint} + \delta_1 \sigma_{it}^{\pi 24m} + \delta_2 RQ_{it} + \nu_i + \nu_Y + \varepsilon_{it}$$

$d_{it}^{numRange}$: pure range AND hybrid targets
$d_{it}^{numPoint}$: pure point target AND focal point

Anchoring effects of numerically defined inflation targets (effects on *probT*)



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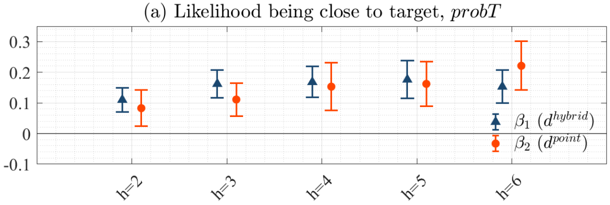
- Not all numerical definitions improve over quant. def. target.
- Sensitivity: data more in favor of num. target if Japan & Turkey dropped
- $\rightarrow$ consistent with Bundick and Smith (2018)

Results (2): differences between numerical targets

$$X_{it}^{h} = c + \beta_1 d_{it}^{hybrid} + \beta_2 d_{it}^{point} + \delta_1 \sigma_{it}^{\pi 24m} + \delta_2 RQ_{it} + \nu_i + \nu_Y + \varepsilon_{it},$$

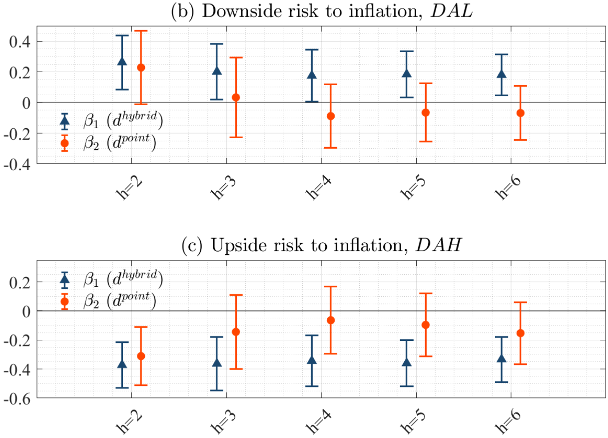
d_{it}^{hybrid}: hybrid targets
d_{it}^{point}: pure point target



Notes: Point estimates and 90% confidence intervals based on Driscoll and Kraay (1998) standard errors. All equations are estimated separately for each forecast horizon from $h = 2$ to $h = 6$ years based on a fixed-horizon approximation. Sample of 29 countries.

→ Inflation target ranges are associated with less well-anchored π^e

Results (2) cont'd: disanchoring



Notes: Point estimates and 90% confidence intervals based on Driscoll and Kraay (1998) standard errors. All equations are estimated separately for each forecast horizon from $h = 2$ to $h = 6$ years based on a fixed-horizon approximation. Sample of 29 countries.

→ Point and hybrid targets dampen the risk of disanchoring, but not symmetrically.

Conditional results: persistent deviations from target

Anchoring conditional on track-record

- Indicator CL_{it} based on inflation performance

$$CL_{it} = \frac{1}{T-1} \sum_{s=t-T}^{t-1} (\pi_{is} - \pi^*_{is}) \mid \pi_{is} - \pi^*_{is} \mid$$

- backward-looking, 60 months (Neuenkirch and Tillmann 2014)
- CL_{it} represents multiple things (credibility loss, persistence of shocks, ...)

Net cumulative undershooting/overshooting

$$CL^{(+)}_{it} = \begin{cases} CL_{it}, & \text{if} \quad CL_{it} \geq 0 \\ 0, & \text{otherwise} \end{cases}$$

$$\text{and } CL^{(-)}_{it} = \begin{cases} \mid CL_{it} \mid, & \text{if} \quad CL_{it} \leq 0 \\ 0, & \text{otherwise} \end{cases}$$

Shifts in the fat tails in periods of inflation stress

$$X_{it}^{h} = c + \beta_1 CL_{it}^{+} + \beta_2 CL_{it}^{-} + \gamma_1 \sigma_{it}^{\pi 24m} + \gamma_2 RQ_{it} + \nu_i + \nu_Y + \varepsilon_{it}$$

