

26 AUGUST 2020

# 2021 Renewal of the Monetary Policy Framework

---

*An Update on the Horse Race of  
Alternative Frameworks*

Rhys Mendes

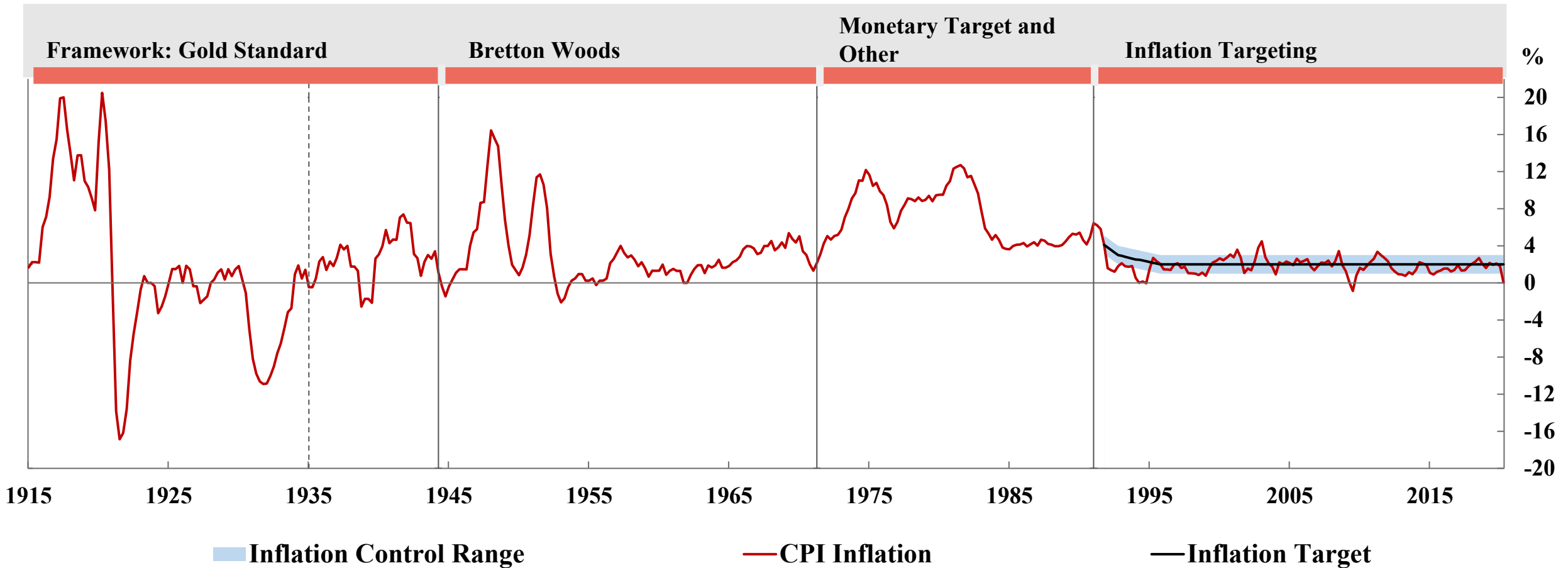
MANAGING DIRECTOR, INTERNATIONAL DEPARTMENT



# Disclaimer

The views expressed in this presentation are solely those of the authors and may differ from official Bank of Canada views. No responsibility for them should be attributed to the Bank.

# Inflation targeting has been very successful



Source: Statistics Canada and Bank of Canada (Year-over-year percentage change, quarterly data)

Last Observation: 2020Q2

# Longer-term challenges for the MP framework

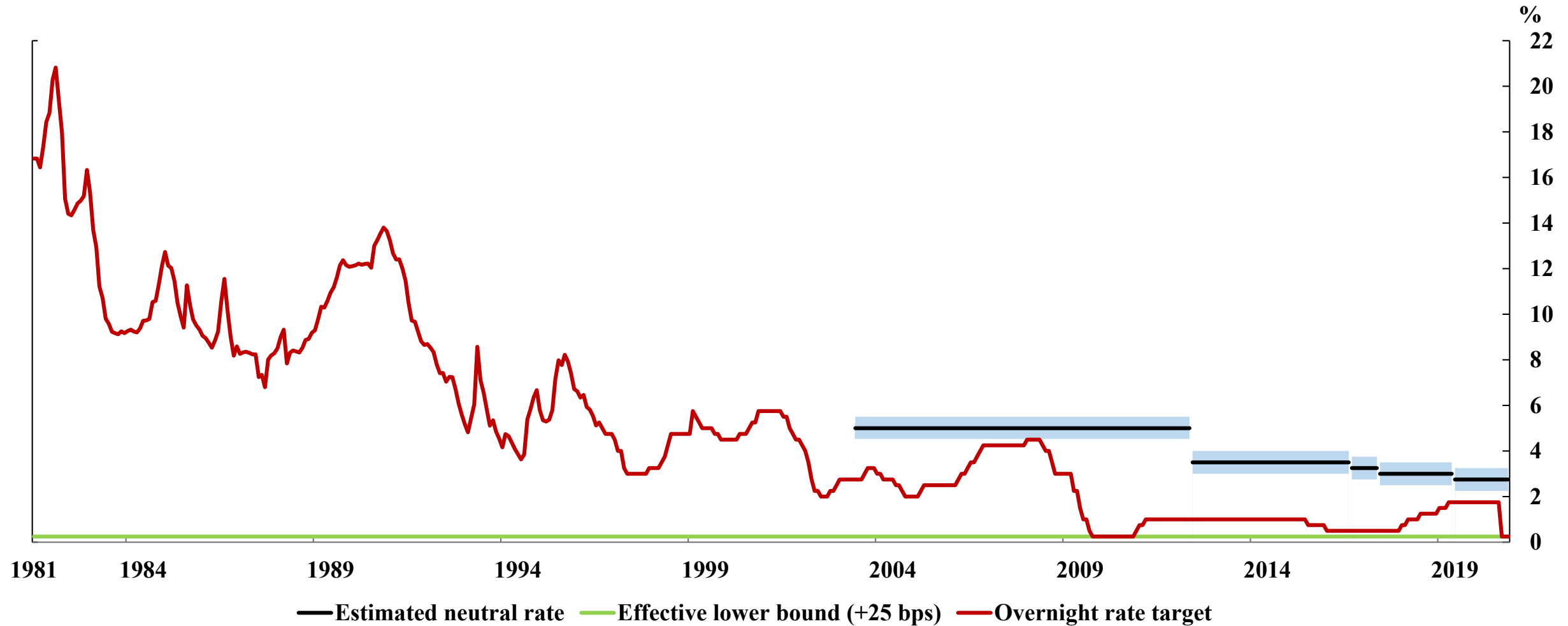
## Less Room to Manoeuvre

- Lower neutral rate
- Effective Lower Bound (ELB) constraint

## Greater Trade-offs with Financial Stability

- Low interest rates can induce greater risk-taking and debt accumulation

# Lower “neutral” level of interest rates



Source: Bank of Canada (Monthly Data)

Last Observation: 2020Q2

# Research questions to address these challenges

Three questions:

- 1) Can we articulate an alternative framework that will do a better job than inflation targeting?
- 2) How can the Bank of Canada's tool kit support whatever monetary policy framework we end up choosing?
- 3) How can other public policies work together with monetary policy to support sustainable growth and price stability?

This session focuses on the first question.

# Elements of the horse race



- **Horses:** Different monetary policy frameworks
- **Tracks:** Different economic models, experiments, consultations
- **Criteria:** Judge which frameworks perform best

# The Horses: Six Different Frameworks

- Inflation targeting (IT)
- Average inflation targeting (AIT)
- Price level targeting (PLT)
- Nominal GDP level targeting (NGDP level)
- Nominal GDP growth targeting (NGDP growth)
- Dual mandate (DM)



# Alternative frameworks differ along two key dimensions

- First, the degree of **history dependence**:
  - Under IT, bygones are bygones.
  - A framework is history dependent if it involves a commitment to make up for past misses
- Greater **history dependence** implies:
  - Better performance in a low neutral rate environment (✓)
  - Greater output volatility if backward-looking behavior is prevalent (✗)

# Alternative frameworks differ along two key dimensions

- Second, the degree of **emphasis on stabilizing a specific real variable**:
  - **IT is flexible IT**: Stabilizing real economy is an important consideration under IT, but not an *explicit* part of the framework.
  - Variants of NGDP targeting and dual mandate make it explicit
- More explicit **emphasis on stabilizing a specific real variable** implies:
  - Greater stability of real economy (✓)
  - Diminished clarity and simplicity (✗)

# The Tracks: Models, Experiments and Consultations

A number of methods are being used to evaluate the frameworks:

- Model simulations
  - ToTEM
  - Heterogeneous agent models
  - A model with bounded rationality
  - Other models that incorporate a long-run inflation-output trade-off, hysteresis and a richer role for financial stability
- Laboratory Experiments
  - Evaluate how well real people understand the alternative frameworks
- Public Consultations

# The Criteria: Qualitative and Quantitative

The frameworks are being evaluated using a broad set of criteria:

- Macroeconomic stability (both price stability and stability of the real economy)
- Financial stability
- Robustness (to different economic circumstances and different assumptions about private-sector behaviour)
- Distributional implications
- Implications for accountability, communications and credibility

# Building on past work

The analysis in the “horse race” builds on work for past renewals. In particular:

