CPI Inflation Targeting and the UIP Puzzle: An Appraisal of Instrument and Target Rules

By

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I. Specification of Monetary Policy

What Should It Be Based on?

Instrument Rule

(McCallum & Nelson)

Target Rule

(Svensson & Woodford)

"clear, succinct, robust(?)"

Instrument Rule

$$x_t = \lambda_1(\pi_t^{CPI} - \pi^{CPI^T}) + \lambda_2 x_{t-1}$$

- x = policy instrument
- π^{CPI} = target (focus) of monetary policy
- λ_1 and λ_2 are policy parameters
- Simple, pre-specified and mechanical
- Choice of policy parameters: optimal ?
- Independent of model & CB's objective function.

Target Rule

- Is firmly grounded in optimizing behavior.
- Is not knowable and practicable without knowledge of CB's objective function and complete model of the economy.
  - Target variables
  - Pre-specified target levels
  - Weight attached to each target
  - Constraint: formed by structure of the economy

- $\theta_1 x_t + \theta_2 x_{t-1} + \pi_t^{CPI} - \pi^{CPI^T} = 0$ Ex. of target rule

- Target rule + macro model give rise to **implicit reaction function.**
- **Mechanical rule** that responds optimally to shocks of model and pre-determined variables.

II. Background: the UIP Puzzle
Chinn and Meredith (2004)

Table 1. Short-Horizon Estimates of b

$$\Delta s_{t,t+k} = \alpha + \beta\left(i_{t,k} - i^*_{t,k}\right) + \varepsilon_{t,t+k}$$

	Maturity		
Currency	3 months	6 months	12 months
Deutsche mark	–0.809* (1.134)	–0.893*** (0.802)	–0.587*** (0.661)
Japanese yen	–2.887*** (0.997)	–2.926*** (0.800)	–2.627*** (0.700)
U.K. pound	–2.202*** (1.086)	–2.046*** (1.032)	–1.418*** (0.986)
French franc	–0.179 (0.904)	–0.154 (0.787)	–0.009 (0.773)
Italian lira	0.518 (0.606)	0.635 (0.670)	0.681 (0.684)
Canadian dollar	–0.477*** (0.513)	–0.572*** (0.390)	–0.610*** (0.490)
Constrained panel[1]	–0.757*** (0.374)	–0.761*** (0.345)	–0.536*** (0.369)

Notes: Point estimates from the regression in equation (7) (serial correlation robust standard errors in parentheses, calculated assuming k-1 moving average serial correlation). Sample is 1980: Q1–2000: Q4. *, **, *** indicate different from null of unity at, respectively, the 10 percent, 5 percent, and 1 percent marginal significance level.

[1]Fixed-effects regression. Standard errors adjusted for serial correlation (see text).

Reasons why UIP may not hold:

- Expectations are not rational
- Existence of a time-varying risk premium
- Conduct of monetary policy: exchange rate target combined with interest rate smoothing
- Carry trade: high interest rate (target) currencies tend to appreciate over short-horizons.

McCallum (1994)

- Provides explanation for inverse relationship between interest differential and exchange rate change
- UIP holds but there is a policy equation. CB smoothes interest rate and resists rapid exchange rate movements.
- Model:

$$x_t = \lambda_1 \Delta s_t + \lambda_2 x_{t-1} \qquad x_t = E_t s_{t+1} - s_t + \varepsilon_t$$

- When combined, the two equations yield an inverse relationship between the observed exchange rate change and the interest rate differential:
- $$\Delta s_t = -\frac{\lambda_2}{\lambda_1} x_{t-1} + \ldots\ldots$$
- Interest rate smoothing and "leaning against the wind" can explain the empirical results.

This Paper

- Focuses on **CPI Inflation Targeting.**
- Evaluates performance of *optimal simple instrument* versus *target rule* in a **small open economy model.**
    - Is one necessarily better than the other?
- Examines the relationship between changes in the nominal exchange rate and the interest differential in an optimizing framework:
    - Can the UIP puzzle be explained by both the **optimal simple instrument rule and the target rule approach** to

      monetary policy?

