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Optimal Policy with Supply Shocks of Unknown Persistence

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Optimal Policy with Supply Shocks of Unknown Persistence

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Abstract

The optimal monetary policy response to a supply shock depends critically on its persistence. Since monetary policy affects inflation with a significant lag, it is often preferable to look through highly transitory shocks and respond more forcefully to persistent ones. In practice, however, neither the central bank nor the private sector knows a shock's persistence in real time; it must be learned gradually. We explore the implications of this uncertainty for optimal policy under commitment in an open-economy DSGE model featuring a mix of transitory and persistent supply shocks, including domestic markup shocks and shocks to the price of commodities and imported production inputs. Agents—including the central bank—observe only a composite foreign supply shock and use the Kalman filter to infer the transitory and persistent components. In this environment, optimal policy initially responds by more to shocks that turn out to be transitory than it would under full information. The cost of this overreaction, however, is small compared to cost of a delayed reaction when the shock is persistent.

1 Introduction

The renewed prominence of inflation since the early 2020s has brought supply shocks back to the centre of monetary policy analysis. The post-pandemic inflation surge combined disruptions to global production and transportation, large movements in food and energy prices, labour-supply constraints, and strong demand. These developments were especially consequential for small open economies, where foreign cost pressures are transmitted through import prices, commodity prices, exchange rates, and global production networks. They also revived a longstanding question: when should monetary policy look through a supply shock, and when should it respond?

Supply shocks create a policy trade-off that is generally absent following a pure demand shock. An adverse supply disturbance raises inflation while reducing the economy's productive capacity. Tightening monetary policy can limit inflation, but it may also deepen the

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contraction in activity. This is the familiar cost-push trade-off in the New Keynesian framework (Clarida et al., 1999). It provides a basis for flexible inflation targeting, under which inflation may return to target gradually when an immediate return would impose excessive output costs.

The case for looking through a highly transitory shock is strengthened by the lags in monetary policy transmission. Imported food, energy, and other commodity prices can affect consumer prices relatively quickly. Changes in monetary policy, by contrast, influence inflation more gradually through aggregate demand, production costs and expectations. If a supply shock dissipates before the peak effect of policy is felt, a forceful response may do little to offset the initial increase in inflation. Its largest effect may instead arrive after the shock has faded, weakening activity and potentially pushing inflation below target. In this case, attempting to stabilize inflation too quickly can increase, rather than reduce, inflation and output volatility (Bandera et al., 2023).

Looking through a transitory shock is particularly attractive when the shock primarily changes a relative price, has limited effects on wages and other prices, and does not alter longer-term inflation expectations. Monetary policy cannot produce more energy, restore damaged productive capacity, or resolve a foreign supply-chain disruption. Its ability to offset the first-round price effect of such a disturbance is therefore limited. A gradual return of inflation to target may achieve a better balance between inflation and output stability than an attempt to reverse the price increase immediately.

These arguments do not imply that all supply shocks should be accommodated. Persistence changes the policy problem because firms and workers make forward-looking decisions. Firms that expect higher input costs to continue have a stronger incentive to pass those costs into their prices. Workers may also seek compensation for a sustained decline in real income. Persistent foreign cost pressure can consequently spread to domestically determined prices and wages, extending inflation beyond the direct effect of the original shock. The repeated observation of above-target inflation may also make short-term expectations more responsive to current inflation, further strengthening propagation (Beaudry et al., 2026).

A large or persistent shock can therefore warrant a materially stronger response than a transitory one. Research on persistent cost-push shocks shows that persistence can increase inflationary bias under discretion and alter the properties of optimal policy under commitment (Nuño et al., 2025). Work on policy delays similarly finds that postponing a response to an inflationary disturbance can increase loss and require a more aggressive adjustment later (Hakamada and Walsh, 2024). The appropriate degree of look-through consequently depends not only on the source or initial size of a shock, but also on its expected duration, its propagation through wages and prices, the state of demand, and the behaviour of inflation expectations.

The question is increasingly important because the macroeconomic environment may become more exposed to adverse supply developments. The period before the pandemic was characterized by expanding international integration, diversified supply chains, relatively stable commodity markets, and generally subdued inflation. Several structural forces could make that environment less representative of the future.

Climate change is one such force. Extreme heat, droughts, floods, wildfires, storms, and other physical hazards can reduce agricultural production, damage capital and infrastructure, disrupt transportation networks, and lower labour productivity. These effects can

simultaneously reduce output and raise prices, although the balance of supply and demand effects differs across hazards and economies. Empirical evidence indicates that droughts have particularly important effects on food-price inflation, while the inflation effects of other natural disasters depend on their intensity, the affected sectors, the income level of the economy, and the monetary policy regime (Kabundi et al., 2022). Higher temperatures can also exert persistent upward pressure on food and headline inflation, with effects that vary across seasons and regions (Kotz et al., 2024).

Geo-economic fragmentation provides a second potential source of supply disturbances. Trade restrictions, geopolitical conflict, limits on technology transfer, and efforts to reorganize supply chains around strategic or security considerations can reduce access to low-cost inputs and make some production networks less diversified. Fragmentation can also affect commodity markets, where production is geographically concentrated and disruptions can transmit rapidly through energy, food, and industrial-input prices. The effects need not always be sudden or inflationary, but fragmentation creates additional channels through which changes in trade, capital flows, technology diffusion, and the provision of global public goods can affect productive capacity and costs (Aiyar et al., 2023).

Even if the optimal response were known for every possible degree of persistence, implementing it would remain difficult because persistence is a latent property of the shock. A temporary factory closure and a prolonged shortage of a critical input may initially produce similar movements in prices and quantities. Persistence can generally be inferred only through time as additional observations arrive.

Recent work addresses uncertainty in the context of the post-pandemic inflation experience. Carceller del Arco and van den End (2023) studies uncertainty about the supply-demand composition of observed inflation when the output gap cannot be reliably observed. Their robust policy balances the risk that insufficient tightening permits demand-driven overheating against the risk that excessive tightening deepens the contraction when inflation is supply-driven. Brandão-Marques et al. (2024) focuses on uncertainty about inflation persistence. They find that a robust policy can involve a more front-loaded response that incurs a modest cost when inflation persistence is low but provides insurance against substantially larger losses when persistence is high. These results demonstrate that uncertainty about persistence can matter for the design of policy even when the underlying model is otherwise well understood.

This paper studies a distinct but complementary information problem concerning foreign supply disturbances. Foreign prices are driven by common transitory and persistent marginal-cost disturbances. Their processes and innovation distributions are known, but domestic private agents and the central bank do not observe their realizations separately. Instead, they observe foreign import and commodity prices and use a Kalman filter to estimate the common latent components. Domestic pricing decisions and monetary policy therefore depend on the estimated composition of foreign supply disturbances rather than on direct observation of their underlying components.

We examine this problem in an estimated small-open-economy DSGE model with domestic price and wage shocks, technology and labour-supply shocks, and foreign shocks to commodity prices and imported production inputs. The model contains a realistic lag between changes in the policy rate and their peak effect on inflation, making an unnecessary response to a transitory shock costly. We compute optimal policy under commitment with

full and incomplete information.

The analysis produces three principal results. First, the optimal policy response increases strongly and nonlinearly with shock persistence as well as with the degree of price flexibility. Second, signal extraction can lead policy to respond somewhat more strongly to a shock that ultimately proves transitory, but the associated additional loss is relatively modest because the response can be unwound as the shock dissipates. Third, treating a persistent disturbance as transitory can allow inflationary pressure to build and require a considerably larger subsequent adjustment. In the model, the loss from initially under reacting to a persistent shock is substantially greater than the loss from initially overreacting to a transitory one. This asymmetry provides a quantitative criterion for evaluating policy rules when policy must be implemented before the persistence of supply disturbances is fully known.

2 Model of a Small Open Economy

The model used in the subsequent simulations is a scaled-down version of ToTEM (Terms-of-Trade Economic Model), one of the Bank of Canada's projection and policy-analysis models; see Murchison and Rennison (2006).

Unless otherwise stated, lowercase letters with hats denote log deviations from a non-stochastic steady state. Inflation is defined as $\pi_t \equiv \log(P_t/P_{t-1})$. Foreign-currency variables carry a star, the nominal exchange rate e_t is the domestic-currency price of one unit of foreign currency, and the real exchange rate is

$$s_t \equiv \frac{e_t P_t^*}{P_t}, \qquad \widehat{s}_t = \widehat{e}_t + \widehat{P}_t^* - \widehat{P}_t. \tag{1}$$

Thus an increase in s_t is a real depreciation.

