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Price Level Targeting in a Small Open Economy with Financial Frictions: Welfare Analysis

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Introduction

- The maintenance of price stability is established as the principal objective of most central banks worldwide.
- Inflation targeting (IT) has been proved successful in sustaining low inflation and low inflation volatility.
- However, some central banks, in particular the Bank of Canada, have started investigating the merits of price-level path (PLT) targeting rather than inflation targeting.
- The Bank of Canada is considering alternative monetary policies when renewing its contract with the government in 2011.

Introduction (con./t)

- Two different implications: (1) IT $\Rightarrow$ all shocks to price level are permanent; (2) PLT $\Rightarrow$ past shocks to price level must be reversed in the future.

- PLT would be equivalent to target a long-run average of inflation rate, but not require central bank to stabilize inflation in the short terms.

- Under PLT, the central bank aims at correcting deviations of the price level from the target using inflationary and deflationary policies to bring the price level to its target.

Introduction (con./t)

- *Conventional wisdom* (Fisher 1994 and Duguay 1994): PLT implies trade-off between long-term price level variability and short-term volatility of inflation and output.

- *New view*:

  1. Svensson (1999): Under rational expectations (RE), PLT leads to lower inflation without increasing output variability (free lunch);
  2. Clarida, Gali and Gertler (1999): In a forward-looking model, optimal monetary policy under commitment is characterized by a stationary price level;
  3. Vestin (2006): If central bank commits to PLT, then rational expectations become automatic stabilizers.

Introduction (con./t)

- Main motivation behind PLT is the presence of nominal contracts in the economy (in particular debt contracts).

- Nevertheless, most of previous DSGE studies that have compared IT vs PLT ignore the presence of nominal debt contract (Batini and Yates 2003, Ortega and Rebei 2006, and others).

- Other recent papers at the Bank of Canada have included nominal contracts, but using different approaches: Covas and Zhang (2007); Kryvtsov, Shukayev and Ueberfeldt (2007); Meh, Rios-Rull and Terajima (2008); and others

This paper

- Extends Dib (2008), a multi-sector small open economy model, by incorporating financial frictions (corporate balance sheet channel à la BGG 1999) and nominal debt contracts ⇒ debt deflation effects.

- Its main objective is **to assess and compare** the merits of PLT vs IT using optimized monetary policy rules and a second-order approximation method.

- Examines the role of financial imperfections in PLT vs IT debate.

- It also estimates the structural parameters of the model using Bayesian approach.

Outline

- Overview of the model
- Calibration and Estimation
- Variance decomposition
- Optimized monetary policy and welfare analysis
- Conclusion

Main features of the model

- A multi-sector SOE model with financial frictions à la BGG (1999)and allowing for domestic and cross-border lending;

- Continuum of households, entrepreneurs in traded and non-traded goods sectors, capital producers, retailers, importers, and a monetary authority;

- Sectorial-specific price and wage rigidities à la Calvo-Yun style contract $\Rightarrow$ price and wage dispersions and partial exchange rate pass-through;

- Different elasticities in the aggregation of consumption and investment;

- Eleven shocks (including two financial shocks to external finance premia).

Households

- Continuum of household with monopoly power in labour markets

- Preferences: $E_0 \sum_{t=0}^{\infty} \beta^t u(C_{ht}, H_{ht})$,

  where $u(\cdot) = \frac{C_{ht}^{1-\tau}}{1-\tau} + \frac{(1-H_{ht})^{1-\gamma}}{1-\gamma}$ and $H_{ht} = \left[\eta_T H_{T,ht}^{\frac{1+\varsigma}{\varsigma}} + \eta_N H_{N,ht}^{\frac{1+\varsigma}{\varsigma}} \right]^{\frac{\varsigma}{1+\varsigma}}$,

