"WHY ARE TARGET INTEREST RATE CHANGES SO PERSISTENT?"

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WEB APPENDIX

This appendix describes the Monte Carlo experiment mentioned in footnote 6 of the paper. The purpose of this experiment is to document that using non-monetary structural shocks as instrumental variables yields consistent estimates of the degree of interest rate smoothing. The model used for simulations is the basic New Keynesian model which is modified to capture the properties of the empirical specification estimated in the paper. Specifically, the modified model aims to replicate the information set available to Fed forecasters when they prepare Greenbook projections. The model is described by the following log-linearized equations:

Actual dynamics of the economy:

$$y_t = (1-\zeta)E_t y_{t+1} + \zeta y_{t-1} - \frac{1}{\sigma}(r_t - E_t \pi_{t+1}) + g_t \quad (1)$$

$$\pi_t = \beta(1-\psi)E_t \pi_{t+1} + \psi \pi_{t-1} + \kappa y_t + \mu_t \quad (2)$$

$$r_t = (1-\rho_r)\phi_\pi E_t^{GB} \pi_t + \rho_r r_{t-1} + e_t \quad (3)$$

where $\kappa = (1-\theta)(1-\beta\theta)/\theta$, θ is the Calvo parameter, σ is the inverse of the intertemporal elasticity of substitution, ζ is the share of backward looking consumers, ψ is the share of backward looking firms, β is the discount factor, ρ_r is the degree of interest rate smoothing, ϕ_π is the long-run response of the nominal interest rate to inflation. Consumers and firms form full-information rational expectations denoted by E_t. However, monetary policy (equation 3) is set using the "Greenbook" forecast (denoted by E_t^{GB}) of inflation. Greenbook forecasts are formed with knowledge of contemporaneous values of μ_t and g_t but not the time-*t* innovations to monetary policy.

More specifically, the Greenbook forecasts are generated using the following dynamics

$$E_t^{GB} y_t = (1-\zeta)E_t^{GB} y_{t+1} + \zeta y_{t-1} - \frac{1}{\sigma}\left(E_t^{GB} r_t - E_t^{GB} \pi_{t+1}\right) + g_t \quad (4)$$

$$E_t^{GB} \pi_t = \beta(1-\psi)E_t^{GB} \pi_{t+1} + \psi \pi_{t-1} + \kappa E_t^{GB} y_t + \mu_t \quad (5)$$

$$E_t^{GB} r_t = (1-\rho_r)\phi_\pi E_t^{GB} \pi_t + \rho_r r_{t-1} + \rho_e e_{t-1} \quad (6)$$

Exogenous shocks follow

$$\mu_t = \rho_\mu \mu_{t-1} + \epsilon_t^\mu \quad (7)$$

$$g_t = \rho_g g_{t-1} + \epsilon_t^g \quad (8)$$

$$e_t = \rho_e e_{t-1} + \epsilon_t^e \quad (9)$$

Equation (1) is the IS curve with g_t being an exogenous "spending" shock. Equation (2) is the Phillips curve with μ_t being an exogenous "markup" shock. Both curves allow for a backward-looking component. Equation (3) is the Taylor rule. The interest rate setting is based on fully-observed past levels of interest rates and projections for inflation. The error term e_t is a potentially serially-correlated policy shock. When Fed staff makes Greenbook projections, they use the model described in equations (4) through (6). The only difference from equations (1)-(3) is that Fed staff can't observe (or are not allowed to incorporate) information about the current value of the policy innovation to e_t. All exogenous shocks are AR(1) processes with uncorrelated innovations $\epsilon_t^\mu, \epsilon_t^g, \epsilon_t^e$ with zero means and standard deviations $\omega_\mu, \omega_g, \omega_e$. We will use $\epsilon_t^\mu, \epsilon_t^g$ innovations (as well as lags of these innovations) as instrumental variables (IV) when we estimate Taylor rule in equation (3).

We use parameter values standard in the literature: $\sigma = 1$, $\kappa = 0.08$, $\phi_\pi = 1.5$, $\zeta = 0.5$, $\psi = 0.5$, $\rho_\mu = \rho_g = 0.9$, $\omega_\mu = \omega_g = \omega_e = 1$. We simulate the model 1,000 times for 400 periods and drop the first 200 burn-in periods. The resulting series are used in the OLS and IV estimation of the Taylor rule in equation (3). In IV estimation, we use $\epsilon_t^\mu, \epsilon_t^g, \epsilon_{t-1}^\mu, \epsilon_{t-1}^g, \epsilon_{t-2}^\mu, \epsilon_{t-2}^g$ as instrumental variables. Appendix Table 1 reports the average estimate of ρ_r as well as the standard deviation of estimated ρ_r across simulations. The results suggest that IV estimates consistently uncover the true estimate irrespective of the serial correlation in e_t. In contrast, OLS performs well when the serial correlation in e_t is low but not when the serial correlation in e_t is high.

APPENDIX TABLE 1 - RESULTS FROM MONTE CARLO SIMULATIONS

		$\rho_e = 0.1$		$\rho_e = 0.5$		$\rho_e = 0.9$	
		OLS	IV	OLS	IV	OLS	IV
$\rho_r = 0.1$	mean	0.14	0.10	0.23	0.10	0.32	0.11
	st.dev.	0.03	0.04	0.03	0.04	0.06	0.06
$\rho_r = 0.5$	mean	0.54	0.50	0.60	0.50	0.55	0.51
	st.dev.	0.02	0.05	0.03	0.06	0.04	0.09
$\rho_r = 0.9$	mean	0.88	0.90	0.87	0.90	0.75	0.84
	st.dev.	0.03	0.13	0.03	0.14	0.02	0.15