The Model

- $x_t = i_t - i_t^*$ (1)
- $x_t = Es_{t+1} - s_t + \rho_t$ (2)
- $\pi_t = -\alpha x_t + \alpha(E_t\pi_{t+1} - E_t\pi_{t+1}^*) + u_t$ (3)
- $\pi_t^{CPI} = (1-\gamma)\pi_t + \gamma(\Delta s_t + \pi_t^*)$ (4)

$$u_t = \kappa(v_t - a_1(i_t^* - E_t\pi_{t+1}^*) + (a_2 - a_1\gamma)\rho_t) + w_t$$

$$\alpha = \kappa((1-\gamma)a_1 + a_2)$$

1. A Simple Instrument Rule

- $$x_t = \lambda_1(\pi_t^{CPI} - \pi^{CPI^T}) + \lambda_2 x_{t-1} \quad (6)$$
- Combine instrument rule with (1) - (4) to solve for endogenous variables of the model.
- Solutions:

$$x_t = \frac{\lambda_1\gamma}{\lambda_1\gamma + \lambda_2}\rho_t$$

$$\pi_t = \left(-\frac{\alpha\lambda_1\gamma}{\lambda_1\gamma + \lambda_2} + \kappa(a_2 - a_1\gamma)\right)\rho_t + \kappa(v_t - a_1 i_t^*) + w_t$$

$$\pi_t^{CPI} = \frac{\gamma}{\lambda_1\gamma + \lambda_2}\rho_t - \frac{\lambda_2}{\lambda_1}x_{t-1}$$

$$\Delta s_t = \left(\frac{1+\lambda_1(1-\gamma)\alpha}{\lambda_1\gamma+\lambda_2} - \frac{(1-\gamma)}{\gamma}\kappa(a_2 - a_1\gamma)\right)\rho_t - \frac{\lambda_2}{\lambda_1\gamma}x_{t-1} - \frac{(1-\gamma)}{\gamma}(\kappa(v_t - a_1 i_t^*) + w_t) - \pi_t^*$$

- Coefficient on lagged interest rate differential changes to $-\frac{\lambda_2}{\lambda_1\gamma}$.
- γ = weight on exchange rate in CPI.
- Coefficient on foreign inflation is unity.

γ

Other Findings

- Policy instrument responds only to risk premium (*ρ)*.
- CPI inflation rate depends on lagged policy instrument and responds to risk premium.
- Domestic inflation responds to risk premium and composite shock (*u*).
- Exchange rate acts as “shock absorber” as it responds to all shocks.
- CPI inflation and policy instrument insensitive to structure of economy (*α).*

2. **Optimal Simple** Instrument Rule

- Determination requires specification of objective function of CB.
- CB strives to minimize variability of
  - CPI inflation rate
  - Policy instrument.
- Policy problem is:

$$\underset{\lambda_1,\lambda_2}{Min}\; E(L_t) = V(x_t) + \mu V(\pi_t^{CPI})$$

Straightforward Minimization Exercise?

- Problem 1: Multiple complex solutions

$$\lambda_1^* = -\frac{\sqrt{\mu}}{\sqrt{-1-\mu\gamma^2}} \quad \lambda_2^* = \frac{\gamma\sqrt{\mu}}{\sqrt{-1-\mu\gamma^2}}$$

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Example of inoperative instrument rule.

- Problem 2: Not consistent with a well-defined rational expectations equilibrium as two roots of the characteristic equation equal zero.

- Indeterminacy apparent in the solutions:

$$\lambda_1^* \gamma + \lambda_2^*$$

adds up to zero.

- The coefficients on risk premium in the solutions for all endogenous variables “blow up” as a result.
- UIP Puzzle: coefficient on x_{t-1} in Δs_t reduces to:

$$-\frac{\lambda_2^*}{\lambda_1^* \gamma} = 1$$ → UIP Puzzle disappears.