- Budget constraint:

$$P_t C_{ht} + D_{ht} + \frac{e_t B_{ht}^*}{\kappa_t R_t^*} \leq W_{T,ht} H_{T,ht} + W_{N,ht} H_{N,ht}$$
$$+ R_{t-1} D_{ht-1} + e_t B_{ht-1}^* + \Omega_{ht} - T_{ht}$$

Entrepreneurs

- Produce wholesale traded or non-traded goods using labour supplied by households and capital constructed by capital producers.
- Risk neutral and have finite expected lifetime with a given probability of surviving to next period.
- Borrow from a domestic or foreign financial intermediaries to finance a fraction of their capital acquisitions.
- **Information asymmetry between financial intermediaries and entrepreneurs** and **costly state verification** imply external finance premia.

Entrepreneurs (con./t)

Balance sheet identity :

- Non-tradable sector:

  $X_{N,t} = q_{N,t} K_{N,t+1} - D_t,$

- Tradable sector:

  $X_{T,t} = q_{T,t} K_{T,t+1} - s_t D_t^*,$

Optimal Loan Contracts

- Optimal loan contracts:

  - Non-tradable sector: $E_t f_{N,t+1} = E_t \left[\frac{R_t}{\pi_{t+1}} \left(\frac{X_{N,t}}{q_{N,t} K_{N,t+1}} \right)^{-\psi_N} \Gamma_{N,t} \right]$

  - Tradable sector: $E_t f_{T,t+1} = E_t \left[\frac{R_t^*}{\pi_{t+1}^*} \frac{s_{t+1}}{s_t} \left(\frac{X_{T,t}}{q_{T,t} K_{T,t+1}} \right)^{-\psi_T} \Gamma_{T,t} \right]$,

  where $\Gamma_{j,t} \sim AR(1)$ are EFP (financial sector) shocks and

$$E_t f_{j,t+1} = E_t \left[\frac{z_{j,t+1} + (1-\delta) q_{j,t+1}}{q_{j,t}} \right]$$

Optimal Loan Contracts (con./t)

- Net worth
  - Non-tradable sector: $X_{N,t} = \zeta_N \left[f_{N,t} q_{N,t-1} K_{N,t} - E_{t-1} f_{N,t} D_{t-1} \right],$
  - Non-tradable sector: $X_{T,t} = \zeta_T \left[f_{T,t} q_{T,t-1} K_{T,t} - E_{t-1} f_{T,t} s_t D^*_{t-1} \right],$

Capital producers

- Capital producers use aggregated investment to produce capital goods.
- Investment adjustment costs: $S(I_{j,t}, I_{j,t-1}) = \frac{\chi_j}{2}\left(\frac{I_{j,t}}{I_{j,t-1}} - 1\right)^2 I_{j,t}$.
- Maximization problem is dynamic

  $E_t \sum_{t=0}^{\infty} \beta^t \lambda_t \left[\sum_{j=N,T} q_{j,t}[\mu_t - S(I_{j,t}, I_{j,t-1})] - p_{I,t} I_{j,t}\right]$,

  where $\mu_t \sim AR(1)$, investment-efficiency shock.

Capital producer (con./t)

- FOC $\Rightarrow$ Capital prices in sector $j = N, T$ is given by

$$\mu_t q_{j,t} = p_{I,t} \{1 + S'(., t)\} - \beta E_t [p_{I,t+1} S'(., t+1) p_{I,t+1}]$$

- Laws of motion of capital stocks:

$K_{j,t+1} = \mu_t I_{j,t} + (1 - \delta) K_{j,t}$

Consumption Goods

- Consumption,

$$\widetilde{C}_t = \left[{\omega_T^C}^{\frac{1}{\nu^C}} {Y_{T,t}^C}^{\frac{\nu^C - 1}{\nu^C}} + {\omega_N^C}^{\frac{1}{\nu^C}} {Y_{N,t}^C}^{\frac{\nu^C - 1}{\nu^C}} + {\omega_F^C}^{\frac{1}{\nu^C}} {Y_{F,t}^C}^{\frac{\nu^C - 1}{\nu^C}} \right]^{\frac{\nu^C}{\nu^C - 1}},$$

where $\widetilde{C}_t = C_t + G_t$

- consumer-price index (P_t)

$$P_t = \left[\omega_T^C P_{T,t}^{1-\nu^C} + \omega_N^C P_{N,t}^{1-\nu^C} + \omega_F^C P_{F,t}^{1-\nu^C} \right]^{1/(1-\nu^C)}$$