- 2011 work on PLT
  - Potential gains in terms of long-run price-level certainty and short-run macro stability
  - But uncertainty about expectations formation meant that the potential benefits of PLT did not clearly outweigh the costs and risks of moving away from the proven IT framework.
- 2016 work on raising the inflation target
  - Higher target may yield modest improvements in macroeconomic performance by alleviating the effects of the ELB constraint.
  - The availability of an extended policy toolkit limits the gains.
- *Estimates of neutral have fallen since this work was done, so it is important to revisit these issues.*





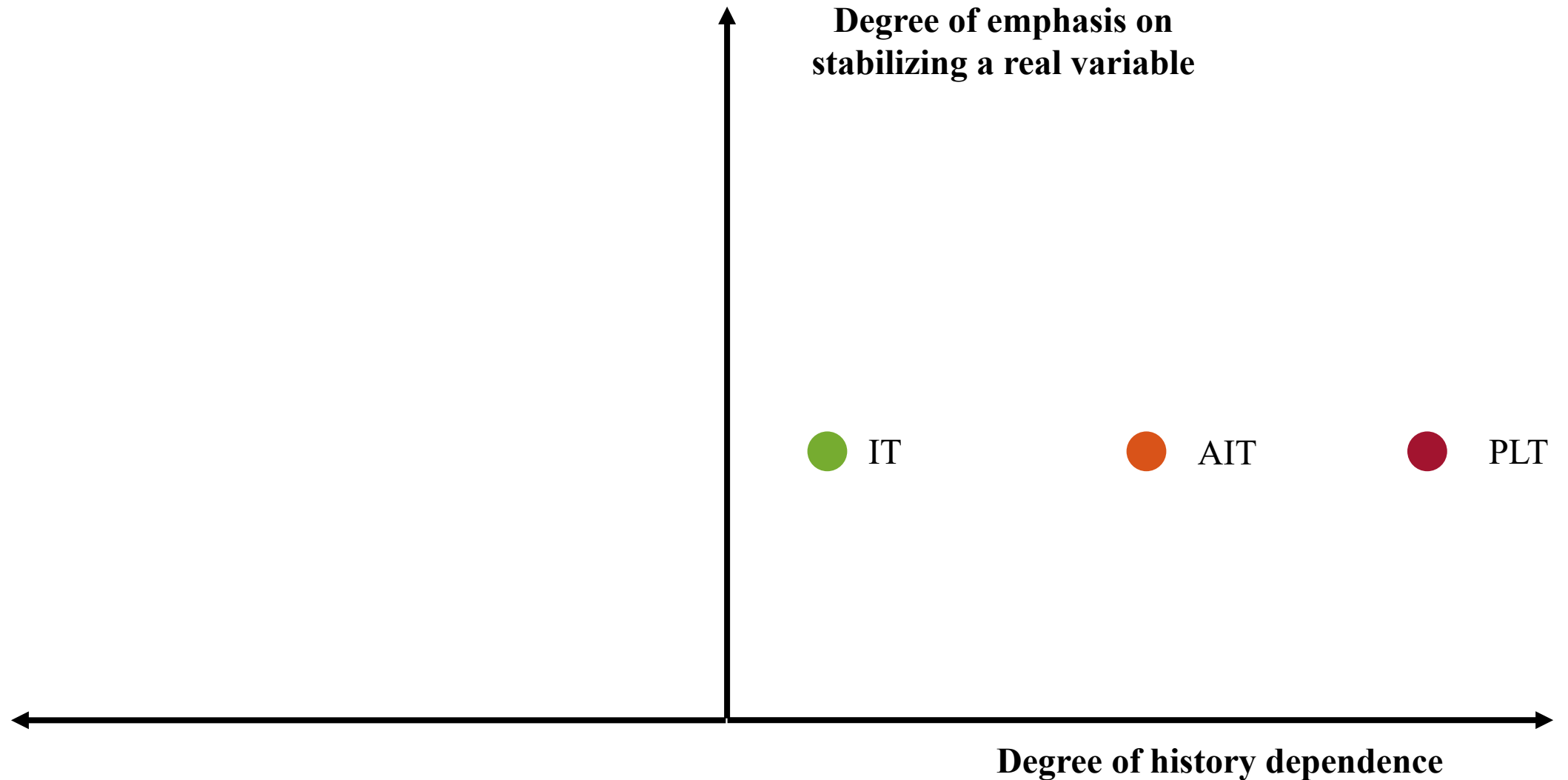
# IT, AIT and PLT: Assessing the Role of History Dependence



# All in the Family: IT, AIT and PLT

Framework	Target	Degree of History Dependence
IT	12-month inflation rate	Low (bygones are bygones – base drift in price level)
AIT	Multi-year inflation rate	Moderate (partially undo impact of shocks on price level)
PLT	Level of price index = cumulation of all past inflation	High (fully undo impact of shocks on price level)

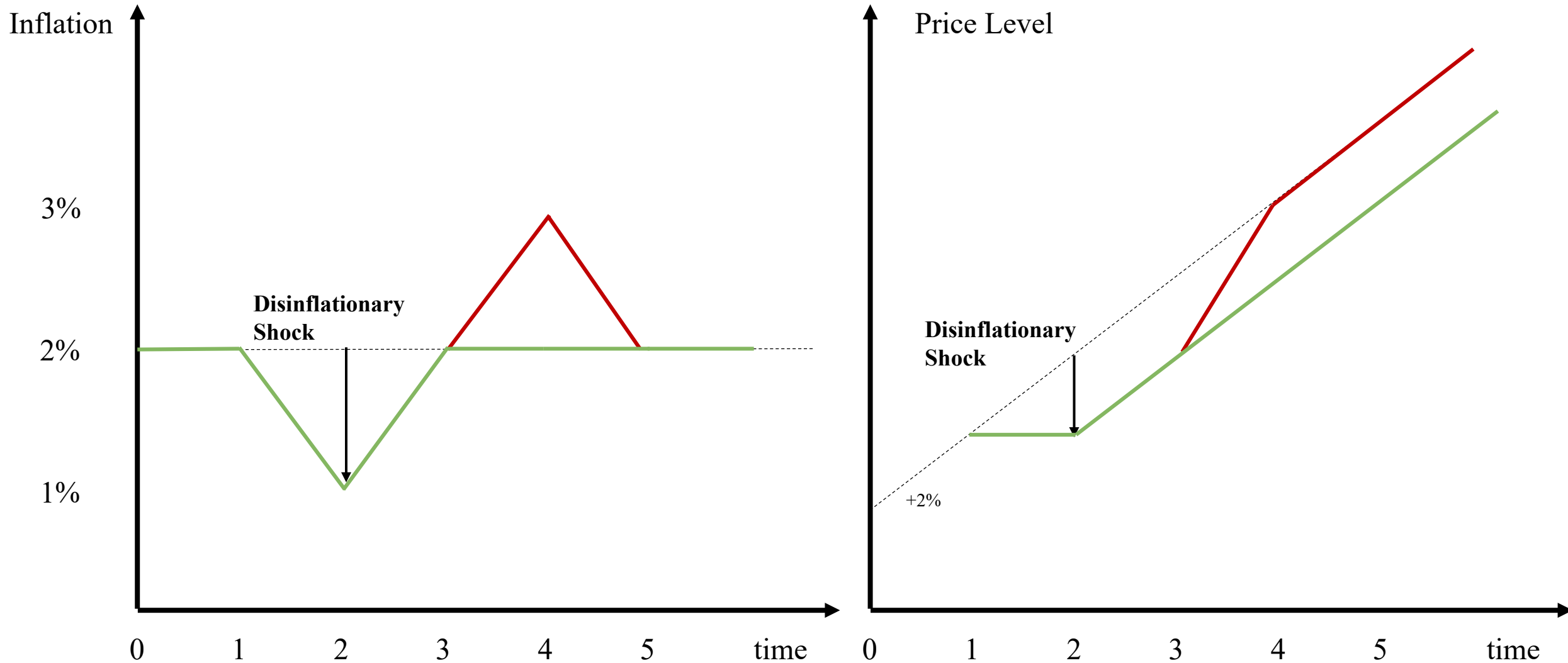
# IT, AIT and PLT differ in degree of history dependence