These Results Suggest that

- optimal instrument rule is fraught with problems.
- Proviso:
  - Highly stylized model
  - Definition of policy instrument
  - Robustness check.

3. Target Rule Approach

- Objective function: $V(x_t) + \mu V(\pi_t^{CPI})$
- Monetary policy is conducted from a timeless perspective.
- Gives rise to inertial monetary policy:

$$\theta_1 x_t + \theta_2 x_{t-1} + \pi_t^{CPI} = 0 \qquad (14)$$

Appendix provides details on derivation of target rule from intertemporal perspective.

- Target rule looks deceptively similar to IR.

Solving the Model

- Combine target rule with equations (1) – (4):
- $$x_t = \frac{\gamma}{\gamma + \theta_2}\rho_t$$

$$\pi_t = -\left(\frac{\kappa\left(\left((1-\gamma)a_1 + a_2\right) - (a_2 - a_1\gamma)(\gamma + \theta_2)\right)}{\gamma + \theta_2}\right)\rho_t + \kappa(v_t - a_1 i_t^*) + w_t$$

$$\pi_t^{CPI} = -\theta_2 x_{t-1} - \frac{\theta_1}{\gamma + \theta_2}\rho_t$$

- Notice that θ_1 does not appear in solutions for x_t and π_t.

- The solution for the exchange rate change:

$$\Delta s_t = -\frac{\theta_2}{\gamma} x_{t-1}$$
$$-\left[\left(\frac{\theta_1 + (1-\gamma)(-\alpha)}{\gamma}\right)\frac{\gamma}{\gamma+\theta_2} - \frac{(1-\gamma)}{\gamma}\kappa(a_2 - a_1\gamma)\right]\rho_t$$
$$-\frac{(1-\gamma)}{\gamma}\left(\kappa(v_t - a_1 i_t^*) + w_t)\right) - \pi_t^*$$

Determining the Weights in the Target Rule

- Policy objective: $\min_{\theta_1,\theta_2} E[L_t] = V(x_t) + \mu V(\pi_t^{CPI})$
- Optimal values of policy parameters:

$$\theta_1^* = 0 \qquad \theta_2^* = \frac{1}{\mu\gamma}$$

- Hence optimal target rule becomes:

$$\pi_t^{CPI} = -\frac{1}{\mu\gamma} x_{t-1}$$

Consistent with intertemporal approach.

Implications of the Target Rule Approach

- CPI inflation is pre-determined and immune to risk premium.
- Hence components of CPI inflation – domestic inflation and ex-rate change - bear burden of adjustment.
- Response of other endogenous variables to risk premium is well-defined.
- Policy instrument and CPI inflation independent of α.

Target Rule and the UIP Puzzle

- Coefficient on x_{t-1} in Δs_t equals $-\frac{1}{\mu\gamma^2}$.
- There is a well-defined relationship between the exchange rate and the lagged interest rate differential but it cannot be positive.
- The greater the emphasis on stable inflation, the weaker the link between the two variables.
- In countries where CPI inflation is the “overriding goal of monetary policy” one should find little or no evidence in standard tests for UIP.

A Comparison

Table 1A: The Response of the Policy Instrument and Domestic Inflation to the Risk Premium.