β_1: cum. overshooting
β_2: cum. undershooting

Tab. 3: Effect of persistent target deviations on expectation anchoring

	(1) $\pi - \pi^*$	(2) probT(4)	(3) probT(6)	(4) DAL(4)	(5) DAL(6)	(6) DAH(4)	(7) DAH(6)	(8) Mean(4)	(9) Mean(6)
$CL^{(-)}$	-0.103 (0.0831)	-0.0222** (0.0108)	-0.0301*** (0.0104)	0.0632*** (0.0146)	0.0850*** (0.0102)	-0.0410*** (0.0149)	-0.0549*** (0.00858)	-0.0407* (0.0232)	-0.0344*** (0.0125)
$CL^{(+)}$	0.722*** (0.201)	-0.00636 (0.00848)	-0.00169 (0.00735)	-0.00118 (0.0126)	-0.0373*** (0.00891)	0.00754 (0.0145)	0.0389*** (0.0110)	0.354*** (0.0561)	0.233*** (0.0275)
sd infl. (24m)	-0.151 (0.260)	-0.0106 (0.0226)	-0.0311 (0.0204)	-0.0303 (0.0258)	0.0182 (0.0209)	0.0409 (0.0247)	0.0129 (0.0179)	0.0933 (0.0681)	0.0236 (0.0344)
Regulatory quality	0.307 (0.505)	0.00819 (0.0698)	-0.117 (0.0842)	0.0930 (0.0586)	0.276*** (0.0930)	-0.101 (0.0749)	-0.160* (0.0847)	-0.919*** (0.165)	-0.761*** (0.100)
Constant	-0.0425 (0.542)	0.174** (0.0680)	0.353*** (0.0780)	0.235*** (0.0692)	0.0694 (0.0988)	0.592*** (0.0758)	0.578*** (0.0941)	3.582*** (0.153)	3.359*** (0.100)
country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N.Obs	3978	827	825	827	825	827	825	833	831
N.Countries	28	28	28	28	28	28	28	28	28
adj. R-squared	0.31	0.06	0.06	0.16	0.21	0.19	0.19	0.55	0.51

Notes. Standard errors based on Driscoll and Kraay (1998) in parentheses. ***/**/*/ denote statistical significance at the 1%/5%/10% level.

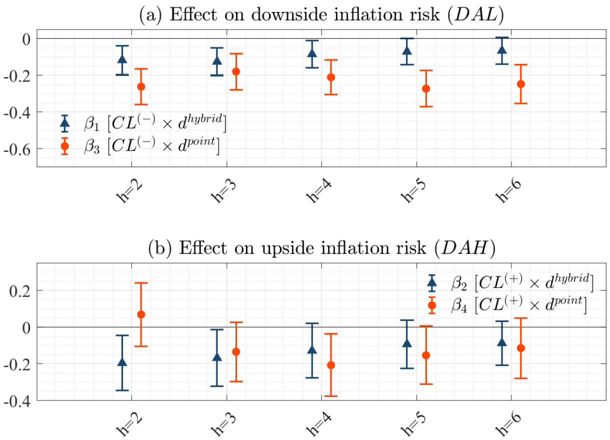
→ Stronger disanchoring from low inflation?

Shifts in the fat tails and target formulations

Are movements in the fat tails equal across target formulations?

$$
\begin{aligned}
X_{it}^{h} =& c + \beta_1 \left[CL_{it}^{-} \times d_{it}^{hybrid} \right] + \beta_2 \left[CL_{it}^{+} \times d_{it}^{hybrid} \right] + \delta_1 d_{it}^{hybrid} \\
& + \beta_3 \left[CL_{it}^{-} \times d_{it}^{point} \right] + \beta_4 \left[CL_{it}^{+} \times d_{it}^{point} \right] + \delta_2 d_{it}^{point} \\
& + \gamma_1 CL_{it}^{+} + \gamma_2 CL_{it}^{-} + \gamma_3 \sigma_{it}^{\pi 24m} + \gamma_4 RQ_{it} + \nu_i + \nu_Y + \varepsilon_{it}
\end{aligned}
$$

Shifts in the fat tails and target formulations (results)



Notes: Point estimates and 90% confidence intervals based on Driscoll and Kraay (1998) standard errors. All equations are estimated separately for each forecast horizon from $h = 2$ to $h = 6$ years based on a fixed-horizon approximation. Sample of 29 countries.

$\rightarrow$ Point targets are slightly more effective in limiting shifts in the tails of the distribution.

Robustness

- absolute distance, mean to target
- subsample of AEs conly
- subsample w/o Japan, Turkey $(*)$
- No controls $(RQ, sdinfl(24m))$
- No year dummies

Conclusion

- Debate about pros and cons of **inflation target formulations** unsettled, reflected in numerous CB strategy reviews [Apel Clausen 2017, Chung et al 2020]
- **Challenges of disanchoring** remain present
- ... due to persistently low or high inflation, *not necessarily symmetric*
- ... expectation bias in the presence of ZLB [Bianchi Melosi Rottner 2019]

This paper

- (1) proposes a **novel anchoring measure** based on cross-sectional distribution
- (2) finds **point targets** have favorable (conditional & unconditional) anchoring characteristics
- Limitations:
  1. Professional forecasters attentive to CB announcements
     - affect other agents [Carroll 2003]
     - still, not sure if results would hold for HH, firms. [Coibion Gorodnichenko Weber 2019, Lewis Makridis Mertens 2020]
  2. Cannot fully control for selection bias (endogeneity)
     $\rightarrow$ SCM for causal interpretation (work in progress)

Thank you.

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