Bumps in the Road: Ever-Evolving Monetary Policy in Canada

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Online Appendix

Baseline specification

Our baseline specification is a forward-looking monetary policy rule that allows the policy rate to respond to the real-time forecasts of inflation, output gap, a time-varying real interest rate, and a lagged policy interest rate:

$$i_t = c + \rho i_{t-1} + \phi_r r_t + \phi_\pi E_t\,(\pi_{t+h_\pi} - \pi^*_{t+h_\pi}) + \phi_x E_t\,(x_{t+h_x}) + \epsilon_t\,,$$

where i_t is the nominal policy rate at time t, r_t is the long-run real interest rate, E_t denotes the Bank's forecasts formed at time t, π_t is the inflation rate, π^*_t is the inflation target, x_t is the output gap, h_π and h_x are the forecast horizons for inflation and output gap, respectively, and ϵ_t represents the monetary policy shocks. The parameter ρ measures the degree of policy inertia, and the parameters ϕ_π and ϕ_x are the Bank's short-run responses to expected inflation and output gap, respectively. The long-run response to expected inflation is given by $\frac{\phi_\pi}{1-\rho}$. If $\frac{\phi_\pi}{1-\rho} > 1$,

the Taylor principle is satisfied. To account for the fact that the neutral real interest rate varies over time, we use the 10-year real government bond returns for r_t as in Clarida (2012).

We set the baseline forecast horizons for inflation and output gap at $h_\pi = 4$ and $h_x = 2$, respectively. We consider all possible combinations of forecast horizons ($h = 0,\dots,7$) for the forward-looking variables and we compute the AIC, BIC and HQIC criteria for each specification. All the information criteria favour the $h_\pi = 4$ and $h_x = 2$ specification as it achieves the lowest AIC, BIC and HQIC scores.[1] Estimates of our baseline specification using data between 1991Q1 and 2015Q4 and the results of various robustness analysis can be found in Table 1 in Pang and Shiamptanis (2024).[2]

Specification with new inflation term

We draw from Surico (2007), Neuenkirch and Tillmann (2014), Paloviita et al. (2021) and Bianchi et al. (2021) and augment the baseline monetary policy reaction function with the new inflation term

$$i_t = c + \rho i_{t-1} + \phi_r r_t + \phi_\pi E_t\,(\pi_{t+h_\pi} - \pi^*_{t+h_\pi}) + \phi_x E_t\,(x_{t+h_x}) + \phi_{id}\,\tilde{\pi}_t\,|\tilde{\pi}_t| + \epsilon_t\,,$$

where $\tilde{\pi}_t\,|\tilde{\pi}_t|$ is the new term and $\tilde{\pi}_t$ can be backward looking and equal the average of past inflation deviations over the last P quarters,

$$\tilde{\pi}_t = \frac{\sum_{p=1}^{P}(\pi_{t-p} - \pi^*_{t-p})}{P};$$

1 See Table 2 in Pang and Shiamptanis (2024) online appendix for detailed results.

2 Additional robustness analysis can be found in Sections 2 and 4 in Pang and Shiamptanis (2024) online appendix.

alternatively, $\tilde{\pi}_t$ can be forward looking and equal the average of the contemporaneous and future forecasts of inflation deviations over the next Q quarters,

$$\tilde{\pi}_t = \frac{\sum_{q=0}^{Q}(\pi_{t+q} - \pi^*_{t+q})}{1+Q}.$$

We then investigate the possibility of an asymmetric response to positive and negative inflation deviations and estimate the following equation

$$i_t = c + \rho i_{t-1} + \phi_r r_t + \phi_\pi E_t(\pi_{t+h_\pi} - \pi^*_{t+h_\pi}) + \phi_x E_t(x_{t+h_x})$$
$$+\phi_{id}^{pos} D_t^{pos} \tilde{\pi}_t|\tilde{\pi}_t| + \phi_{id}^{neg} D_t^{neg} \tilde{\pi}_t|\tilde{\pi}_t| + \epsilon_t,$$

where $\tilde{\pi}_t\,|\tilde{\pi}_t|>0$ captures positive inflation deviations (i.e., overshoots) and $\tilde{\pi}_t\,|\tilde{\pi}_t|<0$ captures negative inflation deviations (i.e., undershoots). D_t^{pos} is a dummy variable that is equal to 1 if $\tilde{\pi}_t\,|\tilde{\pi}_t|>0$ and 0 otherwise, and D_t^{neg} is a dummy variable that is equal to 1 if $\tilde{\pi}_t\,|\tilde{\pi}_t|<0$ and 0 otherwise.