Unless otherwise indicated, $\mathbb{E}_t$ denotes expectations conditional on the common information set $\mathcal{I}_t$ available to domestic private agents and the central bank. These agents observe foreign-currency import and commodity prices and know the structure and parameters of the foreign price-setting equations, including the sectoral shock loadings and the laws of motion and innovation variances of the underlying disturbances. They do not observe foreign nominal marginal costs or their transitory and persistent components directly. Foreign price setters observe the underlying marginal-cost components. Expectations in their price-setting equations are denoted by $\mathbb{E}_t^F$ and are conditional on their information set $\mathcal{F}_t$, with $\mathcal{I}_t \subseteq \mathcal{F}_t$. Domestic agents use the signal-extraction procedure in Section 5.1 to estimate the common foreign disturbances.

2.1 Finished-goods production

There is a continuum of monopolistically competitive firms, indexed by $i \in [0, 1]$, that produce differentiated finished goods. Firm i combines labour, capital services, domestically produced commodities, and imported inputs using the constant-returns CES gross-production technology

$$Z_{it}^g = \left[\delta_1^{1/\sigma}(A_t L_{it})^{(\sigma-1)/\sigma} + \delta_2^{1/\sigma}(u_{it}K_t)^{(\sigma-1)/\sigma} + \delta_3^{1/\sigma}(COM_{it}^d)^{(\sigma-1)/\sigma} + \delta_4^{1/\sigma}M_{it}^{(\sigma-1)/\sigma}\right]^{\sigma/(\sigma-1)}, \tag{2}$$

Here A_t is labour-augmenting technology, L_{it} is labour, u_{it} is utilization, K_t is an index of the capital stock, which is common across all firms, COM_{it}^d is the commodity input, and M_{it} is the imported input. The industry owns the aggregate capital stock and allocates it equally across firms. Because capital is chosen at the industry level and the remaining factor-demand conditions are static, firms that reset their prices in the same period face the same relevant state and choose a common reset price.

Utilization is costly. Net output available for sale is

$$Z_{it} = Z_{it}^g - a(u_{it})K_t, \qquad a(u) \equiv \phi_u \left[e^{\kappa(u-1)} - 1\right], \quad \kappa > 0. \tag{3}$$

The parameter ϕ_u is chosen so that steady-state utilization is $\overline{u} = 1$. Although gross production is constant returns to scale, convex utilization costs and the predetermined industry capital stock make short-run firm-level marginal cost increasing in output.

A competitive aggregator purchases the differentiated goods and produces the finished-good composite. The non-homothetic preference specification described in Murchison (2025) admits a conditional, implicit time-varying CES representation:

$$Z_t = \left(\int_0^1 Z_{it}^{(\varepsilon_t - 1)/\varepsilon_t} \, di \right)^{\varepsilon_t/(\varepsilon_t - 1)}, \tag{4}$$

$$P_t = \left(\int_0^1 P_{it}^{1-\varepsilon_t} \, di \right)^{1/(1-\varepsilon_t)}, \tag{5}$$

where each purchaser takes aggregate demand, and hence ε_t, as given. Cost minimization gives

$$Z_{it} = \left(\frac{P_{it}}{P_t} \right)^{-\varepsilon_t} Z_t. \tag{6}$$

The elasticity of substitution is

$$\varepsilon_t = 1 + (\varepsilon - 1)\exp\{-\varepsilon(\eta \widehat{Z}_t + \epsilon_t^{\varepsilon})\}, \qquad \eta \geq 0, \quad \varepsilon > 1, \qquad \epsilon_t^{\varepsilon} \sim \mathcal{N}(0, \sigma_{\varepsilon}^2). \tag{7}$$

This lognormal formulation guarantees $\varepsilon_t > 1$. It also implies $\partial \varepsilon_t / \partial \widehat{Z}_t < 0$: households are less price-sensitive when aggregate demand is strong. A positive ϵ_t^{ε} likewise reduces the substitution elasticity and raises the desired markup.

Since capital is a quasi-fixed factor, firm-level marginal cost is increasing in its production level and therefore decreasing in its relative price. Let λ_{it} denote firm i's real marginal cost and λ_t its symmetric aggregate counterpart. Locally,

$$\lambda_{it} = \lambda_t \left(\frac{P_{it}}{P_t} \right)^{-\rho \varepsilon_t}, \tag{8}$$

where ρ is the elasticity of marginal cost with respect to firm output:

$$\rho = \frac{\kappa s_K}{1 + \sigma\kappa(1 - s_K) - \bar{\lambda} s_K}, \tag{9}$$

and $\bar{\lambda}$ and s_K equal to steady state real marginal cost and capital's share of output, respectively. With all factor prices expressed relative to P_t, the log-linearized static factor-demand conditions are

$$\widehat{w}_t = \widehat{\lambda}_t + \frac{1}{\sigma}(\widehat{Z}_t^g - \widehat{L}_t) + \left(1 - \frac{1}{\sigma}\right)\widehat{A}_t, \tag{10}$$

$$\widehat{u}_t = \frac{\sigma}{1+\sigma\kappa}\widehat{\lambda}_t + \frac{1}{1+\sigma\kappa}(\widehat{Z}_t^g - \widehat{K}_t), \tag{11}$$

$$\widehat{p}_t^{com} = \widehat{\lambda}_t + \frac{1}{\sigma}(\widehat{Z}_t^g - \widehat{COM}_t^d), \tag{12}$$

$$\widehat{p}_t^m = \widehat{\lambda}_t + \frac{1}{\sigma}(\widehat{Z}_t^g - \widehat{M}_t). \tag{13}$$

Here $w_t \equiv W_t/P_t$, $p_t^{com} \equiv P_t^{com}/P_t$, and $p_t^m \equiv P_t^m/P_t$.

2.1.1 Capital and investment

A representative industry council chooses the aggregate capital stock and investment, internalizing capital accumulation and adjustment costs. Capital evolves according to

$$K_{t+1} = (1-\delta)K_t + I_t - \frac{\phi_I}{2}\left(\frac{I_t}{I_{t-1}} - 1\right)^2 I_t. \tag{14}$$

Investment and finished goods are identical, so the relative purchase price of investment is one. Let q_t be the shadow value of installed capital in units of finished goods. The log-linearized q equation is

$$\widehat{q}_t = -\widehat{r}_t^z + \mathbb{E}_t\left[\frac{\sigma\kappa}{1+\sigma\kappa}\widehat{\lambda}_{t+1} + \frac{\kappa}{1+\sigma\kappa}(\widehat{Z}_{t+1}^g - \widehat{K}_{t+1})\right] + \beta(1-\delta)\mathbb{E}_t\widehat{q}_{t+1}, \tag{15}$$

where $\widehat{r}_t^z \equiv \widehat{R}_t - \mathbb{E}_t\widehat{\pi}_{t+1}$ is the ex ante real rate in finished-good units. The investment first-order condition is

$$\widehat{I}_t = \frac{1}{1+\beta}\widehat{I}_{t-1} + \frac{\beta}{1+\beta}\mathbb{E}_t\widehat{I}_{t+1} + \frac{1}{(1+\beta)\phi_I}\widehat{q}_t. \tag{16}$$

2.1.2 Domestic price setting

In each period a fraction $1-\theta$ of firms is selected to reset prices. Of these firms, a fraction ω follows a rule of thumb (ROT), while a fraction $1-\omega$ chooses its price optimally. Optimizing firms do not index. ROT firms partially index to lagged inflation. The geometric-average reset price is

$$\overline{P}_t^* = (P_t^*)^{1-\omega}(\widetilde{P}_t^*)^{\omega}, \tag{17}$$

where

$$\widetilde{P}_t^* = P_{t-1}\left(\frac{P_{t-1}}{P_{t-2}}\right)^{\gamma}, \qquad 0 \le \gamma \le 1. \tag{18}$$

The sectoral price index evolves according to

$$P_t = \left[\theta P_{t-1}^{1-\varepsilon_t} + (1-\theta)(\overline{P}_t^*)^{1-\varepsilon_t}\right]^{1/(1-\varepsilon_t)}. \tag{19}$$

Define the log relative optimal reset price by

$$p_t^* \equiv \log(P_t^*/P_t). \tag{20}$$

Its log-linearized first-order condition is

$$\widehat{p}_t^* = (1-\beta\theta)\mathbb{E}_t \sum_{k=0}^{\infty}(\beta\theta)^k \left\{\sum_{j=1}^{k}\widehat{\pi}_{t+j} + \frac{1}{1+\varepsilon\rho}\left[\widehat{\lambda}_{t+k} + \eta\widehat{Z}_{t+k} + \epsilon_{t+k}^{\varepsilon}\right]\right\}, \tag{21}$$

where $\sum_{j=1}^{0}\widehat{\pi}_{t+j} \equiv 0$. The term $1/(1+\varepsilon\rho)$ captures strategic complementarity generated by upward-sloping firm-level marginal cost. The activity and elasticity-shock terms enter because strong demand and a positive ϵ_t^{ε} lower the substitution elasticity and raise the desired markup.