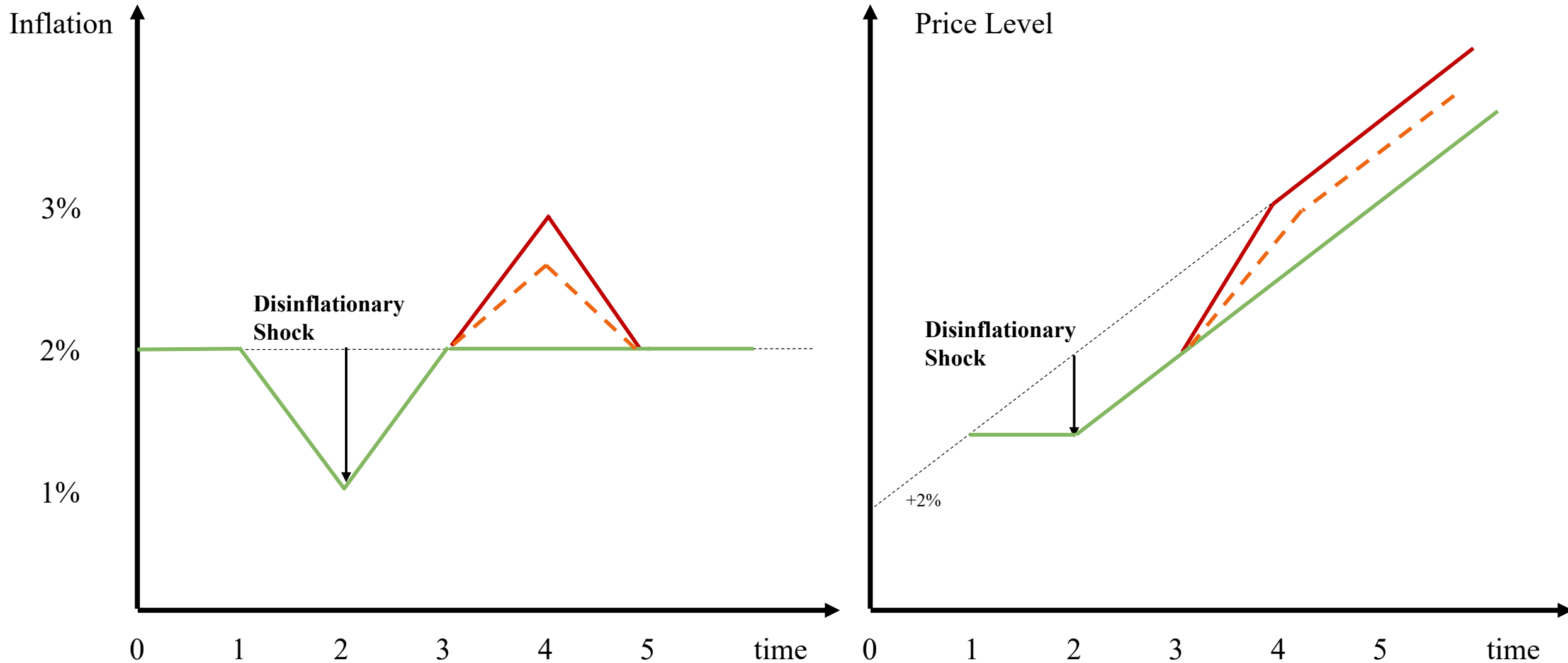
# PLT reverses the impact of shocks on the price level

— Inflation Targeting (IT) — Price Level Targeting (PLT)



# AIT is an intermediate case between IT and PLT

— Inflation Targeting (IT)    - - - Average Inflation Targeting (AIT)    — Price Level Targeting (PLT)



# When does history dependence help?

- History dependence induces beneficial shifts in expectations in two situations:
  - 1) At the **ELB**
    - The commitment to correct past misses creates expectations of low-for-longer interest rates
  - 2) In response to shocks that generate a **trade-off** between inflation and output gap stabilization
    - After a positive markup shock, a commitment to stabilize the price level reduces expected inflation.
    - Lower inflation expectations partially offset the shock, reducing the initial decline in the output gap

# Benchmark results in ToTEM

- Terms of Trade Economic Model (ToTEM)
- One of the Bank's main policy analysis and projection models
- An estimated DSGE model with:
  - Open economy features
  - Multiple sectors
  - Staggered nominal wage and price adjustment
  - Relatively high degree of rule-of-thumb behaviour in wage and price setting

# Characterization of monetary policy in ToTEM

- Frameworks modelled as simple rules:

$$IT: \quad i_t = 0.85i_{t-1} + (1 - 0.85)\{i^* + \gamma_{yy}(\pi_t^{yy} - \bar{\pi}^a) + \alpha_{yy}\tilde{x}_t\}$$

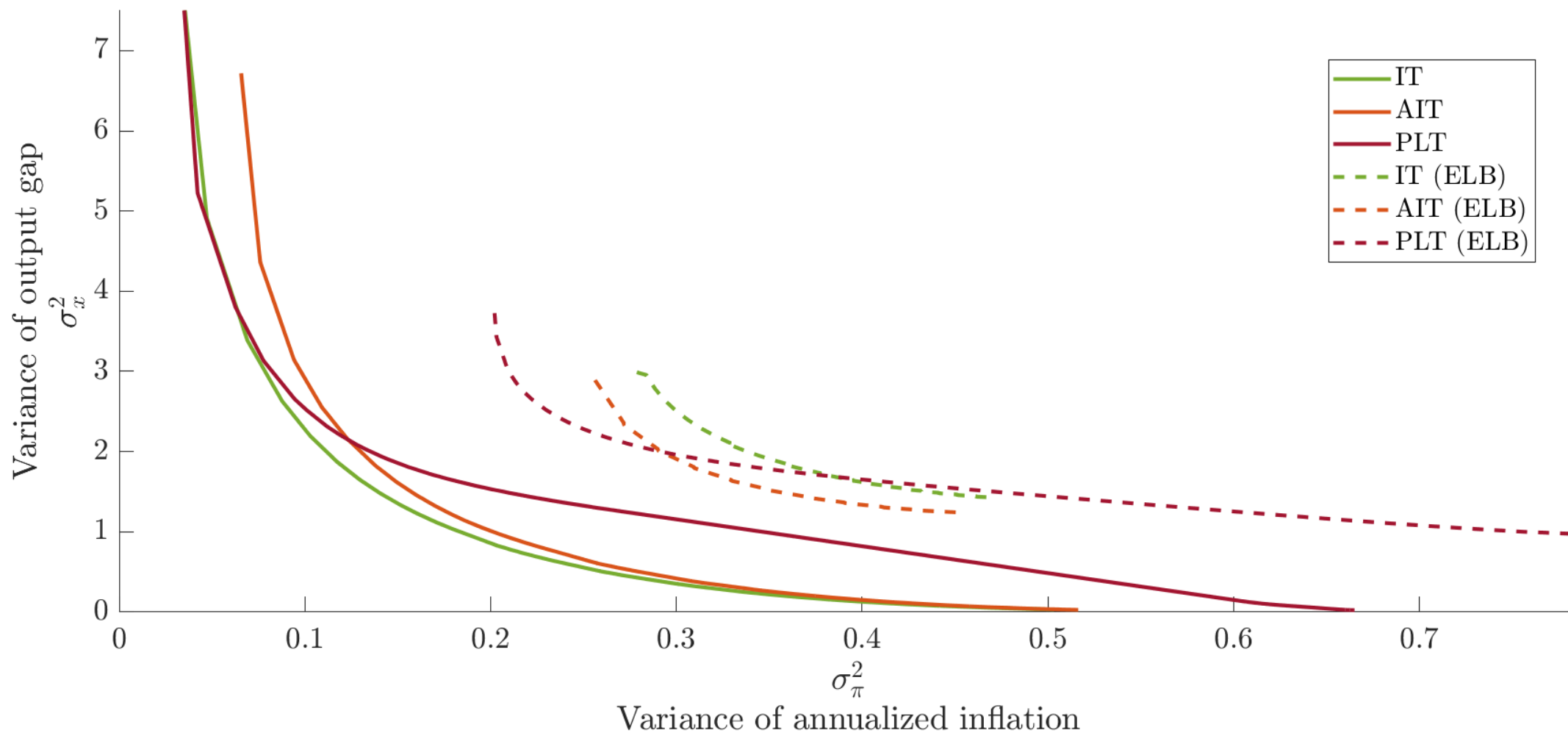
$$AIT: \quad i_t = 0.85i_{t-1} + (1 - 0.85)\{i^* + \gamma_{3y}(\pi_t^{3y} - \bar{\pi}^a) + \alpha_{3y}\tilde{x}_t\}$$

$$PLT: \quad i_t = 0.85i_{t-1} + (1 - 0.85)\{i^* + \gamma_p(p_t - \bar{p}_t) + \alpha_p\tilde{x}_t\}$$

# Other Key Assumptions

- Nominal neutral rate of interest: 2.75 percent
  - Real: 0.75 percent
- Effective lower bound: 0.25 percent
- Extended monetary policy toolkit (QE, etc.):
  - Two polar cases:
    - **No ELB:** ELB is not a constraint. Interpret as very effective extended toolkit.
    - **ELB:** Occasionally binding ELB. No other effective tools at the ELB.
  - Reality likely lies somewhere in between
    - Extended toolkit partially compensates for ELB constraint