Construction of the two scenario paths

To evaluate the Bank's monetary policy stance since 2019, we use estimates of the symmetric and asymmetric scenarios reported in Columns 2 and 4 of Table 5 in Pang and Shiamptanis (2024). The statistically insignificant coefficients are set to zero in each scenario.[3]

Symmetric

$$i_t = 0.001997 + 0.886265 \times i_{t-1} + 0.130933 \times r_t + 0 \times E_t\,(\pi_{t+h_\pi} - \pi^*_{t+h_\pi})$$
$$+ 0.139939 \times E_t\,(x_{t+h_x}) + 90.29357 \times \tilde{\pi}_t\,|\tilde{\pi}_t| + \epsilon_t;$$

Negative Deviations

$$i_t = 0.001993 + 0.886181 \times i_{t-1} + 0.130886 \times r_t + 0 \times E_t\,(\pi_{t+h_\pi} - \pi^*_{t+h_\pi})$$
$$+ 0.140254 \times E_t\,(x_{t+h_x}) + 0 \times D_t^{pos}\,\tilde{\pi}_t\,|\tilde{\pi}_t| + 89.9912 \times D_t^{neg}\,\tilde{\pi}_t\,|\tilde{\pi}_t| + \epsilon_t$$

The estimated coefficient on the persistent future inflation deviation term in the symmetric case is 90.29357 and statistically significant at the 1 percent level, which suggests that if the average inflation over the current and the next 9 quarters is expected to overshoot (undershoot) the 2 percent target by 1 percentage point, then the Bank will increase (decrease) the interest rate by 0.9029357 percentage points.[4] The quadratic feature of the new term indicates that larger deviations prompt even larger interest rate changes. If inflation is expected to overshoot (undershoot) its target by 2 percentage points, then the interest rate will increase (decrease) by 3.6117428 percentage points.[5] In the asymmetric case,

3 The paths are almost identical even if the statistically insignificant coefficients are set to the estimated values.

4 0.01 × 0.01 × 90.29357 × 100 = 0.9029357, i.e., 90.29357 basis points.

5 0.02 × 0.02 × 90.29357 × 100 = 3.6117428, i.e., 361.17428 basis points.

Table A1: 2019Q1 – 2024Q2 Data					
	i_t	r_t	$E_t\,(\pi_{t+4} - \pi^*_{t+4})$	$E_t\,(x_{t+2})$	$\tilde{\pi}_t$
2019Q1	2.00	0.26	0.08	-0.70	1.99
2019Q2	2.00	-0.48	0.00	-0.30	1.97
2019Q3	2.00	-0.53	-0.05	-0.20	1.98
2019Q4	2.00	-0.58	0.00	-0.30	2.01
2020Q1	1.73				
2020Q2	0.50	0.69	-1.15	-6.19	0.92
2020Q3	0.50	0.35	-0.98	-3.84	1.04
2020Q4	0.50	-0.03	-0.50	-3.42	1.45
2021Q1	0.50	-0.35	0.15	-2.68	2.18
2021Q2	0.50	-1.91	0.75	-2.73	2.77
2021Q3	0.50	-2.87	0.78	-1.81	3.08
2021Q4	0.50	-3.12	1.00	-0.30	3.29
2022Q1	0.58	-3.67	1.98	0.32	3.84
2022Q2	1.34	-4.61	3.35	0.90	5.02
2022Q3	2.80	-4.20	1.87	1.10	4.12
2022Q4	3.98	-3.54	0.60	0.69	3.35
2023Q1	4.68	-2.17	0.40	0.79	2.70
2023Q2	4.82	-0.49	0.55	0.19	2.61
2023Q3	5.22	-0.06	0.70	-0.10	2.72
2023Q4	5.25	0.38	0.40	-0.90	2.54
2024Q1	5.25	0.63	0.18	-1.20	2.32
2024Q2	5.00	0.88	0.20	-1.25	2.20

Source: Authors' compilation.

both coefficients ϕ_{id}^{pos} and ϕ_{id}^{neg} have the expected sign, but only the negative inflation deviation term is statistically significant (at the 1 percent level), suggesting that between 1995Q1 and 2015Q4 the Bank appears to be responding more to inflation undershooting than overshooting. The estimated coefficient on the negative inflation deviation term is 89.9912, which suggests that if the average inflation over the current and the next 9 quarters is expected to undershoot the 2 percent target by 1 percentage point, then the Bank will decrease the interest rate by 0.899912 percentage points.[6]

6 0.01 × 0.01 × 89.9912 × 100 = 0.899912, i.e., 89.9912 basis points.