The resulting domestic-price Phillips curve is

$$\widehat{\pi}_t = a_{\pi,-1}\widehat{\pi}_{t-1} + a_{\pi,+1}\mathbb{E}_t\widehat{\pi}_{t+1} + \vartheta_z(\widehat{\lambda}_t + \eta\widehat{Z}_t + \epsilon_t^{\varepsilon}), \tag{22}$$

where

$$\phi_z \equiv \theta + \omega(1-\theta)(1+\beta\theta\gamma), \tag{23}$$

$$a_{\pi,-1} \equiv \frac{(1-\theta)\gamma\omega}{\phi_z}, \qquad a_{\pi,+1} \equiv \frac{\beta\theta}{\phi_z}, \tag{24}$$

$$\vartheta_z \equiv \frac{(1-\omega)(1-\theta)(1-\beta\theta)}{\phi_z(1+\varepsilon\rho)}. \tag{25}$$

2.2 Commodity production

Competitive commodity producers combine finished goods, Z_t^c, with a fixed factor, land $\mathbb{L}$, and face quadratic adjustment costs:

$$COM_t = (Z_t^c)^{s_z}\mathbb{L}^{1-s_z} - \frac{\phi_{com}}{2}\left(\frac{Z_t^c}{Z_{t-1}^c} - 1\right)^2 Z_t^c, \qquad 0 < s_z < 1. \tag{26}$$

Land generates diminishing returns and ensures finite supply at the foreign-currency commodity price faced by domestic producers. Transportation, logistical, and other short-run frictions are summarized by the adjustment cost. Domestic commodity producers are price takers, and the law of one price gives

$$P_t^{com} = e_t P_t^{com,*}, \tag{27}$$

where $P_t^{com,*}$ is the foreign-currency commodity price. The foreign-currency commodity price $P_t^{com,*}$ is determined by foreign suppliers under Calvo price setting. Foreign commodity suppliers and foreign suppliers of imported inputs have the same non-adjustment probability θ^*.

Their nominal marginal costs are driven by the same transitory and persistent disturbances, but the commodity-sector loading is larger reflecting commodity prices' greater historical volatility. The foreign price-setting equations and sectoral loadings are specified below.

The log-linearized production condition is

$$\widehat{Z}_t^c = \frac{\widehat{p}_t^{com} + \phi_{com}\widehat{Z}_{t-1}^c + \beta\phi_{com}\mathbb{E}_t\widehat{Z}_{t+1}^c}{(1-s_z)+(1+\beta)\phi_{com}}, \tag{28}$$

where $p_t^{com} = P_t^{com}/P_t$. Commodity output is allocated to domestic production, household consumption, and exports:

$$COM_t = COM_t^d + C_t^{com} + X_t^{com}. \tag{29}$$

2.3 Imported inputs

A competitive importer aggregates differentiated imported inputs:

$$M_t = \left(\int_0^1 M_{jt}^{(\varepsilon_m-1)/\varepsilon_m}\, dj\right)^{\varepsilon_m/(\varepsilon_m-1)}, \tag{30}$$

$$P_t^m = \left(\int_0^1 (P_{jt}^m)^{1-\varepsilon_m}\, dj\right)^{1/(1-\varepsilon_m)}, \tag{31}$$

with demand

$$M_{jt} = \left(\frac{P_{jt}^m}{P_t^m}\right)^{-\varepsilon_m} M_t. \tag{32}$$

Foreign suppliers set foreign-currency prices under Calvo contracts. In each period, a fraction $1-\theta^*$ resets its price, while the remaining fraction θ^* leaves its nominal price unchanged. The same non-adjustment probability applies to foreign suppliers of imported inputs and commodities. Let $j \in \{m, com\}$ index the two foreign-price sectors. Foreign nominal marginal-cost deviations are

$$\widehat{\lambda}_t^{j,*} = b_j\left(v_t^* + v_{p,t}^*\right), \qquad b_m = 1, \qquad b_{com} > 1. \tag{33}$$

There are no additional foreign marginal-cost disturbances. Foreign price setters observe the common components when choosing their prices. The log-linearized foreign-price equation is

$$\widehat{P}_t^{j,*} = \theta^*\widehat{P}_{t-1}^{j,*} + (1-\theta^*)(1-\beta\theta^*)\mathbb{E}_t^F\sum_{k=0}^{\infty}(\beta\theta^*)^k\widehat{\lambda}_{t+k}^{j,*}, \qquad j \in \{m, com\}. \tag{34}$$

Using the shock processes specified in Section 2.9 gives

$$\widehat{P}_t^{j,*} = \theta^*\widehat{P}_{t-1}^{j,*} + b_j(1-\theta^*)(1-\beta\theta^*)\left[v_t^* + \frac{v_{p,t}^*}{1-\beta\theta^*\rho^*}\right]. \tag{35}$$

The persistent component has a larger price loading than the transitory component because it affects the expected future stream of nominal marginal costs.

Import prices are also sticky in domestic currency and use the same ROT structure as domestic prices, with sector-specific parameters. The resulting import-price Phillips curve is:

$$\widehat{\pi}_t^m = a_{m,-1}\widehat{\pi}_{t-1}^m + a_{m,+1}\mathbb{E}_t\widehat{\pi}_{t+1}^m + \vartheta_m\left(\widehat{s}_t + \widehat{p}_t^{m,*} - \widehat{p}_t^m + u_t^m\right), \tag{36}$$

where u_t^m is an import-markup shock and

$$\phi_m \equiv \theta_m + \omega_m(1-\theta_m)(1+\beta\theta_m\gamma_m), \tag{37}$$

$$a_{m,-1} \equiv \frac{(1-\theta_m)\gamma_m\omega_m}{\phi_m}, \qquad a_{m,+1} \equiv \frac{\beta\theta_m}{\phi_m}, \tag{38}$$

$$\vartheta_m \equiv \frac{(1-\omega_m)(1-\theta_m)(1-\beta\theta_m)}{\phi_m}. \tag{39}$$

Thus, θ^* governs the common degree of foreign-currency price rigidity among foreign suppliers of imported inputs and commodities, whereas θ_m governs the domestic-currency price rigidity faced by domestic purchasers of imported inputs. The relative foreign-currency border price is

$$p_t^{m,*} \equiv \frac{P_t^{m,*}}{P_t^*}. \tag{40}$$

The domestic-currency cost of imported inputs relative to the domestic finished-good price is therefore

$$\frac{e_t P_t^{m,*}}{P_t} = s_t p_t^{m,*}. \tag{41}$$

2.4 Households

The representative household derives utility from habit-adjusted consumption and supplies a continuum of differentiated labour services. Period utility is

$$U_t = \frac{\mu}{\mu-1}(C_t - \xi C_{t-1})^{(\mu-1)/\mu}\exp\left[\frac{\eta_l(1-\mu)}{\mu(1+\eta_l)}\int_0^1 L_{ht}^{(\eta_l+1)/\eta_l}\,dh\right]\eta_t^c, \tag{42}$$

where habits are external: the household takes C_{t-1} as given. The household maximizes

$$\mathbb{E}_0\sum_{t=0}^{\infty}\beta^t U_t \tag{43}$$

subject to

$$P_t^{cpi}C_t + \frac{B_{t+1}}{1+R_t} + \frac{e_t B_{t+1}^f}{(1+R_t^f)} = B_t + e_t B_t^f + \int_0^1 W_{ht}L_{ht}\,dh + \Pi_t. \tag{44}$$

Here B_t and B_t^f are domestic- and foreign-currency bond holdings, respectively. Positive B_t^f denotes net foreign assets.