# History dependence is beneficial only when the ELB is a constraint



# A loss function interpretation of a dual mandate

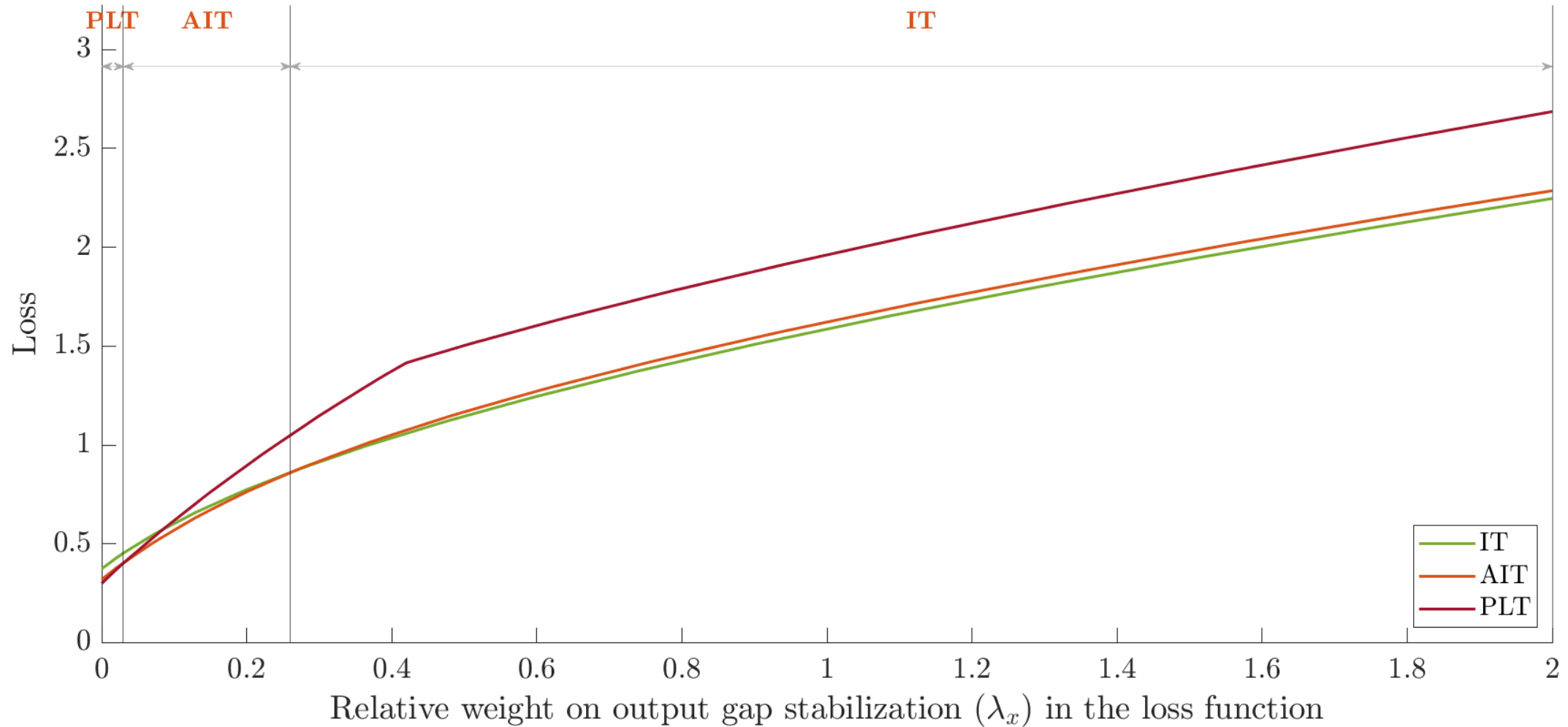
- Next, evaluate the frameworks using a loss function of the form:

$$L_t = \underbrace{(\pi_t^a - \bar{\pi}^a)^2}_{\text{Inflation deviation from target}} + \lambda_x \underbrace{\tilde{x}_t^2}_{\text{Output gap}} + 0.5 \underbrace{(i_t - i_{t-1})^2}_{\text{Change in nominal interest rate}}$$

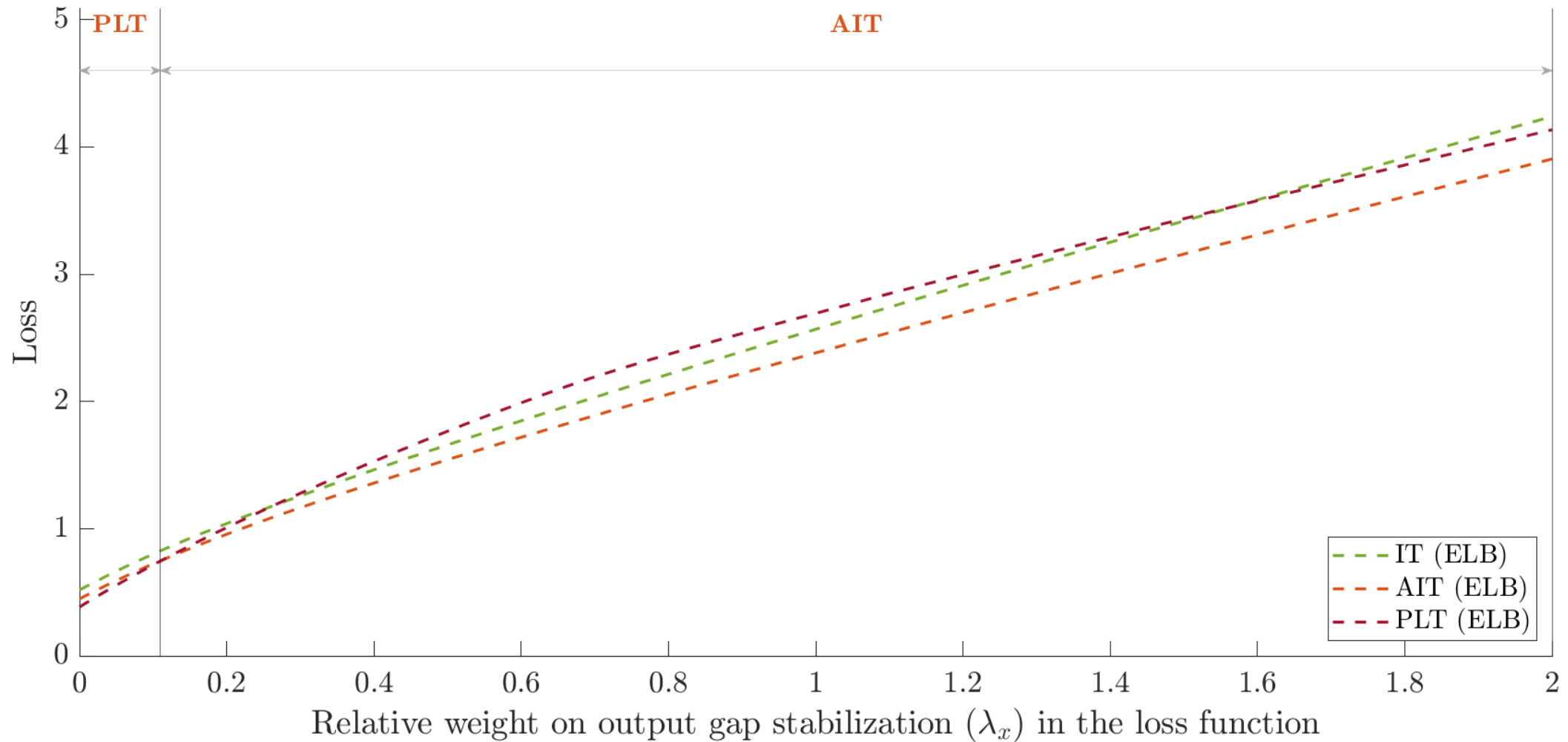
- Much of the Bank's past work has assumed  $\lambda_x = 1$ .
- One possible interpretation of a "dual mandate" is a larger value of  $\lambda_x$ .



# IT performs well when the ELB is not a constraint



# AIT takes the lead when the ELB is a constraint



# AIT appears more robust to assumptions about ELB

- PLT dominated by less history-dependent alternatives because of departures from rational expectations in ToTEM
- The “horse race” between IT and AIT depends on the assumed effectiveness of the EMP toolkit.
  - No gains from moving from IT to AIT if extended toolkit can compensate for ELB
    - But IT is only ahead by a nose in this situation
  - AIT has a somewhat larger lead over IT if the extended toolkit is ineffective
  - AIT appears more robust to assumptions about ELB and extended toolkit



A low-angle, upward-looking perspective of several modern skyscrapers with glass facades. The buildings are arranged in a way that they appear to converge towards the top of the frame, creating a sense of height and scale. The glass reflects the sky and clouds, adding to the visual complexity. The sky is a clear blue with scattered white clouds. A semi-transparent dark grey horizontal band is positioned across the middle of the image, serving as a background for the text.

# Expanding the Horse Race



# New entrants in the horse race

Expand the horse race to include frameworks that place more explicit emphasis on stabilization of a specific real variable:

- Unemployment-inflation dual mandate
- Nominal GDP level targeting
- Nominal GDP growth targeting