	Instrument Rule	Target Rule
Coefficient on\ Solution for	x_t	
ρ_t	$\frac{\lambda_1\gamma}{\lambda_1\gamma+\lambda_2}$	$\frac{\mu\gamma^2}{\mu\gamma^2+1}$
	π_t	
ρ_t	$\frac{-\alpha\lambda_1\gamma}{\lambda_1\gamma+\lambda_2}+\kappa(a_2-a_1\gamma)$ **If** $\frac{\lambda_1}{\lambda_2}=\mu\gamma$ **then above equals** $-\frac{\kappa(a_1\gamma(\gamma\mu+1)-a_2)}{\gamma^2\mu+1}$	$-\frac{\kappa(a_1\gamma(\gamma\mu+1)-a_2)}{\gamma^2\mu+1}$

A Hypothetical Instrument Rule

- Choose ratio of policy parameters in the instrument rule such that $\frac{\lambda_1}{\lambda_2} = \mu\gamma$.
- This choice delivers identical response of π_t and x_t *to risk premium* under the instrument and the target rule approach.
- Both variables do not depend on lagged policy instrument.
- Need to look at π_t^{CPI} and Δs_t which do.

Table 1B: The Response of CPI inflation and the Change in the Exchange Rate to the Lagged Policy Instrument and the Risk Premium.

	Instrument Rule	Target Rule
Coefficient on\ Solution for	π_t^{CPI}	
x_{t-1}	$-\frac{\lambda_2}{\lambda_1}$	$-\frac{1}{\mu\gamma}$
ρ_t	$\frac{\gamma}{\lambda_1\gamma + \lambda_2}$ If $\frac{\lambda_1}{\lambda_2} = \mu\gamma$ then above equals $\frac{\frac{\gamma}{\lambda_2}}{\mu\gamma^2 + 1}$	0
	Instrument Rule	Target Rule
Coefficient on\ Solution for	Δs_t	
x_{t-1}	$-\frac{\lambda_2}{\lambda_1\gamma}$	$-\frac{1}{\mu\gamma^2}$
ρ_t	$\frac{1+\lambda_1(1-\gamma)\alpha}{\lambda_1\gamma+\lambda_2}$ If $\frac{\lambda_1}{\lambda_2} = \mu\gamma$ then above equals $\frac{\frac{1}{\lambda_2} + \alpha(1-\gamma)\mu\gamma}{\mu\gamma^2 + 1}$	$\frac{\alpha(1-\gamma)\mu\gamma}{\mu\gamma^2+1}$

…..so even if this ratio is chosen, the target rule is superior as

- the instrument rule cannot deliver optimal response of CPI inflation and the change in exchange rate to risk premium.
- This can be seen by comparing the entries of the second and fourth row of Table 1B.
- CPI Inflation: according to the target rule approach, the optimal response coefficient should be zero.
- The instrument rule cannot achieve this.

- Change in exchange rate: same argument applies. The only way to make the two coefficients equal is to let $\lambda_2 \to \infty$. But this conflicts with keeping $\frac{\lambda_1}{\lambda_2}$ equal to $\mu\gamma$.

Why is the Target Rule Superior Than the Instrument Rule?

$$x_t = \frac{1}{(1-\gamma)\alpha}\left(\theta_2 x_{t-1} + (1-\gamma)(\alpha(E_t\pi_{t+1} - E_t\pi^*_{t+1}) + u_t) + \gamma(\Delta s_t + \pi^*_t)\right)$$

$$u_t = \kappa(v_t - a_1(i^*_t - E_t\pi^*_{t+1}) + (a_2 - a_1\gamma)\rho_t) + w_t$$

- Target rule relies on mechanical reaction function that adjusts policy instrument optimally in the wake of *all* shocks of the model.
- Reaction function responds to u_t .
- Simple instrument rule responds to CPI inflation rate only.
- Target rule relies on more information.

Conclusion

- Developed a highly stylized open-economy macro model
- Central bank cares only about the variability of CPI inflation and the policy instrument
- An optimizing strategy based on a simple instrument rule cannot be implemented.
- The target rule approach works and yields the optimal outcome.

- A hypothetical instrument rule that depends on the ratio of the policy parameters works but is inferior to the target rule approach.
- The target rule assumes that the policymaker can react to all shocks of the model: more information intensive than instrument rule.
- UIP Puzzle cannot be explained by optimizing central bank that operates a simple instrument rule.
- Target rule approach can explain phenomenon.