The log-linearized consumption Euler equation is

$$\widehat{C}_t = \frac{1}{1+\xi}\mathbb{E}_t\widehat{C}_{t+1} + \frac{\xi}{1+\xi}\widehat{C}_{t-1} - \frac{\mu(1-\xi)}{1+\xi}\widehat{r}_t^c + \frac{(1-\xi)(1-\mu)\overline{L}^{(\eta_l+1)/\eta_l}}{1+\xi}(\widehat{L}_t - \mathbb{E}_t\widehat{L}_{t+1}) + \epsilon_t^c, \tag{45}$$

where

$$\widehat{r}_t^c \equiv \widehat{R}_t - \mathbb{E}_t\widehat{\pi}_{t+1}^{cpi}, \qquad \epsilon_t^c \equiv \frac{\mu(1-\xi)}{1+\xi}(\widehat{\eta}_t^c - \mathbb{E}_t\widehat{\eta}_{t+1}^c) + \nu_b\widehat{B}_t^f. \tag{46}$$

where the $\nu_b\widehat{B}_t^f$ term permits temporarily higher consumption when the foreign asset position is above its steady-state level. This is used in place of the more typical closure condition that links deviations in the net foreign asset position to the exchange rate.

2.4.1 Consumption composition and the CPI

Aggregate consumption combines core finished goods and commodities:

$$C_t = \left[\alpha_c^{1/\psi}(C_t^z)^{(\psi-1)/\psi} + (1-\alpha_c)^{1/\psi}(C_t^{com})^{(\psi-1)/\psi}\right]^{\psi/(\psi-1)}. \tag{47}$$

The corresponding CPI is

$$P_t^{cpi} = \left[\alpha_c P_t^{1-\psi} + (1-\alpha_c)(P_t^{com})^{1-\psi}\right]^{1/(1-\psi)}. \tag{48}$$

Conditional demands are

$$C_t^z = \alpha_c\left(\frac{P_t}{P_t^{cpi}}\right)^{-\psi} C_t, \tag{49}$$

$$C_t^{com} = (1-\alpha_c)\left(\frac{P_t^{com}}{P_t^{cpi}}\right)^{-\psi} C_t. \tag{50}$$

Consequently,

$$\frac{C_t^{com}}{C_t^z} = \frac{1-\alpha_c}{\alpha_c}\left(\frac{P_t^{com}}{P_t}\right)^{-\psi}. \tag{51}$$

Core inflation is $\pi_t = \Delta\log P_t$, CPI inflation is $\pi_t^{cpi} = \Delta\log P_t^{cpi}$, and the relative CPI is $p_t^{cpi,z} \equiv P_t^{cpi}/P_t$.

2.4.2 Wage setting

Differentiated labour services are aggregated with steady-state elasticity $\varepsilon_w > 1$. Wages are set under Calvo contracts with optimizing and ROT wage setters. Define $w_t \equiv W_t/P_t$ as the real product wage. The real consumption wage is therefore $W_t/P_t^{cpi} = w_t/p_t^{cpi,z}$. The wage Phillips curve is

$$\widehat{\pi}_t^w = a_{w,-1}\widehat{\pi}_{t-1}^w + a_{w,+1}\mathbb{E}_t\widehat{\pi}_{t+1}^w - \vartheta_w\left[\widehat{w}_t - \widehat{p}_t^{cpi,z} - \frac{1}{\eta_l}\widehat{L}_t - \frac{\widehat{C}_t - \xi\widehat{C}_{t-1}}{1-\xi}\right] + u_t^w, \tag{52}$$

where u_t^w is a wage-markup shock and

$$\phi_w \equiv \theta_w + \omega_w(1-\theta_w)(1+\beta\theta_w\gamma_w), \tag{53}$$

$$a_{w,-1} \equiv \frac{(1-\theta_w)\gamma_w\omega_w}{\phi_w}, \qquad a_{w,+1} \equiv \frac{\beta\theta_w}{\phi_w}, \tag{54}$$

$$\vartheta_w \equiv \frac{(1-\omega_w)(1-\theta_w)(1-\beta\theta_w)}{\phi_w(1+\varepsilon_w/\eta_l)}. \tag{55}$$

2.5 International asset pricing and the exchange rate

The foreign-bond first-order condition implies uncovered interest parity. To capture inertia and excess-return movements parsimoniously, the empirical real-exchange-rate equation is written as:

$$\widehat{s}_t = \zeta\widehat{s}_{t-1} + (1-\zeta)\left[m\mathbb{E}_t\widehat{s}_{t+1} - \widehat{r}_t^c + \widehat{r}_t^{c,*}\right] + \tau_t^s, \tag{56}$$

where $0 < m \leq 1$ is a cognitive-discounting parameter, in the spirit of Gabaix (2020), and τ_t^s is an excess-return shock. The case $m = 1$ corresponds to the standard specification, while $m < 1$ reduces the weight placed on the expected future real exchange rate.

2.6 Other Foreign links

Domestic commodity producers take the foreign-currency commodity price as given. That price is determined by the foreign Calvo price-setting process described above, with foreign nominal marginal cost treated as exogenous to the domestic economy. Non-commodity exports are differentiated from foreign goods. Because exported non-commodity goods are identical to domestic finished goods, their domestic-currency price is P_t. Foreign demand is

$$X_t^{nc} = \left(\frac{P_t/e_t}{P_t^*}\right)^{-\varepsilon_{nc}} Y_t^* = s_t^{\varepsilon_{nc}} Y_t^*, \tag{57}$$

where the second equality follows from (1). The foreign block is represented by a restricted VAR for foreign inflation, foreign output, and the foreign policy rate. Foreign import and commodity prices are determined separately by the common transitory and persistent marginal-cost disturbances and the foreign Calvo price-setting equations. Foreign variables and the common disturbance processes are exogenous to domestic monetary policy. Domestic agents forecast foreign import and commodity prices using their observed price histories, the known price-setting equations, and filtered estimates of the common latent components.

2.7 Monetary policy

For model estimation, monetary policy follows a forward-looking Taylor-style rule:

$$\widehat{R}_t = \psi_r\widehat{R}_{t-1} + (1-\psi_r)\left[\psi_\pi\mathbb{E}_t\widehat{\pi}_{t+i}^{4,cpi} + \psi_y\widehat{y}_t\right] + u_t^r, \tag{58}$$

where $\pi_t^{4,cpi} \equiv \log(P_t^{cpi}/P_{t-4}^{cpi})$ is year-over-year CPI inflation, i is the forecast horizon, y_t is the output gap, and u_t^r is a monetary-policy shock. and $(\psi_r = 0.85, \psi_\pi = 3.2, \psi_y = 0.3, i = 4)$.

Under commitment, the policymaker chooses an entire state-contingent sequence $\{R_t\}_{t\geq 0}$ once and for all to minimize

$$\mathcal{L}^C = E_0 \sum_{t=0}^{\infty} \beta^t \left[(\pi_t^{cpi})^2 + \lambda_y y_t^2 + \lambda_R (\Delta R_t)^2 \right] \tag{59}$$

with $\lambda_y = 1.0$ and $\lambda_R = 0.5$, subject to all private-sector equilibrium conditions. The implementable system therefore includes the first-order conditions with respect to policy and the private variables, together with the Lagrange multipliers and their initial commitment conditions.

2.8 Market clearing, profits, and net foreign assets

The principal market-clearing conditions are

$$Z_t = C_t^z + I_t + Z_t^c + X_t^{nc}, \tag{60}$$

$$Y_t = C_t + I_t + X_t^{com} + X_t^{nc} - M_t, \tag{61}$$

$$COM_t = COM_t^d + C_t^{com} + X_t^{com}. \tag{62}$$

Sectoral nominal profits are

$$\Pi_t^z = P_t Z_t - W_t L_t - P_t^{com} COM_t^d - P_t I_t - P_t^m M_t, \tag{63}$$

$$\Pi_t^{com} = \varsigma \left(P_t^{com} COM_t - P_t Z_t^c \right), \tag{64}$$

$$\Pi_t^m = P_t^m M_t - e_t P_t^{m,*} M_t. \tag{65}$$

where ς captures the share of commodity profits that accrue to domestic producers. The remaining profits are assumed to go to foreign shareholders. Combining the household budget constraint with market clearing yields the net foreign asset accumulation equation. Under the timing in which B_t^f is the foreign-currency asset position entering period t, a transparent nominal form is

$$\begin{aligned} e_t B_{t+1}^f = (1 + R_t^f)(e_t B_t^f + P_t X_t^{nc} + P_t^{com} X_t^{com} - e_t P_t^{m,*} M_t \\ - (1 - \varsigma) \left(P_t^{com} COM_t - P_t Z_t^c \right)), \end{aligned} \tag{66}$$