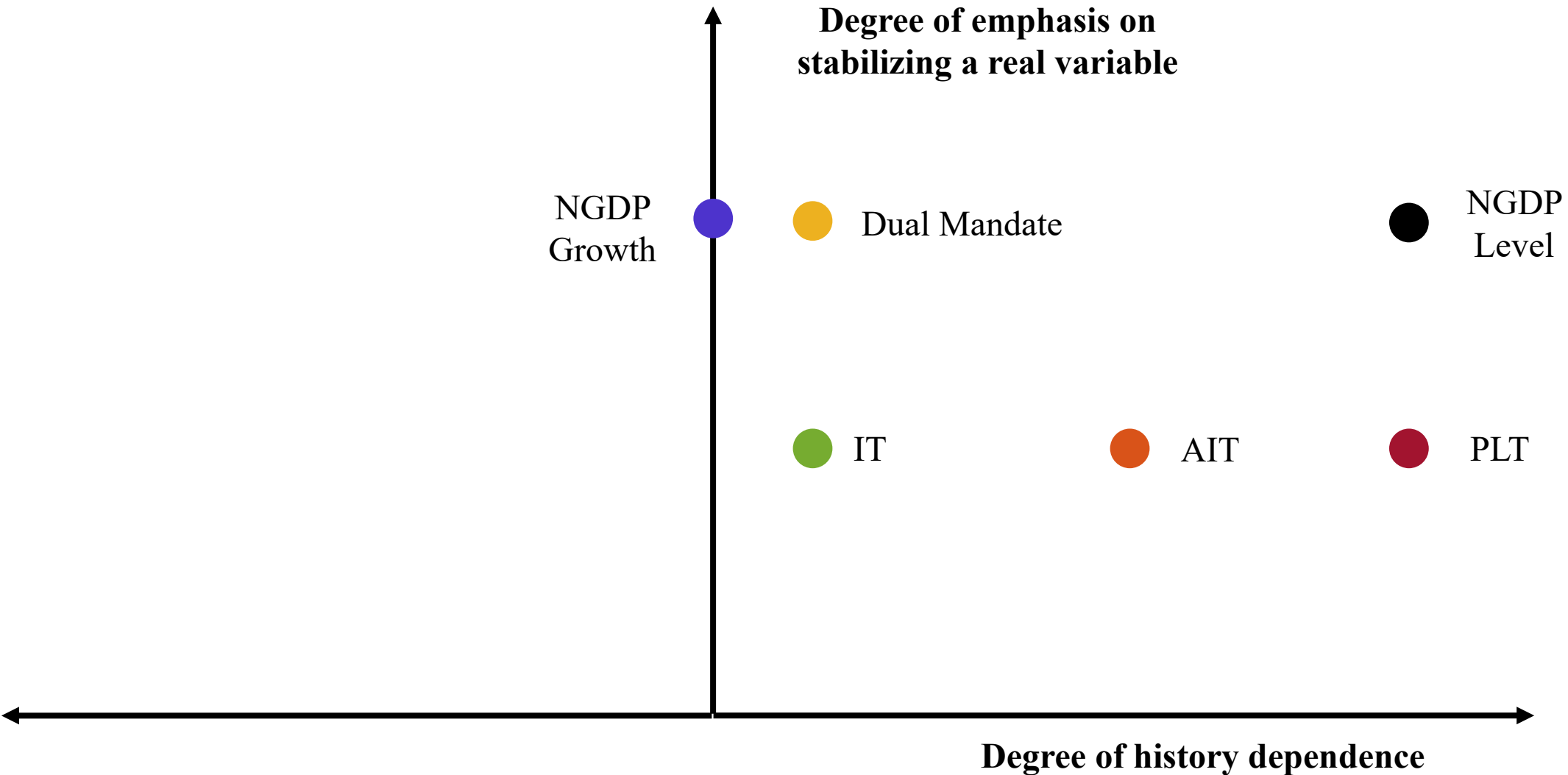
# New entrants in the horse race

Expand the horse race to include frameworks that place more explicit emphasis on stabilization of a specific real variable.

Framework	Relevant Nominal Variable	Relevant Real Variable	Degree of History Dependence
Unemployment-Inflation Dual Mandate	12-month CPI inflation rate	Unemployment rate	Low (similar to IT)
NGDP Level Targeting	Level of GDP deflator	Level of real GDP	High (similar to PLT)
NGDP Growth Targeting	Y/Y GDP deflator inflation rate	Y/Y real GDP growth	Very low (because real variable is in growth terms)

- NGDP targeting variants incorporate GDP rather than an output gap measure.
  - This leads them to call for higher interest rates than IT/AIT/PLT after a positive productivity shock.
  - This could promote financial stability objectives.

# Most alternatives embed more history dependence and/or more emphasis on a real variable than IT



# Approach to running the expanded horse race

- IT, AIT and PLT were similar enough that they could be fairly evaluated using a simple *ad hoc* loss function
- This approach could unfairly penalize new entrants because they are different
- Approach for expanded horse race:
  - Each framework characterized by (i) regime-specific delegated loss function, and (ii) a simple policy rule.
  - Delegated loss function is used to choose the parameters of rule, but not to evaluate framework
  - Frameworks are evaluated using volatilities of several key variables
    - No explicit weighting
    - Look for frameworks that stabilize broad range of variables



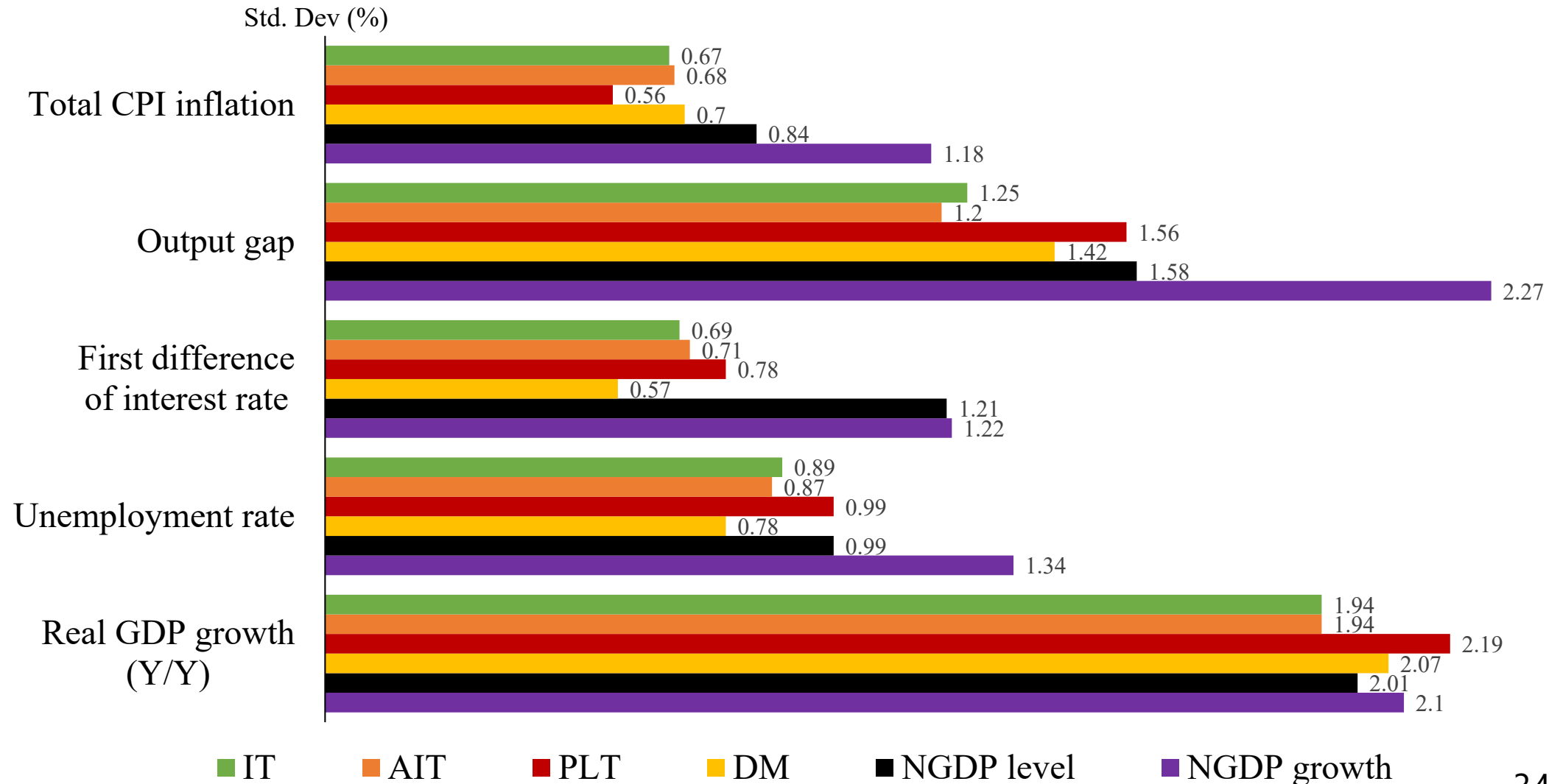
# Delegated loss functions and interest rate rules

Framework	Loss specification	Interest rate rules
IT	$L^{IT} = (\pi_t^{yy} - \bar{\pi}^a)^2 + 0.5 (\Delta i_t)^2 + (\tilde{x}_t)^2$	$i_t = i^* + \gamma(\pi_t^{yy} - \bar{\pi}^a) + \alpha \tilde{x}_t$
AIT	$L^{AIT} = (\pi_t^{3y} - \bar{\pi}^a)^2 + 0.5 (\Delta i_t)^2 + (\tilde{x}_t)^2$	$i_t = i^* + \gamma (\pi_t^{3y} - \bar{\pi}^a) + \alpha \tilde{x}_t$
PLT	$L^{PLT} = (p_t - \bar{p}_t)^2 + 0.5 (\Delta i_t)^2 + (\tilde{x}_t)^2$	$i_t = i^* + \gamma(p_t - \bar{p}_t) + \alpha \tilde{x}_t$
NGDP Level	$L^{NGDPL} = \left\{ \frac{(y_t + p_{GDP,t})}{-(\bar{y}_t + \bar{p}_{GDP,t})} \right\}^2 + 0.5 (\Delta i_t)^2$	$i_t = i^* + \delta \left[ \frac{(y_t + p_{GDP,t})}{-(\bar{y}_t + \bar{p}_{GDP,t})} \right]$
NGDP Growth	$L^{NGDPG} = \left\{ \frac{(\Delta y_t^{yy} + \Delta p_{GDP,t}^{yy})}{-(\overline{\Delta y_t^{yy}} + \overline{\Delta p_{GDP,t}^{yy}})} \right\}^2 + 0.5 (\Delta i_t)^2$	$i_t = i^* + \delta \left[ \frac{(\Delta y_t^{yy} + \Delta p_{GDP,t}^{yy})}{-(\overline{\Delta y_t^{yy}} + \overline{\Delta p_{GDP,t}^{yy}})} \right]$
Unemployment-Inflation Dual Mandate	$L^{DM} = (\pi_t^{yy} - \bar{\pi}^a)^2 + (\tilde{u}_t)^2 + 0.5 (\Delta i_t)^2$	$i_t = i^* + \gamma(\pi_t^{yy} - \bar{\pi}) + \alpha \tilde{u}_t$