Investment Goods

- Investment:

$$I_t = \left[\omega_T^I{}^{\frac{1}{\nu^I}} Y_{T,t}^I{}^{\frac{\nu^I - 1}{\nu^I}} + \omega_N^I{}^{\frac{1}{\nu^I}} Y_{N,t}^I{}^{\frac{\nu^I - 1}{\nu^I}} + \omega_F^I{}^{\frac{1}{\nu^I}} Y_{F,t}^I{}^{\frac{\nu^I - 1}{\nu^I}} \right]^{\frac{\nu^I}{\nu^I - 1}}$$

where $I_t = I_{Nt} + I_{Tt}$

- Investment-price index $(P_{I,t})$

$$P_{I,t} = \left[\omega_T^I P_{T,t}^{1-\nu^I} + \omega_N^I P_{N,t}^{1-\nu^I} + \omega_F^I P_{F,t}^{1-\nu^I} \right]^{1/(1-\nu^I)}$$

- $\nu^C > \nu^I$ and $\omega^C \neq \omega^I \Rightarrow P_t \neq P_{I,t}$.

Monetary authority

- Inflation Targeting (IT) rule:

$$\log\left(\frac{R_t}{R}\right) = \varrho_R \log\left(\frac{R_{t-1}}{R}\right) + \varrho_\pi \log\left(\frac{\pi_t}{\tilde{\pi}_t}\right) + \varrho_Y \log\left(\frac{\widetilde{Y}_t}{Y}\right) + \varepsilon_{Rt},$$

where $\tilde{\pi}_t \sim AR(1)$ is an inflation targeting shock and $\widetilde{Y}_t$ is output gap.

- Price Level Targeting (PLT) rule:

$$\log\left(\frac{R_t}{R}\right) = \varrho_R \log\left(\frac{R_{t-1}}{R}\right) + \varrho_P \log\left(\frac{P_t}{\widetilde{P}_t}\right) + \varrho_Y \log\left(\frac{\widetilde{Y}_t}{Y}\right) + \varepsilon_{Rt},$$

where $P_t = \pi_t P_{t-1}$ and $\widetilde{P}_t = \widetilde{\pi}_t \widetilde{P}_{t-1}$ are level and targeted prices, respectively.

Table 1: **Calibration of the parameters**

Financial sector:			
ζ_T=**0.987**;	ζ_N=**0.987**;	$\frac{X_T}{q_T K_T}$=**0.6**;	$\frac{X_N}{q_N K_N}$=**0.6**
Preferences:			
β=0.991;	τ= 2;	ς=1 ;	γ=1
Technology:			
α_T=0.35;	α_N=0.3;	δ=0.025	
Aggregation:			
ν^C=0.8;	ω_T^C=0.2;	ω_N^C=0.58;	ω_F^C=0.22;
ν^I=0.6;	ω_T^I=0.2	ω_N^I=0.4;	ω_F^I=0.4;
θ=6;	ϑ=8		
Nominal interest and inflation rates:			
R=1.0182;	π=1.0089;	R^*=1.0149;	π^*=1.0088

Estimation

- Estimation procedure: Bayesian procedure is used
- Only structural parameters not affecting the steady-state equilibrium are estimated: Elasticities of external finance premia ψ_T and ψ_N; monetary policy parameters; price and wage rigidity parameters; investment adjustment cost parameters; exogenous processes parameters.
- Data: We use 11 Canadian and US time series covering the period 1981Q1–2007Q2.