2.9 Law of Motion for Shocks

The model distinguishes between domestic supply (markup) disturbances and the common foreign marginal-cost disturbances underlying imported-input and commodity prices. In each case, transitory and persistent innovations are mutually independent. As discussed in Section 2.3, foreign nominal marginal costs are driven by transitory and persistent disturbances. Domestic private agents and the central bank observe foreign prices, the degree of price stickiness and the shock processes, but do not observe the underlying shocks. Foreign price setters observe both components. The common transitory disturbance is serially uncorrelated:

$$v_t^* = \sigma_v^* \xi_{v,t}^*. \tag{67}$$

The common persistent disturbance follows an AR(1) process:

$$v_{p,t}^* = \rho^* v_{p,t-1}^* + \sigma_p^* \xi_{p,t}^*, \qquad \rho^* < 1. \tag{68}$$

The innovations satisfy

$$\begin{bmatrix} \xi_{v,t}^* \\ \xi_{p,t}^* \end{bmatrix} \overset{\text{i.i.d.}}{\sim} \mathcal{N}(0, I_2), \tag{69}$$

and are independent of innovations to the remaining foreign block and domestic shocks. Using the known sectoral loadings, domestic agents construct a normalized signal from each observed foreign price:

$$y_t^{j,*} \equiv \frac{\widehat{P}_t^{j,*} - \theta^* \widehat{P}_{t-1}^{j,*}}{b_j} = (1-\theta^*)(1-\beta\theta^*) \left[v_t^* + \frac{v_{p,t}^*}{1-\beta\theta^*\rho^*} \right]. \tag{70}$$

Consequently,

$$y_t^{m,*} = y_t^{com,*} = y_t^*. \tag{71}$$

The raw foreign-price movements differ in magnitude, but the normalized signals contain the same information about the two latent components.

3 Model Estimation

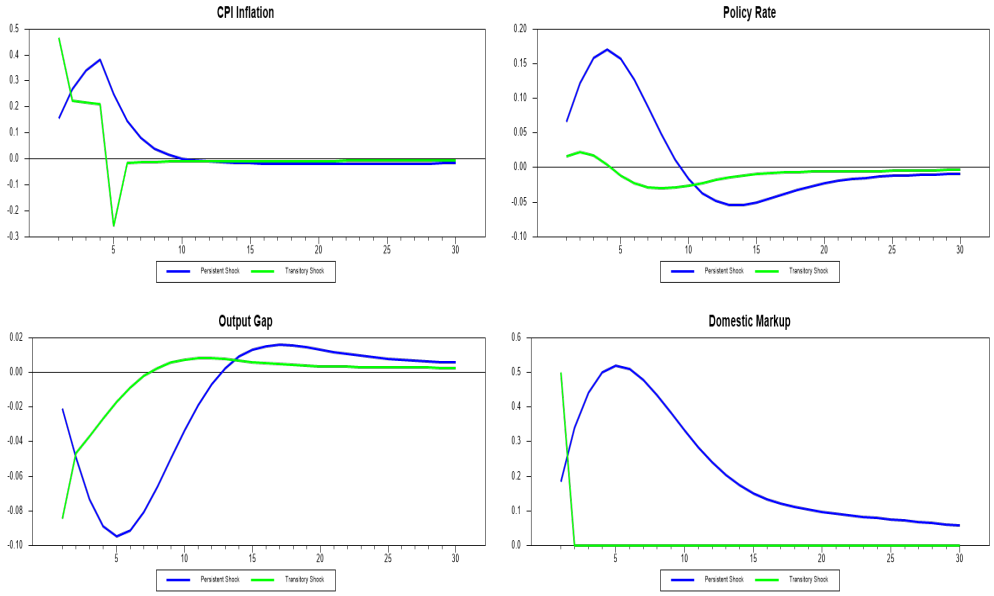
The linearized model is estimated by maximum likelihood estimation on detrended data from 1997Q1-2025Q3. The observed series are detrended using the equivalent of a one-sided HP filter and the resulting gap data are used in estimation. The parameters governing domestic price, import price and wage dynamics θ, γ, ω, including the persistence parameters for the persistent markup shocks as well as η. The remaining parameters affecting the model's dynamics are calibrated based on previous work at the Bank of Canada using a model version quite similar to that presented here. Historical shares appearing in the linearized model are also computed based on data from 1997Q1-2025Q3. The estimated parameter values can be found in Table 1. Finally, since there are more shocks than observed variables in the model due to the presence of both transitory and persistent markup shocks, the Kalman filter is used to compute the historical shocks and prediction errors. The persistent and transitory shocks are assumed to be orthogonal, and the ratio of their standard deviations is calibrated to be 0.1, following Erceg et al. (2024).

Table 1: Estimated Key Structural Parameters

Parameter	Description	Estimate
Nominal rigidity		
θ	Domestic-price Calvo non-adjustment probability	0.75
θ_m	Import-price Calvo non-adjustment probability	0.24
θ_w	Wage Calvo non-adjustment probability	0.5
θ^*	Foreign-price Calvo non-adjustment probability	0.5
Rule-of-thumb price and wage setting		
ω	Share of domestic-price resetters using the rule of thumb	0.41
ω_m	Share of import-price resetters using the rule of thumb	0.0
ω_w	Share of wage resetters using the rule of thumb	0.65
Indexation		
γ	Degree of indexation for ROT domestic-price setters	1.0
γ_m	Degree of indexation for ROT import-price setters	-
γ_w	Degree of indexation for ROT wage setters	1.0
Shock persistence		
ρ^ϵ	AR(1) coefficient of the persistent domestic-price markup component	0.69
ρ^*	AR(1) coefficient of the common persistent foreign marginal-cost component	0.9
Non-homothetic preferences		
η	Sensitivity of the substitution elasticity to aggregate demand	0.92

Notes: The parameters θ, θ_m, θ_w, and θ^* denote the quarterly probabilities that the relevant nominal price or wage is not reset. The parameters ω, ω_m, and ω_w denote the shares of resetting agents that use the corresponding rule-of-thumb mechanism. The parameters γ, γ_m, and γ_w govern the degree of indexation used by rule-of-thumb domestic-price, import-price, and wage setters, respectively. The parameters ρ_z and ρ^* govern the persistence of the domestic-price markup component and the common foreign nominal marginal-cost component, respectively. The latter enters both foreign imported-input and commodity marginal costs. The non-homothetic-preference parameter η governs the sensitivity of the substitution elasticity to aggregate activity, as specified in equation (7).

Figure 1: Optimal policy looks through transitory domestic markup shocks



4 Supply Shocks and the Role of Expected Persistence

In the presence of nominal rigidity, pricing decisions become forward looking with firms taking into account the discounted future sum of marginal costs, not just the current level. As a result, shock persistence becomes a critical factor in determining the size of the short run inflation response. As a result, the optimal monetary policy response can be sensitive to the persistence of markup shocks. In this section, we quantify that sensitivity. The implementation of optimal policy under commitment proceeds as in Dennis (2007).

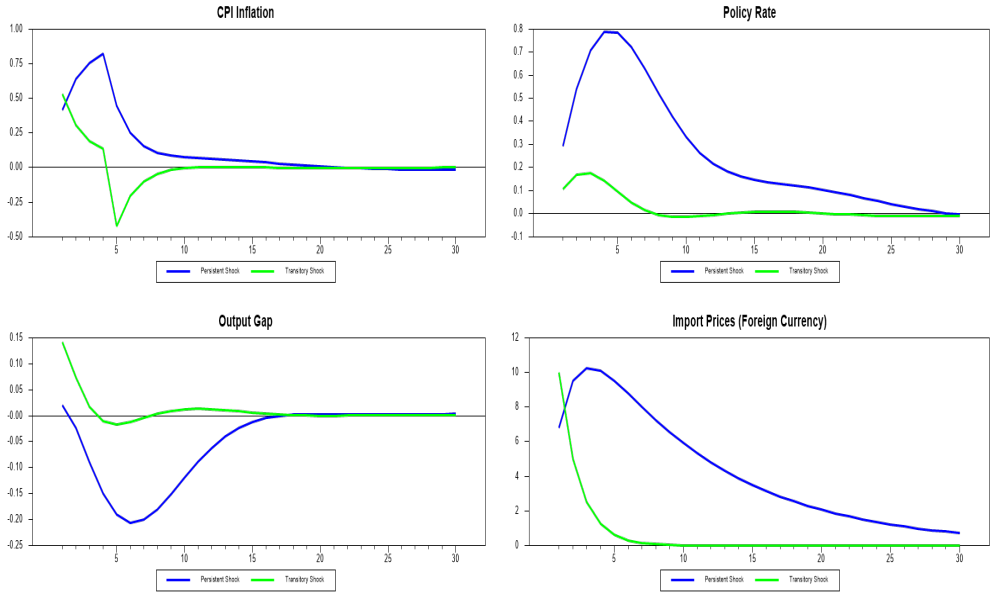
Figure 1 compares two domestic markup shocks that differ only in their persistence. Although both shocks represent an increase in firms' desired markups and therefore operate as cost-push disturbances, their macroeconomic implications are quite different.