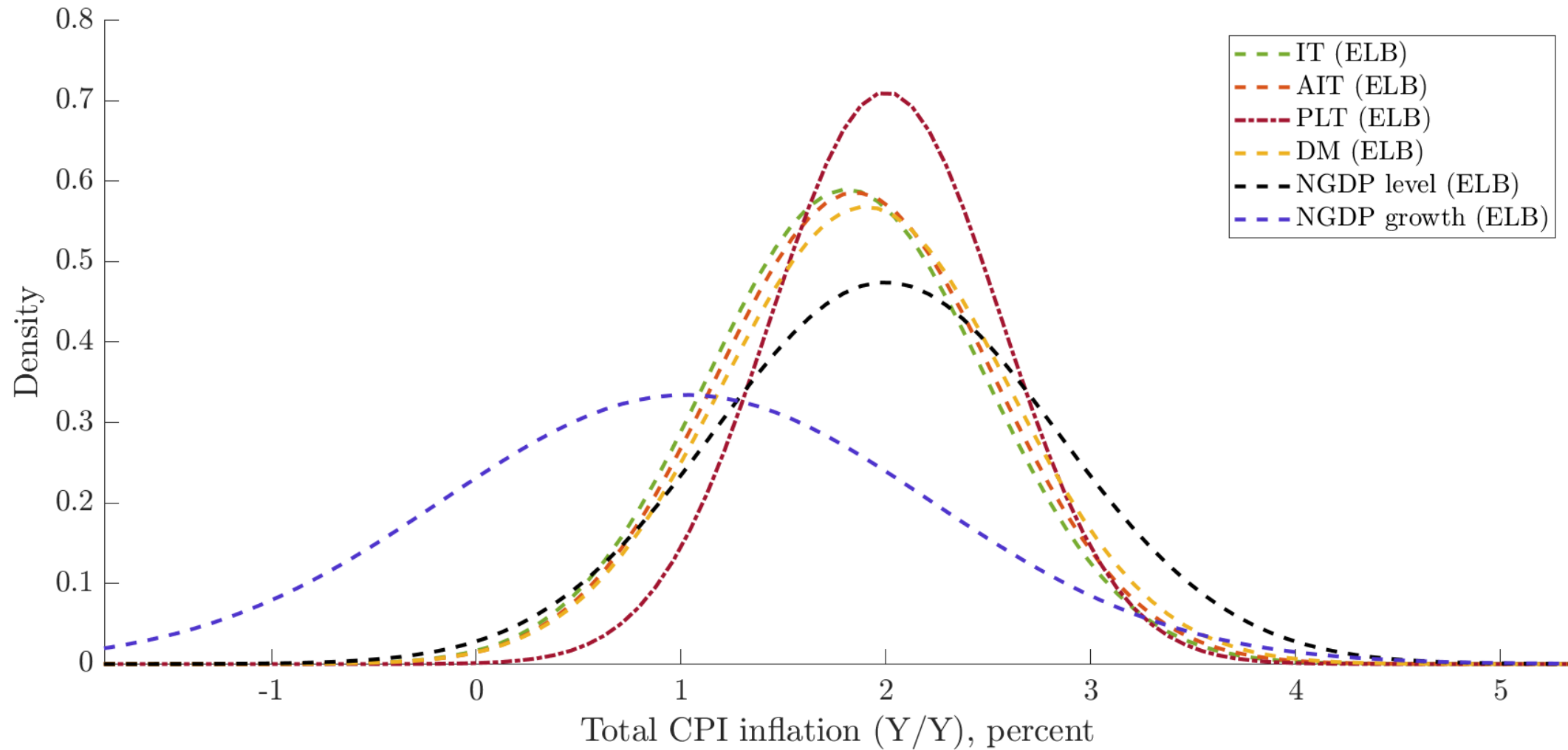
Note: Actual rules used in simulations include a smoothing parameter of 0.85.

# ELB Case:

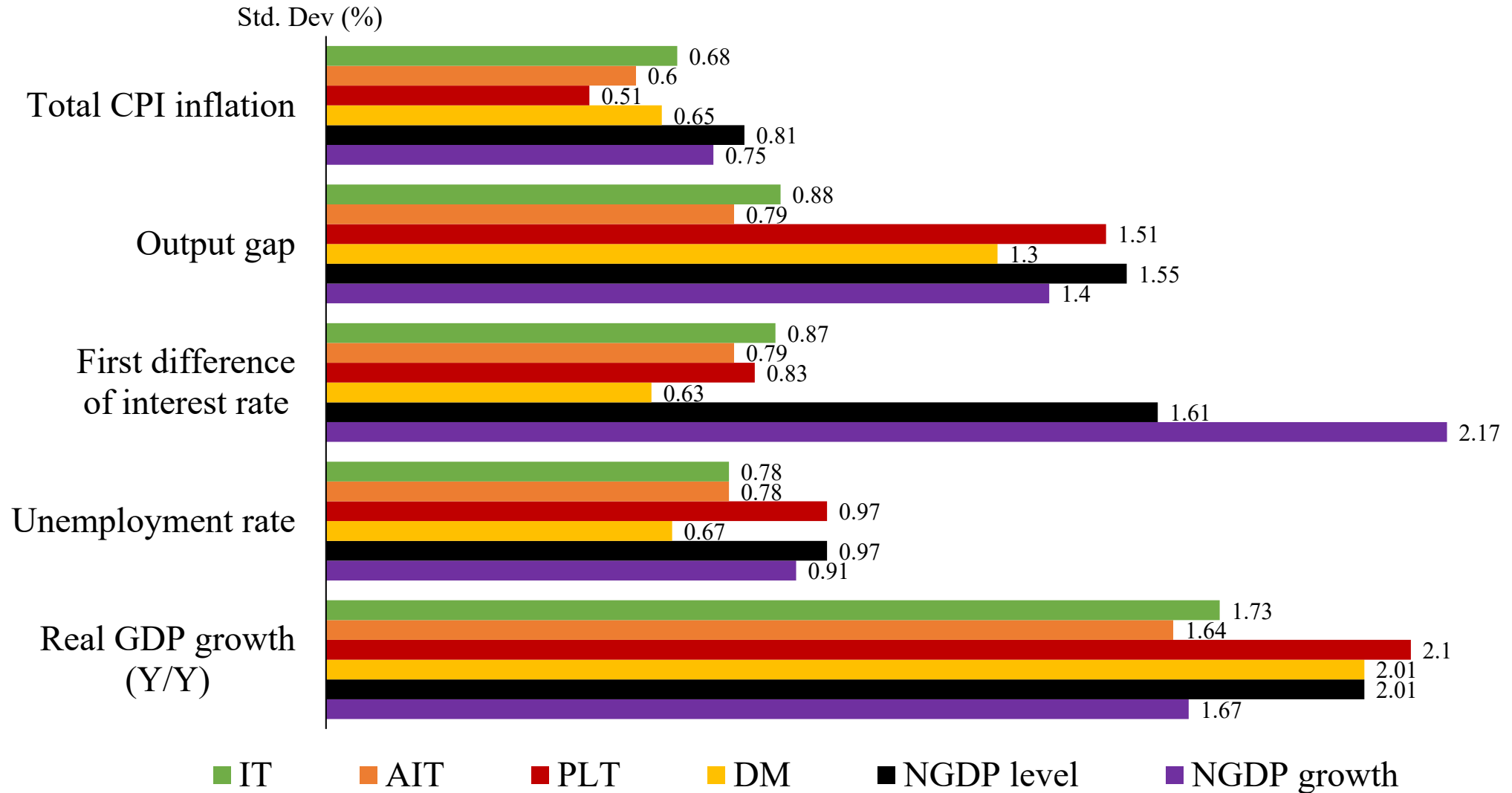
## IT, AIT and DM again generate relatively low volatilities



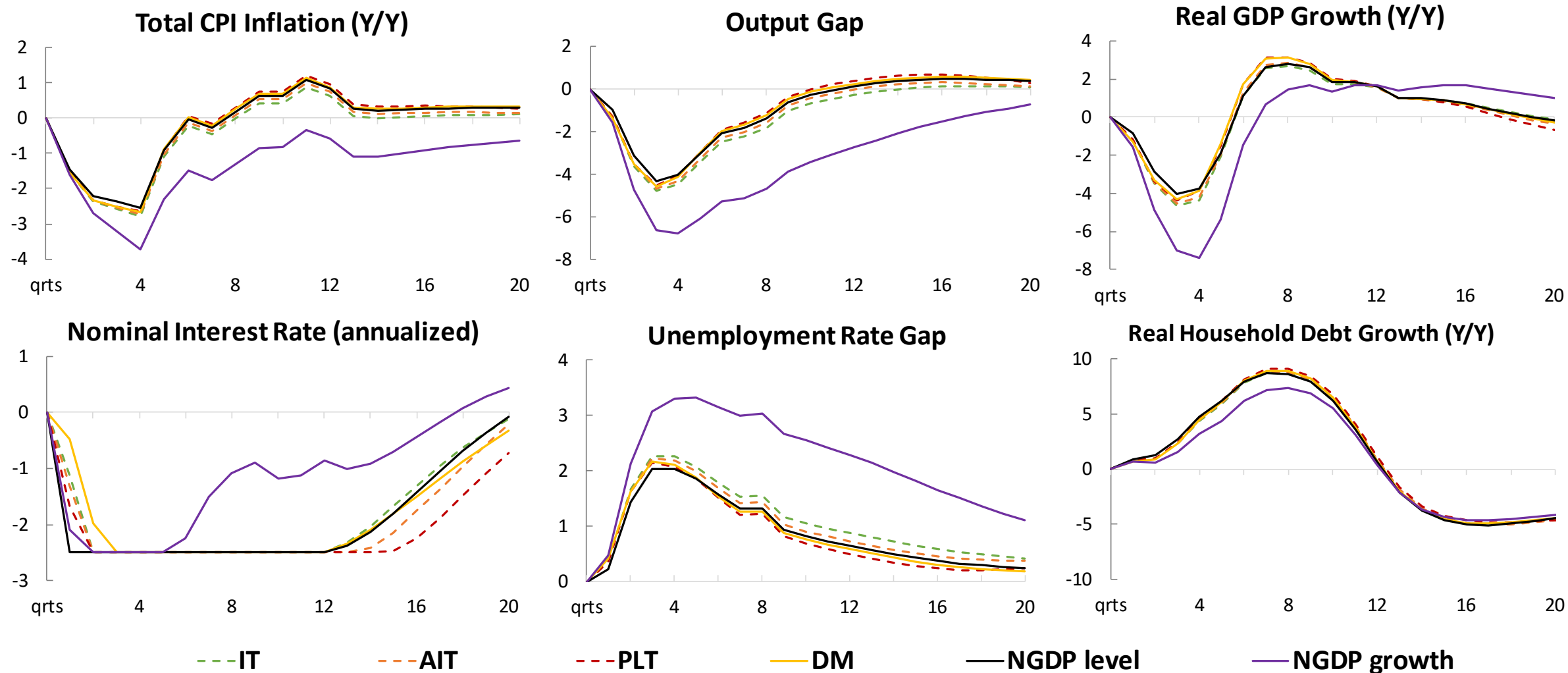
# PLT reduces likelihood of very low inflation outcomes