Table 2: **Prior and posterior estimates: Sample 1981Q1–2007Q2**

		Prior			Posterior		
Coef.	Description	Density	Mean	Std	Mean	[5 ,	95]
ψ_T	EFP elasticity	G	0.07	0.025	**0.033**	0.023	0.042
ψ_N	EFP elasticity	G	0.07	0.025	**0.028**	0.019	0.037
χ_T	Inv. adjust. cost	G	4.00	1.00	**0.54**	0.45	0.65
χ_N	Inv. adjust. cost	G	4.00	1.00	**0.45**	0.44	0.46
ϱ_R	Taylor rule: Smoothing	B	0.60	0.20	**0.81**	0.71	0.92
ϱ_π	Taylor rule: Inflation	G	0.50	0.30	**0.47**	0.36	0.58
ϱ_Y	Taylor rule: Output	N	0.125	0.10	**0.028**	0.008	0.0046
ϕ_T	Calvo price parameter	B	0.67	0.05	0.66	0.59	0.74
ϕ_N	Calvo price parameter	B	0.67	0.05	0.49	0.42	0.55
ϕ_F	Calvo price parameter	B	0.67	0.05	0.72	0.65	0.79
φ_T	Calvo wage parameter	B	0.67	0.05	0.63	0.55	0.72
φ_N	Calvo wage parameter	B	0.67	0.05	0.56	0.48	0.65

Table 3: **Prior and posterior estimates: Sample 1981Q1–2007Q2**

		Prior			Posterior		
Coef.	Description	Density	Mean	Std	Mean	[5 ,	95]
ρ_{AT}	Technology	B	0.60	0.20	0.86	0.80	0.91
ρ_{AN}	Technology	B	0.60	0.20	0.92	0.88	0.96
ρ_{G}	Government spending	B	0.60	0.20	0.90	0.87	0.92
ρ_{x}	Investment-specific	B	0.60	0.20	0.95	0.92	0.97
ρ_{Γ_T}	Foreign Financial	B	0.60	0.20	**0.99**	0.98	0.99
ρ_{Γ_N}	Domestic Financial	B	0.60	0.20	**0.98**	0.97	0.99
ρ_{R^*}	Foreign interest rate	B	0.60	0.20	0.96	0.93	0.99
ρ_{π^*}	Foreign inflation	B	0.60	0.20	0.72	0.63	0.80
ρ_{Y^*}	Foreign output	B	0.60	0.20	0.94	0.91	0.98

Table 4: **Prior and posterior estimates: Sample 1981Q1–2007Q2**

		Prior			Posterior		
Coef.	Description	Density	Mean	Std	Mean	[5 ,	95]
σ_{AT}	Technology	I	0.50	2.00	2.60	2.31	3.33
σ_{AN}	Technology	I	0.50	2.00	0.96	0.81	1.10
σ_{G}	Government spending	I	0.50	2.00	3.42	3.01	3.86
σ_{R}	Monetary policy	I	0.50	2.00	0.36	0.31	0.42
σ_{x}	Investment-specific	I	0.50	2.00	1.54	1.31	1.78
σ_{Γ_T}	Foreign Financial	I	0.50	2.00	**0.10**	0.09	0.12
σ_{Γ_N}	Domestic Financial	I	0.50	2.00	**0.12**	0.10	0.14
$\sigma_{\tilde{\pi}}$	Inflation target	I	0.50	2.00	0.16	0.12	0.20
σ_{R^*}	Foreign interest rate	I	0.50	2.00	0.36	0.28	0.46
σ_{Y^*}	Foreign output	I	0.50	2.00	0.66	0.59	0.74
σ_{π^*}	Foreign inflation	I	0.50	2.00	0.26	0.23	0.29
	log likelihood at mean			-3765.15			