The persistent shock generates a gradual rise in inflation that builds over the first year before returning to control after 10 quarters. Optimal policy in this circumstance responds, resulting in higher interest rates, which, together with the effects of negative supply shock on activity, results in an extended period of excess supply.

Following the transitory shock, CPI inflation rises immediately, then reverses quickly and moves below baseline within a few periods. This reflects the rapid unwinding of the markup disturbance before it can generate substantial propagation. Indeed, at a horizon of 4-5 quarters - where monetary policy has the greatest impact on inflation - the inflationary effects of the shock have fully dissipated. As a result, the response of the policy interest rate is close to zero.

The foreign supply shock shows the same qualitative contrast as the domestic markup shock, but through the external cost channel. The persistent shock generates a sustained increase in the relative price of imported intermediate goods and the relative price of com-

Figure 2: Optimal policy looks through transitory foreign supply shocks

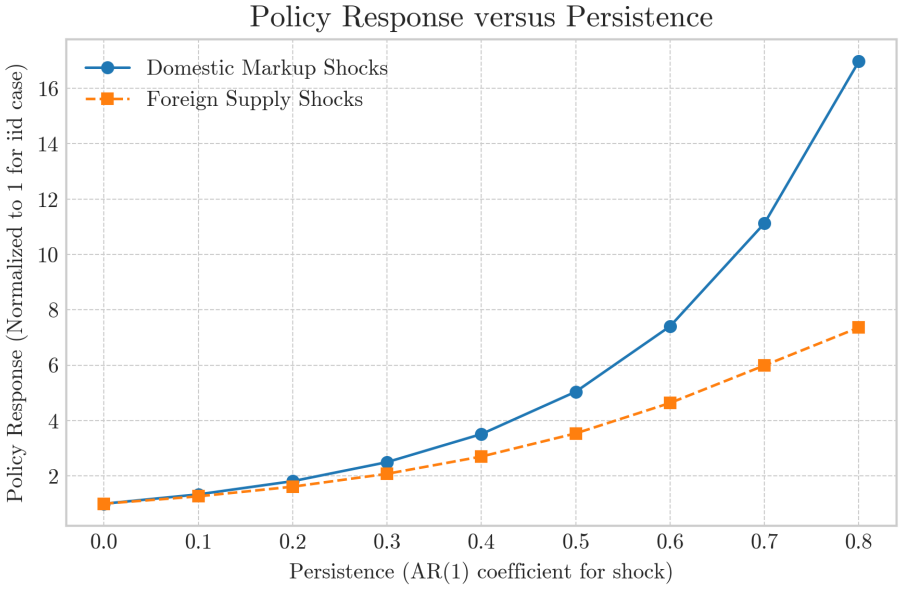


modities, which translates into a larger and more delayed CPI inflation response. Inflation peaks after several quarters, prompting a significant increase in the policy rate. The associated tightening, together with the adverse cost shock, produces a noticeable decline in the output gap before activity gradually recovers. The transitory shock, generates same peak increase in the foreign-currency price of imports and commodities as the persistent shock. But because the relative price quickly returns toward baseline, pass-through to CPI inflation is limited and short-lived. The policy-rate response is correspondingly small, and the output-gap effects are modest relative to the persistent case.

Figure 3 summarizes how the optimal policy response, measured as the average level of the policy rate in the first 2 years following the shock, varies with the persistence of the markup shock. The policy response in the i.i.d. case is normalized to one. For both foreign and domestic markup shocks, the required policy response increases monotonically with the AR(1) coefficient, indicating that persistence materially amplifies the stabilization problem. The relationship is also nonlinear: the policy response rises only modestly at low levels of persistence, but increases much more rapidly once the AR(1) coefficient exceeds roughly 0.4–0.5. For example, in the case of a foreign supply shock, optimal average policy response of high persistence (AR(1)=0.7) is 6 times higher than if the shock lasts only one quarter. This difference reflects the fact that more persistent markup disturbances generate larger cumulative inflationary pressure and therefore require a stronger monetary policy reaction to contain their effects.

The comparison also highlights that domestic markup shocks become relatively more demanding for policy as persistence increases. While foreign markup shocks operate through the external cost channel, domestic markup shocks have more direct implications for domestic inflation dynamics and the output-inflation trade-off. As a result, the gap between the

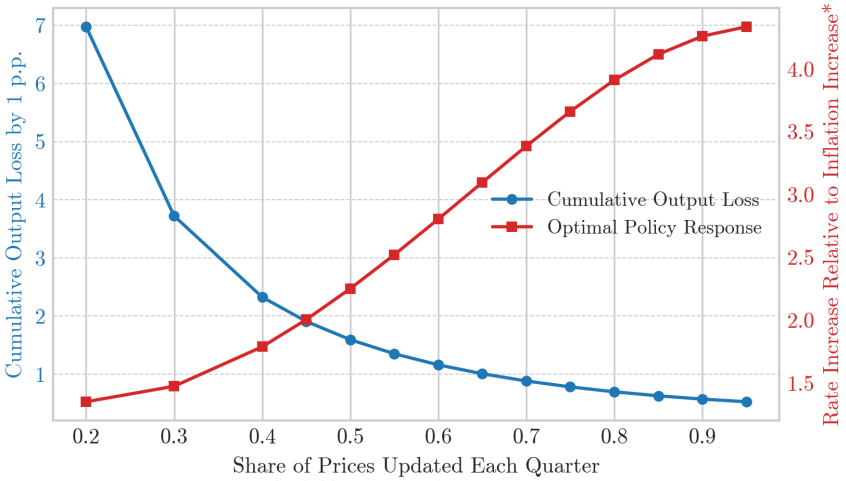
Figure 3: Optimal policy response increases nonlinearly with shock persistence



two policy responses widens at higher persistence levels, with the domestic markup shock generating the steeper schedule.

Another important factor in determining the strength of the policy response is the degree of nominal rigidity. Figure 4 shows how greater price flexibility improves the tradeoff faced by monetary policy following a persistent domestic markup shock. As the share of prices updated each quarter rises, the cumulative output cost of reducing inflation by 1 percentage point (the sacrifice ratio) declines sharply. With more frequent price adjustment, inflation can be stabilized with a smaller decline in real activity, particularly when moving away from very high levels of nominal rigidity. As a result, the size of optimal policy response increases. When the output cost of raising rates is high, optimal policy responds less to supply-driven inflation because stabilizing inflation requires a relatively large contraction in activity. As prices become more flexible, the output cost of disinflation falls, making it optimal for the central bank to focus relatively more on the inflationary effects of the markup shock.

Figure 4: Optimal Policy is More Aggressive When the Sacrifice Ratio is Low



*Average policy rate increase over 2 years divided by average inflation increase following a persistent adverse foreign supply shock

5 Policy Exercises

5.1 Signal extraction

The central bank and domestic private agents observe foreign-currency import and commodity prices and know the foreign price-setting equations and shock processes, but do not observe foreign marginal costs or their components directly. Foreign price setters observe the underlying components when choosing their prices. Let $\mathbb{E}_t$ and $\mathbb{E}_t^F$ denote expectations conditional on domestic and foreign price setters' information, respectively.

Foreign nominal marginal-cost deviations are driven by common transitory and persistent components:

$$\widehat{\lambda}_t^{j,*} = b_j(v_t^* + v_{p,t}^*), \qquad b_m = 1, \quad b_{com} > 1, \qquad j \in \{m, com\}. \tag{72}$$

There are no additional foreign marginal-cost disturbances. The larger commodity loading permits more volatile commodity-price responses to the same shocks. The latent components follow

$$v_t^* = \sigma_v^* \xi_{v,t}^*, \qquad v_{p,t}^* = \rho^* v_{p,t-1}^* + \sigma_p^* \xi_{p,t}^*, \qquad |\rho^*| < 1, \tag{73}$$

where the innovations are independent standard Gaussian variables, independent across time and of the model's other innovations. With a common foreign Calvo non-adjustment probability θ^*, foreign prices satisfy

$$\begin{aligned} \widehat{P}_t^{j,*} &= \theta^* \widehat{P}_{t-1}^{j,*} + (1-\theta^*)(1-\beta\theta^*)\mathbb{E}_t^F \sum_{k=0}^{\infty} (\beta\theta^*)^k \widehat{\lambda}_{t+k}^{j,*} \\ &= \theta^* \widehat{P}_{t-1}^{j,*} + b_j c^* \left(v_t^* + a^* v_{p,t}^*\right), \end{aligned} \tag{74}$$

where $c^* \equiv (1-\theta^*)(1-\beta\theta^*)$ and $a^* \equiv (1-\beta\theta^*\rho^*)^{-1}$. The persistent component has a larger loading because it affects expected future marginal costs as well as current costs.