# No ELB Case: IT, AIT and DM generate relatively low volatilities for most variables



# NGDP growth targeting performs very poorly in severe downside scenario



Percent deviation from steady state



A low-angle, upward-looking perspective of several modern skyscrapers with glass facades. The buildings are arranged in a way that they appear to converge towards the top of the frame, creating a sense of height and scale. The glass reflects the sky and clouds, adding to the visual complexity. A semi-transparent dark horizontal band is overlaid across the middle of the image, serving as a background for the title text.

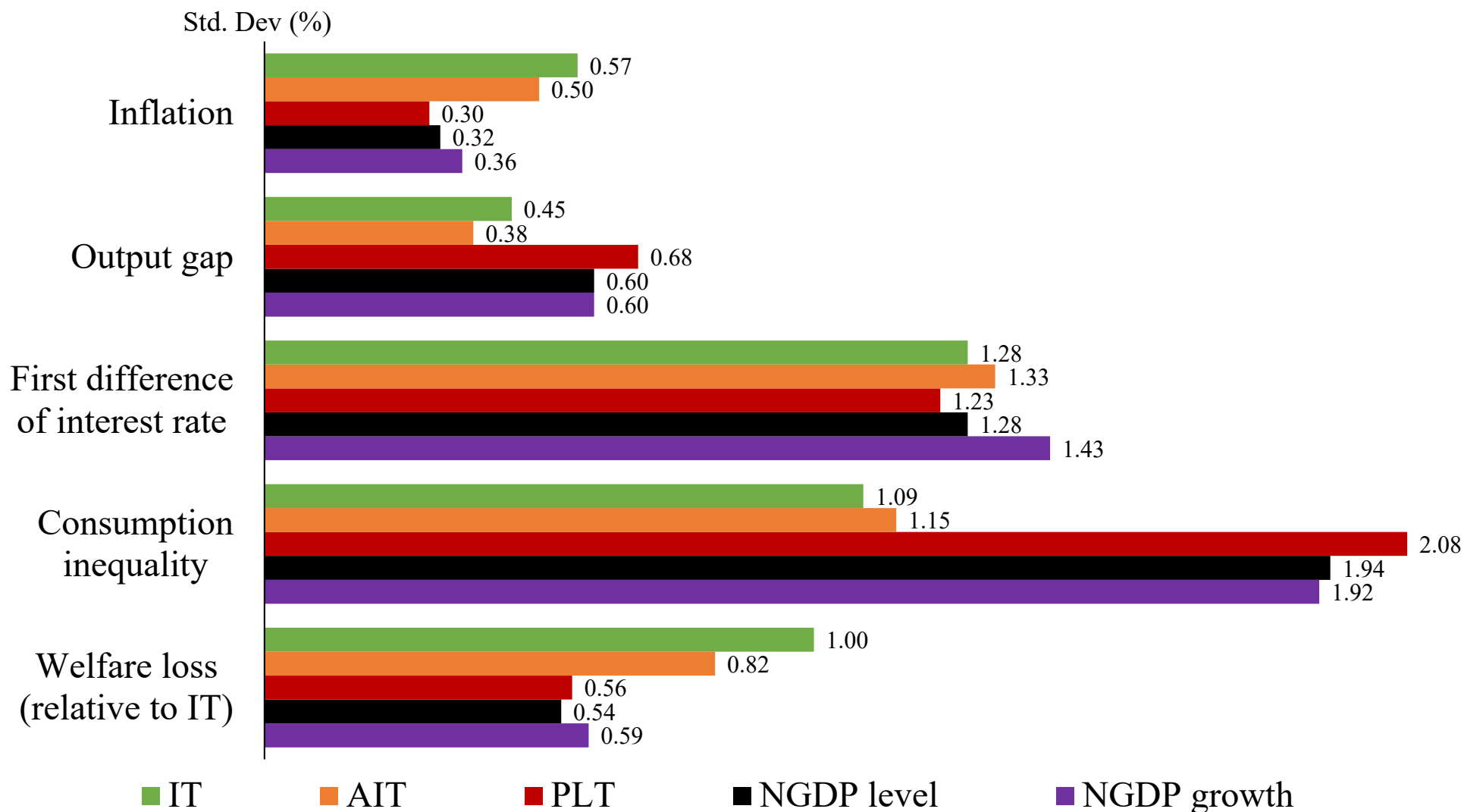
# Heterogeneity and Inequality



# A simple heterogeneous-agent model

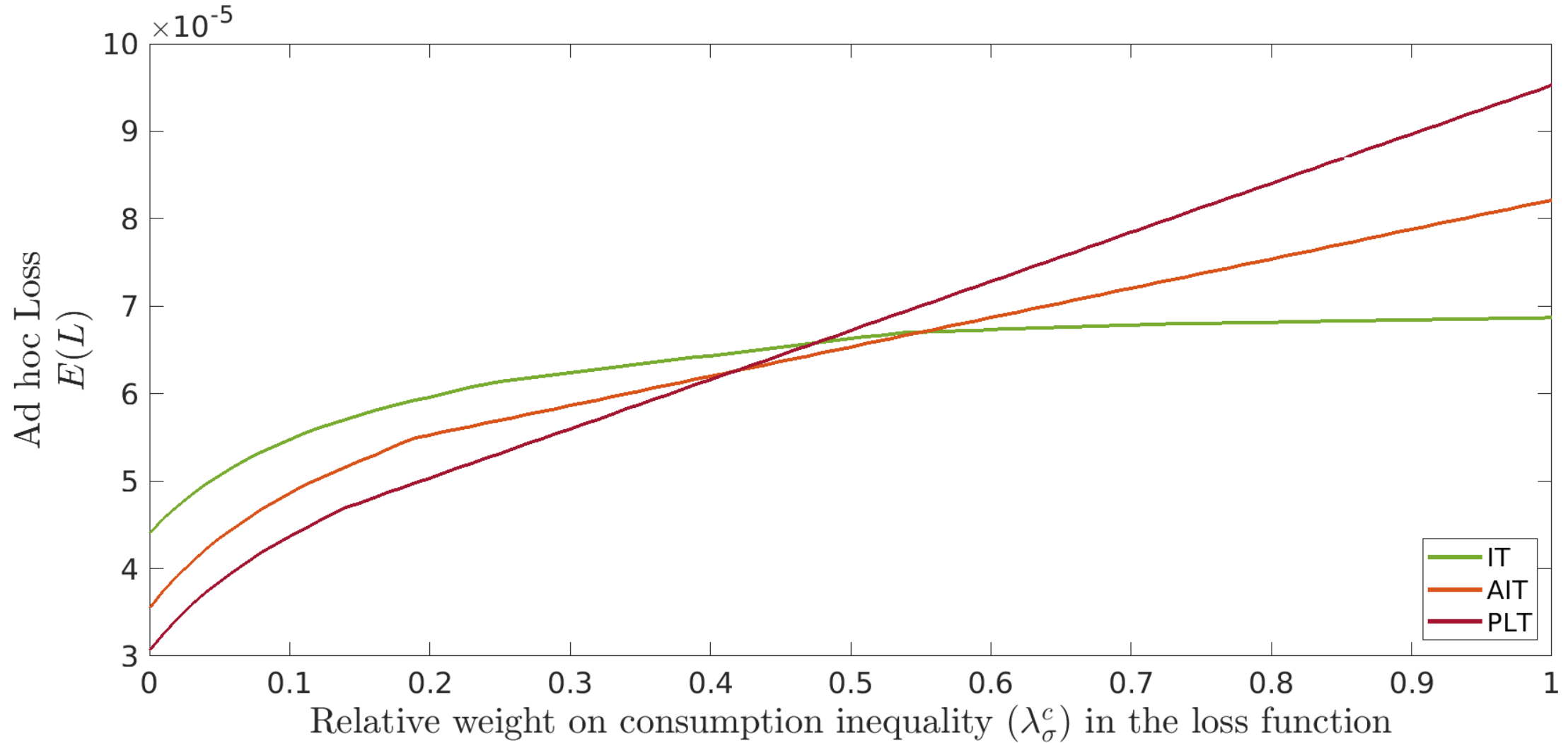
- Simple model with countercyclical idiosyncratic income risk
  - Follows Acharya and Dogra (2020) and Acharya, Challe and Dogra (2020)
  - First step in thinking about distributional implications of alternative frameworks
- In the model:
  - Inequality rises when the output gap is negative
  - Captures the real-world phenomenon that inequality tends to rise in recessions

# Volatilities and welfare in the HANK model





IT is best if loss function heavily penalizes cyclical variation in inequality



$$E(L) = \text{var}(\pi_t^a) + \text{var}(x_t) + \lambda_{\sigma}^c \text{var}(\sigma_t^c)$$



A low-angle, upward-looking perspective of several modern skyscrapers with glass facades. The buildings are arranged in a way that they appear to converge towards the top of the frame, creating a sense of height and scale. The glass reflects the sky and clouds, adding depth to the image. A semi-transparent dark grey horizontal band is positioned across the middle of the image, serving as a background for the text.