Table 5: **Variance Decomposition**

Shocks:	$A_{T,t}$	$A_{N,t}$	R_t	R_t^*	μ_t	Γ_{Tt}	Γ_{Nt}
			Inflation Targeting (IT)				
Real exchange rate	4.2	8.5	3.4	20.1	3.5	**12.6**	**31.9**
Tradable Output	28.9	0.7	0.2	12.2	5.4	**34.6**	**5.9**
Non-Tradable Output	0.0	28.3	2.2	3.0	4.3	**1.4**	**54.9**
CPI Inflation	0.2	3.3	12.3	0.3	0.5	0.3	0.8

Distortions and Monetary Policy

There are two main sources of distortions in this economy:

- **Price and wage stickiness:** Variations in inflation deliver higher costs of price and wage dispersions: A strong anti-inflationary stance reducing the cost of price and wage dispersions could increase welfare.

- **Debt contracts in nominal terms** generate unnecessary redistribution of wealth between borrowers and lenders as a result of unexpected changes in the price level. Stability around a price-level path could minimize the distortion generated by the debt-deflation channel and improve welfare.

Welfare Analysis

We rely on utility-based welfare calculations to assess the desirability of PLT vs IT, using second order approximation procedure. Monetary authority optimization problem is

$$\max_{\{\varrho_Y, \varrho_\pi, or \, \varrho_P\}} E_0 \left[\sum_{t=0}^{\infty} \beta^t U(C_t^*, H_t^*) \right]$$

subject to the model's equilibrium conditions and (IT)

$$\widehat{R}_t = \varrho_R \widehat{R}_{t-1} + \varrho_\pi (\widehat{\pi}_t - \widehat{\widetilde{\pi}}_t) + \varrho_Y \widehat{\widetilde{Y}}_t + \varepsilon_{Rt}$$

or (PLT)

$$\widehat{R}_t = \varrho_R \widehat{R}_{t-1} + \varrho_P (\widehat{P}_t - \widehat{\widetilde{P}}_t) + \varrho_Y \widehat{\widetilde{Y}}_t + \varepsilon_{Rt}$$

Table 6: **Optimal PLT vs. IT Rules**

	Welfare	Welfare cost in % of C
1. Estimated rule: $\varrho_R = 0.81$, $\varrho_\pi = 0.47$,$\varrho_y = 0.03$	-2.2858	**-1.058**
2. Optimal PLT rules:		
A. Smoothing rule: $\varrho_R = 0.81$, $\varrho_p = 2.5$,$\varrho_y = 1.5$	-2.2803	**-0.700**
B. Non-smoothing rule: $\varrho_R = 0$, $\varrho_p = 5$,$\varrho_y = 3$	-2.2804	-0.702

- Optimal PLT $\Longrightarrow$ 34% less consumption loss w.r.t. the estimated rule.

Table 7: **Optimal PLT vs. IT Rules**

	Welfare	Welfare cost in % of C
1. Estimated rule: $\varrho_R = 0.81$, $\varrho_\pi = 0.47, \varrho_y = 0.03$	-2.2858	**-1.058**
2. Optimal PLT rules:		
A. Smoothing rule: $\varrho_R = 0.81$, $\varrho_p = 2.5, \varrho_y = 1.5$	-2.2803	**-0.700**
B. Non-smoothing rule: $\varrho_R = 0$, $\varrho_p = 5, \varrho_y = 3$	-2.2804	-0.702
3. Optimal IT rules:		
A. Smoothing rule: $\varrho_R = 0.81$, $\varrho_\pi = 6.5, \varrho_y = 0.5$	-2.2810	**-0.749**
B. Non-smoothing rule: $\varrho_R = 0$, $\varrho_\pi = 20, \varrho_y = 1.5$	-2.2814	-0.776

- Optimal IT $\Longrightarrow$ 29% less consumption loss w.r.t. the estimated rule.

- A strict anti-inflationary stance (under both rules) is not optimal.