Domestic agents construct the normalized signal

$$y_t^{j,*} \equiv \frac{\widehat{P}_t^{j,*} - \theta^* \widehat{P}_{t-1}^{j,*}}{b_j} = c^* \left(v_t^* + a^* v_{p,t}^* \right). \tag{75}$$

Thus $y_t^{m,*} = y_t^{com,*} = y_t^*$: although commodity-price movements are larger, the two prices provide the same signal after normalization.

Writing $S_t^* = (v_t^*, v_{p,t}^*)'$, the signal-extraction problem is

$$S_t^* = A^* S_{t-1}^* + B^* \xi_t^*, \qquad y_t^* = H^* S_t^*, \tag{76}$$

with

$$A^* = \begin{bmatrix} 0 & 0 \\ 0 & \rho^* \end{bmatrix}, \qquad B^* = \begin{bmatrix} \sigma_v^* & 0 \\ 0 & \sigma_p^* \end{bmatrix}, \qquad H^* = c^* \begin{bmatrix} 1 & a^* \end{bmatrix}, \qquad \xi_t^* = \begin{bmatrix} \xi_{v,t}^* \\ \xi_{p,t}^* \end{bmatrix}. \tag{77}$$

The measurement contains no additional error, but reveals only one linear combination of the two latent components. The Kalman filter produces the common estimate $\widehat{S}_{t|t}^* = \mathbb{E}(S_t^* \mid \mathcal{I}_t)$, where $\mathcal{I}_t$ is the information available to domestic agents and the central bank. The decomposition depends on the inherited state estimate, the persistence parameter, and the relative innovation variances. Domestic forecasts use $\mathbb{E}_t S_{t+\ell}^* = (A^*)^\ell \widehat{S}_{t|t}^*$ for $\ell \geq 1$.

5.2 Separation of estimation and policy

The central bank and domestic private agents observe the same foreign prices, know the same price-setting equations and sectoral loadings, and condition on the same information set. They consequently construct the same normalized foreign-price signal and form identical filtered estimates of the common transitory and persistent disturbances.

Foreign import and commodity prices are also exogenous to domestic monetary policy. The domestic policy instrument affects neither the laws of motion of the foreign disturbances nor the measurement equation used to infer them. Policy therefore cannot influence the informativeness of current or future foreign prices, and there is no informational or dual-control motive for domestic monetary policy.

Under a linearized model with additive Gaussian disturbances and a quadratic policy objective, the separation principle applies. The estimation problem can be solved independently of the optimal-policy problem. The coefficients of the optimal policy rule are those from the corresponding full-information linear-quadratic problem, but the rule is evaluated using the conditional estimate

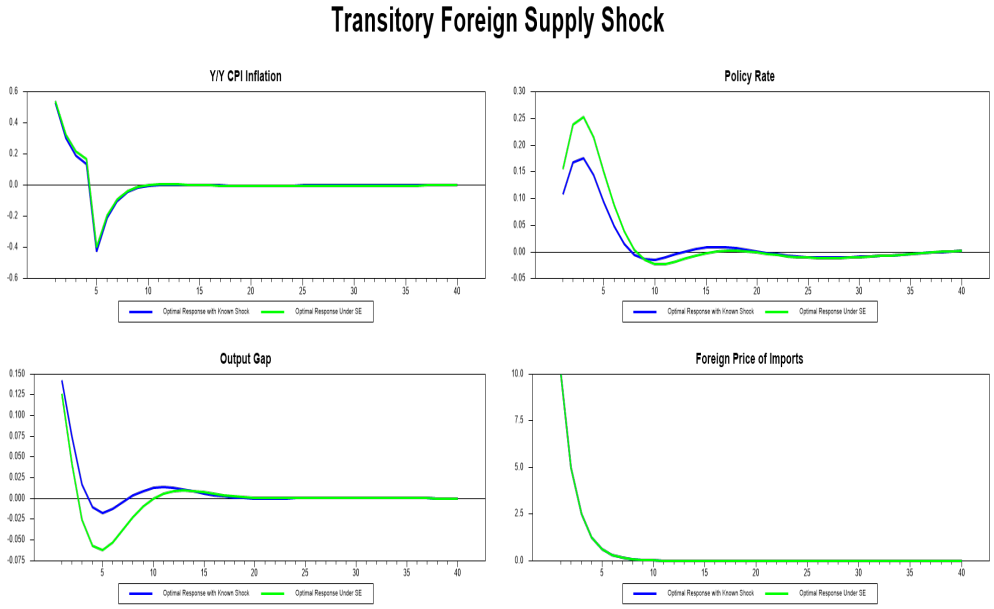
$$\widehat{S}_{t|t}^* = \mathbb{E}(S_t^* \mid \mathcal{I}_t) \tag{78}$$

in place of the unobserved state.

5.3 Results

Figure 5 illustrates the consequences of signal extraction following a transitory foreign supply shock. The realized foreign import-price response is the same under full information and

Figure 5: Signal Extraction Leads to a Modest Over Tightening



partial information, reflecting the assumption that foreign prices are exogenous to domestic monetary policy. The two experiments differ only in the information available to the policymaker. Under full information, the central bank knows that the disturbance is transitory. Under signal extraction, the observed foreign-price increase identifies only a linear combination of the transitory and persistent components. The Kalman gain therefore initially assigns some of the innovation to the persistent component.

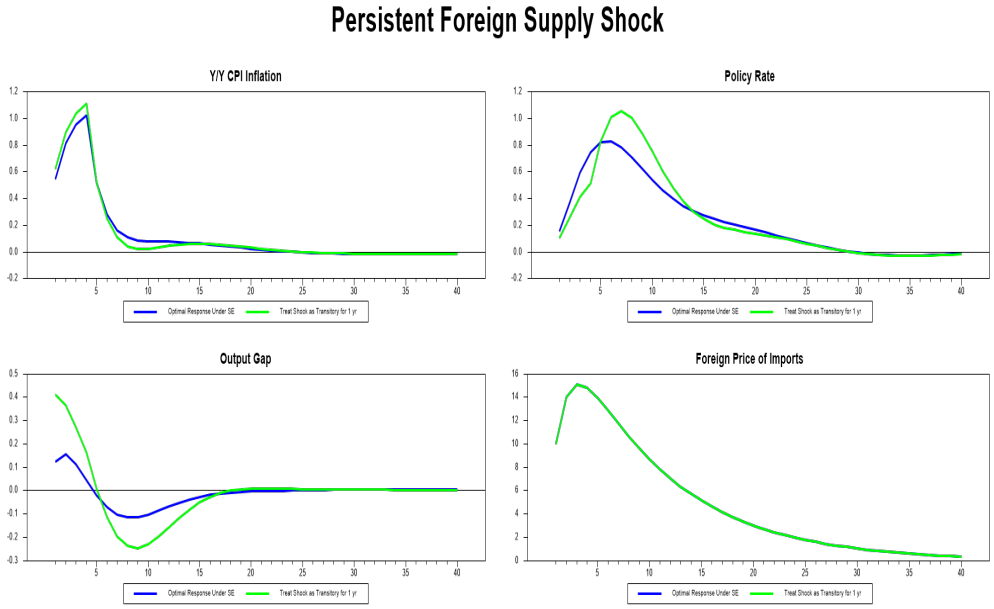
This uncertainty leads to a stronger initial monetary-policy response and produces a deeper contraction in the output gap.

As the foreign price returns rapidly toward its baseline, subsequent observations provide increasing evidence that the disturbance is transitory. The figure illustrates the central tradeoff created by incomplete information: insurance against a potentially persistent inflationary disturbance comes at the cost of greater output variability when the disturbance ultimately proves to be transitory.