# Bounded Rationality



# A Simple NK model with Bounded Rationality

- Relax assumption of rational expectations
- Include bounded rationality following Gabaix (2020):

$$x_t = M \mathbb{E}_t[x_{t+1}] - \Gamma(i_t - \mathbb{E}_t[\pi_{t+1}] - r_t^n) \quad (IS \text{ Curve})$$

$$\pi_t = M^f \beta \mathbb{E}_t[\pi_{t+1}] + \kappa x_t + u_t \quad (\text{New Keynesian Phillips Curve})$$

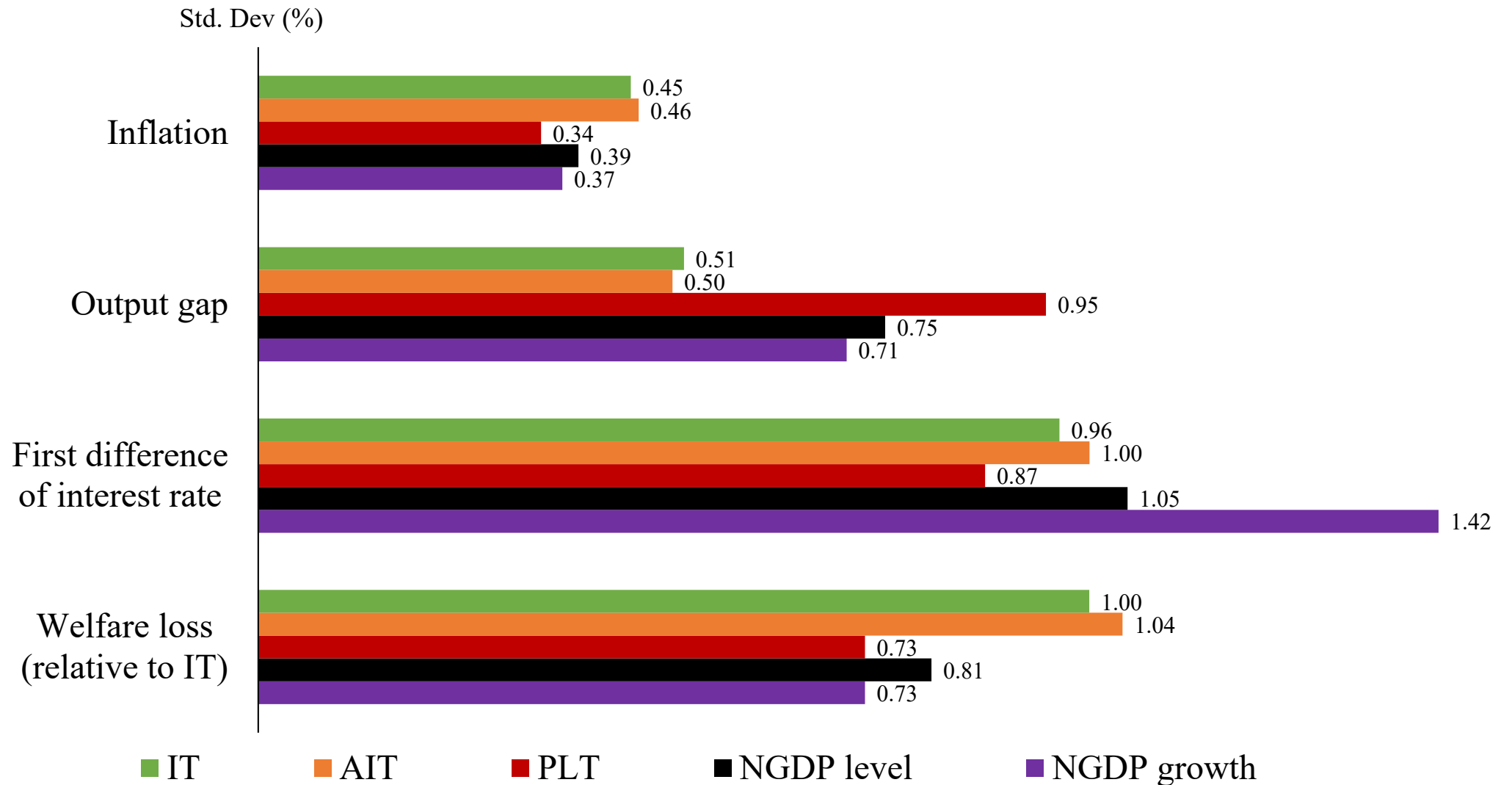
where

$M$ : cognitive discounting of output expectations

$\Gamma$ : Households are myopic to changes in interest rates

$M^f$ : cognitive discounting of inflation expectations

# Volatilities and welfare in the bounded rationality model







# Laboratory Experiments



# An experimental approach to the horse race

- Work-in-progress
- How do alternative frameworks perform in a laboratory experiment with real people?
- Expectations are key to performance of history-dependent frameworks
- Assess how people form expectations under each of the alternative frameworks

# Design of experiment

- Learning-to-forecast experiment
- Decisions by the subjects: inflation forecast and output forecast.
- Actual outcomes are determined by simple NK model conditional on subjects' median forecasts.
- \$ Payoff = function of forecast errors
- In the instructions, subjects are provided information about the experimental economy and monetary policy framework – both equations and qualitative explanations.

# Possible forecasting heuristics

Heuristic Name	Model
Ex-Ante Rational	$E_{i,t}x_{t+1} = f(r_{t-1}^n, \epsilon_t)$ $E_{i,t}\pi_{t+1} = f(r_{t-1}^n, \epsilon_t)$
Gabaix	$E_{i,t}x_{t+1} = \alpha f(r_{t-1}^n, \epsilon_t)$ $E_{i,t}\pi_{t+1} = \alpha f(r_{t-1}^n, \epsilon_t)$
Constant Gain	$E_{i,t}x_{t+1} = E_{i,t-1}x_t - \gamma(E_{i,t-2}x_{t-1} - x_{t-1})$ $E_{i,t}\pi_{t+1} = E_{i,t-1}\pi_t - \gamma(E_{i,t-2}\pi_{t-1} - \pi_{t-1})$
Steady State/Target	$E_{i,t}x_{t+1} = 0$ $E_{i,t}\pi_{t+1} = 0$
Naive	$E_{i,t}x_{t+1} = x_{t-1}$ $E_{i,t}\pi_{t+1} = \pi_{t-1}$
Trend Chasing	$E_{i,t}x_{t+1} = x_{t-1} + \tau(x_{t-1} - x_{t-2})$ $E_{i,t}\pi_{t+1} = \pi_{t-1} + \tau(\pi_{t-1} - \pi_{t-2})$

Notes: models of expectations as functions of exogenous or historical data.  $\alpha \in [0.1, 0.9]$ ,  $\gamma$  and  $\tau \in [0.1, 1.5]$  in increments of 0.1.



# Key interim takeaways from experiments

- Non-rational expectations – trend chasing, constant gain and naïve expectations – are most prevalent.
- IT and the dual mandate outperform more history-dependent alternatives
- This reflects the prevalence of non-rational expectations
  - History-dependent frameworks induce extrapolative expectations (trend-chasing).





# Conclusions and Ongoing Work



# Key Interim Conclusions

- No overall winner
- But the work identifies relevant trade-offs
  - PLT stabilizes inflation well at the cost of more volatility in output and inequality
  - PLT and NGDP level targeting do well for large negative shocks (ELB)
  - NGDP growth targeting does not perform well in terms of macro stabilization at all
  - IT, AIT and dual mandate broadly perform well, though none dominate across the board
- Differences in performance are small by historical standards

# Ongoing work

- Additional model-based work:
  - Assessing the merits of each regime in particular **scenarios**
  - Evaluating the implications of alternative frameworks for **financial stability**.
  - Revisiting the implications of **raising the inflation target** in environments in which the long-run Phillips curve is not vertical and there can be hysteresis in the labour market.
  - Explicitly modelling the **extended monetary policy toolkit**.
  - Allowing for **forward-looking policy rules**.
  - **Relaxing the assumption of simple rules** by modelling frameworks as delegated loss functions that the central bank is tasked to minimize in a discretionary manner.
  - Studying the performance of alternative objectives as **temporary thresholds**.
- Empirical work to assess the historical impact of inflation targeting on labour market outcomes
- Continued work on the laboratory experiments
- Public consultations