Table 8: **Inflation Targeting vs Price Level Targeting**

Costs of price and wage dispersions, ϱ_R=0.81

	Estimated	Optimal PLT	Optimal IT
$\mu(s_T^p)$	1.0034	**1.0019**	**1.0019**
$\mu(s_N^p)$	1.0010	**1.0005**	**1.0004**
$\mu(s_F^p)$	1.0056	**1.0026**	**1.0029**
$\mu(s_T^w)$	1.0035	**1.0016**	**1.0017**
$\mu(s_N^w)$	1.0020	**1.0009**	**1.0009**

- Optimal PLT and IT rules lower costs of price and wage dispersions in all sectors, compared to the estimated rule.

Table 9: **Level and Stabilization Effects: PLT vs IT**

Smoothing coefficient: ϱ_R=0.81

	Estimated	Optimal PLT	Optimal IT
$\sigma(C)$	1.73	1.73	1.73
$\mu(C)$	0.6595	**0.6612**	0.6610
$\sigma(rr)$	0.57	**0.49**	0.60
$\mu(rr)$	1.0091	1.0091	1.0091
$\sigma(\pi)$	1.26	**0.80**	0.79
$\mu(\pi)$	1.0091	**1.0089**	1.0090
$\sigma(Y)$	3.04	**2.83**	3.05
$\mu(Y)$	1.0833	**1.0853**	1.0851
$\sigma(R)$	1.16	**0.86**	0.95
$\mu(R)$	1.0183	1.0181	1.0181
$\sigma(S)$	3.77	**3.49**	3.71
$\mu(S)$	0.4944	0.4950	0.4954

Monetary policy and financial shocks

Table 10: **PLT vs IT and financial shocks**

	welfare cost% of C all shocks	welfare cost% of C no fin. shocks	welfare cost%C Only fin. shocks
IT	0.749	0.516	0.233
PLT	0.700	0.486	-0.214

Table 11: **PLT vs IT: Only Financial Shocks**

Stabilization effects PLT vs IT, financial shocks

	$\sigma(c)$	$\sigma(rr)$	$\sigma(\pi)$	$\sigma(R)$	$\sigma(y)$	$\mu(c)$	$welfarecost$
IT	0.96	0.50	0.18	0.17	1.87	0.6626	$-\mathbf{0.233}$
PLT	0.96	**0.24**	**0.13**	0.26	**1.81**	0.6627	$-\mathbf{0.214}$

In the presence of only financial shocks, PLT implies less volatility.

Inflation and Optimal Policy

What is the probability of inflation being more than 1% above or below target (2% annual) under the alternative rules?

Inflation: 200 periods, average over 500 simulations for each rule

	1% above	1% below	outside band
IT	1.49%	4.98%	6.47%
PLT	13.93%	1.99%	15.92%
$Estimated$	31.84%	10.45%	42.29%

Thus, under PLT, higher welfare but inflation is more likely to be outside a 1% band around the target!

Concluding Remarks

- We have developed a New-Keynesian model with financial frictions and nominal debt contracts. Structural parameters of the model are estimated using Bayesian procedure and Canadian and U.S. data.

- We have assessed the desirability of price-level targeting rules in an estimated small open economy model with financial frictions.

- Compared to an estimated monetary policy rule, an optimal price-level targeting rule reduces the welfare cost of business cycle fluctuations by about 34%.

- In the class of non-inertial rules, there are some welfare gains from adopting an optimal PLT instead of an optimal IT rule (about 10%).

Concluding Remarks

- PLT performs better than IT in terms of social welfare since it delivers lower variability of real interest rates (nominal debt distortion) and slightly reduces costs of price and wage dispersions.

- But, at the estimated interest-rate smoothing the welfare gains of adopting PLT are reduced in the absence of financial shocks.

- Moreover, the two regimes deliver similar inflation volatility; however, inflation variability outside a 1% band around the target is significantly higher under PLT.