The experiment in Figure 6 considers the opposite case; a persistent foreign supply shock under the two alternative monetary-policy responses. In the benchmark case, shown by the blue lines, the central bank follows the optimal policy under signal extraction, using observed foreign prices to update its estimate of the transitory and persistent components of the disturbance each period. The alternative experiment, shown by the green lines, assumes that the central bank treats the disturbance as transitory for the first year, thereby looking through much of the increase in foreign prices during that period. After one year, policy begins responding optimally to the shock. The choice of one year is arbitrary but is useful for illustrating the central point.

While delaying the policy response provides some near-term support to activity, it comes at the cost of a substantially larger subsequent policy adjustment. During the first year, the

Figure 6: Treating Persistent Shocks as Transitory Requires a Large Rate Correction



policy rate is lower and the output gap is appreciably stronger when the shock is treated as transitory, while year-over-year CPI inflation rises somewhat more. Once the persistence of the disturbance is recognized, however, the policy rate must rise considerably more sharply, peaking above the rate required under the optimal signal-extraction policy. This delayed tightening subsequently produces a deeper contraction in the output gap. This provides the counterpart to the preceding transitory-shock experiment and helps explain why, under uncertainty about persistence, the cost of initially under reacting to a persistent shock can exceed the cost of precautionary tightening when a shock ultimately proves transitory.

5.4 Loss asymmetry across shock classifications

In this section, we compare the loss associated with treating markup shocks as transitory versus employing the optimal signal extraction approach. This is a natural experiment since the vast majority of the variance of markup shocks in the estimated model is driven by transitory disturbances.

The asymmetry across the two policy errors can be evaluated using the policymaker's quadratic loss function. Let $z^r_{s,t}$ denote the vector of responses of the variables entering the loss function in period t under policy regime r, following an innovation of type $s \in \{T, P\}$, and let W denote the matrix containing the corresponding policy weights. For a given shock realization, discounted loss is

$$\mathcal{L}^r_s = \sum_{t=0}^{\infty} \beta^t z^{r\prime}_{s,t} W z^r_{s,t}, \tag{79}$$

where β is the policymaker's discount factor.

Let FI, T denote the full-information optimal policy when the realized shock is transitory, let SE denote the optimal policy under signal extraction, and let D denote the counterfactual policy that treats the shock as purely transitory during the first n periods following the shock. For impulse responses normalized to unit innovations, we define the incremental loss from responding when the realized shock is transitory as

$$\Delta\mathcal{L}_T = \sigma_v^{*2} \sum_{t=0}^{\infty} \beta^t \left[z_{T,t}^{SE\prime} W z_{T,t}^{SE} - z_{T,t}^{FI,T\prime} W z_{T,t}^{FI,T} \right], \tag{80}$$

and define the incremental loss from initially treating a persistent shock as transitory as

$$\Delta\mathcal{L}_P = \sigma_p^{*2} \sum_{t=0}^{\infty} \beta^t \left[z_{P,t}^{D\prime} W z_{P,t}^{D} - z_{P,t}^{SE\prime} W z_{P,t}^{SE} \right]. \tag{81}$$

The degree of policy-loss asymmetry can then be summarized by

$$\mathcal{A}_{\mathcal{L}} = \frac{\Delta\mathcal{L}_P}{\Delta\mathcal{L}_T}. \tag{82}$$

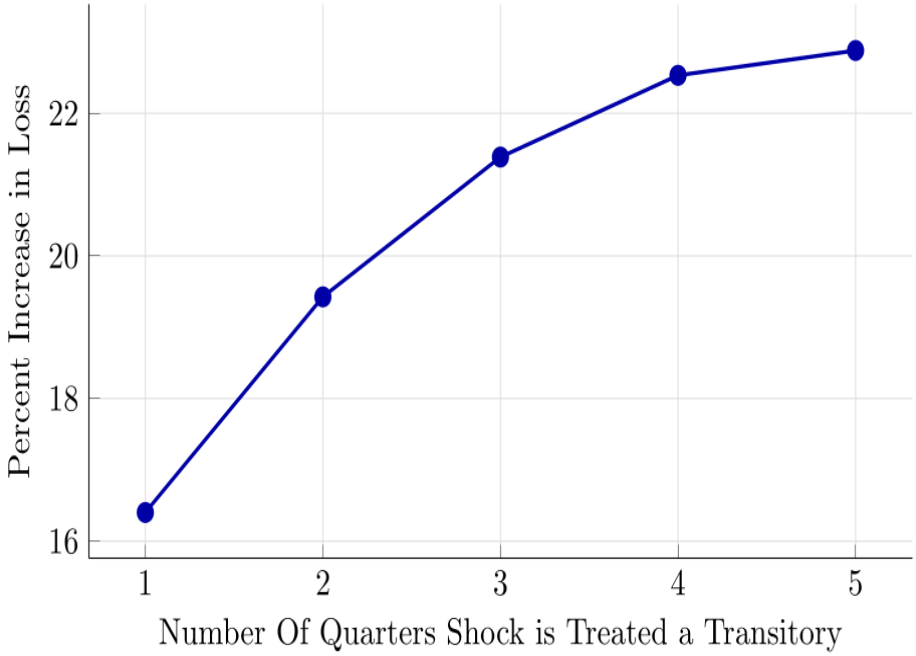
A value of $\mathcal{A}_{\mathcal{L}} > 1$ indicates that the loss from initially treating a persistent disturbance as transitory exceeds the loss from responding when the disturbance ultimately proves transitory.

Both innovations in the model are independent Gaussian shocks rather than mutually exclusive shock types. Accordingly, their relative variances do not represent probabilities that a disturbance is transitory or persistent.

Measured in the units of the policymaker's objective, the main policy claim can therefore be assessed by comparing $\Delta\mathcal{L}_P$ with $\Delta\mathcal{L}_T$. The simulation results imply an economically important asymmetry if the delayed-response loss associated with a persistent shock is substantially larger than the precautionary loss associated with a transitory shock. In that case, responding to the risk of persistence is justified not because precautionary tightening is costless, but because its expected loss is small relative to the loss that can result from allowing a persistent foreign supply disturbance to be treated as temporary.

Figure 7 compares the additional loss from treating a persistent foreign supply shock as transitory for the first n quarters with the additional loss from using signal extraction when the realized shock is transitory, for different values of n. The former is measured relative to optimal policy under signal extraction following a persistent shock; the latter is measured relative to the correct assumption that the shock is temporary. In other words, the figure quantifies the additional loss associated with the central bank always treating foreign supply shocks as temporary, rather than adopting the optimal filtering approach under imperfect information. The horizontal axis varies the delayed-recognition period from one to five quarters, and the vertical axis reports $100[\mathcal{A}_{\mathcal{L}}(n) - 1]$. The additional loss from delayed recognition of a persistent shock exceeds the additional loss from signal extraction following a transitory shock by 16.4 percent for $n = 1$, up to 23 percent for $n = 5$. Thus, even a one-quarter delay generates a larger incremental loss than the precautionary response to a transitory shock, and this difference widens as recognition is delayed.

Figure 7: Initially Treating a Persistent Shock as Transitory Can be Costly ($100(\mathcal{A}_{\mathcal{L}} - 1)$)



6 Conclusion

The appropriate monetary policy response to a supply shock depends not only on its initial effect on inflation, but also on how long the underlying disturbance is expected to last. In the small-open-economy model examined here, monetary transmission lags make it optimal to look through disturbances whose inflationary effects dissipate quickly. Persistent disturbances warrant a stronger response because they generate sustained cost pressures and greater propagation through domestic prices and wages. The strength of the optimal response also depends on nominal rigidity: greater price flexibility improves the output–inflation trade-off and permits more forceful inflation stabilization.

In practice, the persistence of a disturbance cannot be inferred from its initial effects alone. This paper examines that information problem in an environment where agents know the processes governing transitory and persistent supply disturbances but cannot observe their realizations separately. The central bank and private agents use observed foreign prices to estimate the underlying components and update those estimates as new information arrives. Optimal policy therefore responds to the estimated state of the economy rather than to the subsequently revealed nature of the shock.

The results highlight an asymmetry in the costs of responding before persistence is fully known. When a disturbance proves transitory, signal extraction initially produces more tightening than would be optimal under full information. As evidence of its temporary nature accumulates, that additional tightening is unwound. By contrast, initially treating a persistent disturbance as transitory allows inflationary pressure to build and requires a larger subsequent policy adjustment. In the model's policy experiments, the cost of the precautionary response to a transitory disturbance is smaller than the cost of delaying the

response to a persistent one.

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