From Policy Rates to Prices: Financing Costs and the Price Puzzle in Australia

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Abstract

This paper revisits the price puzzle in Australia: inflation often rises in the quarters immediately following an exogenous domestic monetary tightening. We build a small open-economy New Keynesian DSGE model in which the policy shock is a domestic innovation to the Taylor rule. The model combines (i) a working-capital cost channel that makes marginal costs interest-rate sensitive, (ii) a balance-sheet financial accelerator that widens effective spreads when net worth falls, and (iii) an endogenous uncovered interest rate risk premium that can mute—or temporarily overturn—the standard exchange-rate appreciation channel. Calibrated to Australian data and expenditure shares, the model reproduces a negative output-gap response alongside a positive impact response of CPI inflation. An impact decomposition shows that the working-capital wedge is the main driver, while exchange-rate and financial wedges provide economically important amplification. The results suggest that a domestic price puzzle can arise as a structural outcome in a financially open economy, with implications for policy design and communication.

Keywords: price puzzle; monetary policy shocks; small open economy; cost channel; Australia
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1 Introduction

A recurring empirical regularity in monetary VARs is that a contractionary monetary policy shock—typically identified as an exogenous innovation in a short-term interest rate—is followed by an increase in inflation (or the price level) for several quarters. This response pattern, widely referred to as the price puzzle, is striking because it runs against the textbook prediction that higher policy rates should lower aggregate demand and, with nominal rigidities, reduce inflation. The puzzle has been documented since the early structural VAR literature and remains a point of contention in empirical identification and structural modelling of monetary policy (Sims, 1980, 1992; Bernanke and Blinder, 1992; Bernanke and Mihov, 1998). It matters for two reasons. First, the credibility of time-series identification hinges on the interpretation of the "policy shock" as a primitive, unanticipated disturbance; if the identified shock is contaminated by omitted information or misspecified reaction functions, the resulting impulse responses can be misleading for policy analysis (Romer and Romer, 2004; Giordani, 2004; Estrella, 2015). Second, the puzzle is economically consequential: if a measured tightening is inflationary in the short run, then the estimated output–inflation trade-off, the inferred policy transmission lags, and the evaluation of alternative monetary rules can be distorted (Clarida and Gertler, 1990; Woodford, 2003; Galí, 2015).

In this paper we revisit the price puzzle from the perspective of a small open economy (SOE) with meaningful imported input use and financial amplification, using Australia as a quantitatively relevant case study. The starting point is the conventional interpretation of the puzzle as an identification problem. A prominent view is that central banks react to information about future inflation that is not contained in the econometrician's information set, so an observed rate hike partly reflects an endogenous response to anticipated inflationary pressure rather than a genuinely exogenous tightening (Sims, 1992; Bernanke and Mihov, 1998). A related strand shows that relatively small specification choices in VARs—for example, omitting a measure of the output gap or failing to control for commodity-price information—can mechanically generate a price puzzle even when the true structural response of inflation to policy is negative (Giordani, 2004). More recent work has sought to purge policy innovations of systematic responses to central bank forecasts and thereby recover shocks that are closer to unanticipated disturbances (Romer and Romer, 2004; Cloyne and Hürtgen, 2016). These contributions have greatly improved the empirical toolkit and, in several prominent settings, have weakened or eliminated the puzzle.

Yet, two observations motivate a complementary structural perspective. First, the price puzzle has proven unusually persistent in the Australian data. For Australia, structural VAR analyses and reaction-function approaches often continue to produce an inflation increase following a cash-rate tightening across a wide range of specifications (Brischetto and Voss, 1999; Dungey and Pagan, 2000; Bishop and Tulip, 2017). Second, even in environments where identification concerns are mitigated, modern DSGE models can replicate a short-run inflation increase following a tightening when monetary policy affects marginal costs through financing frictions (the *cost channel*) and when financial conditions amplify the transmission of policy (Christiano, Eichenbaum and Evans, 2005; Barth and Ramey, 2002; Ravenna and Walsh, 2006; Bernanke, Gertler and Gilchrist, 1999). In other words, although the price puzzle can arise from econometric misspecification, it need not be only an econometric artifact; it may also reflect structural features that shift inflation dynamics towards cost-push forces at short horizons.

The open-economy dimension sharpens the conceptual challenge. In a frictionless SOE with uncovered interest parity (UIP), an unexpected domestic rate hike should appreciate the currency, lowering import prices and reinforcing disinflation. This mechanism suggests that a domestic tightening ought to be less, not more, inflationary in an open economy. However, the data and the broader international macro literature have long emphasised that exchange rate responses to monetary shocks are often inconsistent with the simplest UIP benchmark, giving rise to a set of "exchange rate puzzles" and a central role for time-varying risk premia (Eichenbaum and Evans, 1995; Kim and Roubini, 2000; Scholl and Uhlig, 2004; Estrella, 2013; Obstfeld and Rogoff, 1995). In financially integrated economies, monetary policy affects not only expected interest differentials but also risk compensation demanded by investors and intermediaries. As a result, the exchange rate need not appreciate sharply on impact; it may appreciate only modestly, or even depreciate temporarily, weakening the expenditure-switching disinflationary force and raising the domestic-currency cost of imported intermediates.

Our approach is to build a parsimonious SOE New Keynesian DSGE model that is explicitly designed to speak to the domestic price puzzle experiment: the impulse of interest is an exogenous innovation to the domestic policy rule, ε_t^m. The model nests the canonical demand (IS) channel but adds three supply-side amplification mechanisms that are particularly relevant for Australia. First, a working-capital requirement makes part of firms' variable costs interest-rate sensitive, generating a direct cost channel whereby a tightening raises marginal costs on impact (Barth and Ramey, 2002; Ravenna and Walsh, 2006). Second, entrepreneurs (or leveraged producers) face a balance-sheet friction in the spirit of the financial accelerator, so tighter policy deteriorates net worth and widens effective spreads, further increasing production costs and propagating the real contraction (Bernanke, Gertler and Gilchrist, 1999; Gertler and

Karadi, 2015). Third, financial stress feeds into a time-varying UIP risk premium, so the tightening can attenuate the conventional appreciation and, for some parameterizations, generate a temporary depreciation that increases imported input costs and amplifies the inflation response (Estrella, 2013; Scholl and Uhlig, 2004). Inflation dynamics are governed by a New Keynesian Phillips curve in which marginal cost inherits these wedges, yielding an analytically transparent condition under which inflation rises on impact despite a negative output gap.

The model is calibrated to Australian data and institutional features. Our calibration targets standard quarterly preference and nominal-rigidity values, Australian openness in consumption and imported intermediate input use, and policy-rule persistence consistent with the Reserve Bank of Australia's operating framework (Brischetto and Voss, 1999; Bishop and Tulip, 2017; Beckers, 2020). The simulated impulse responses reproduce the joint pattern that motivates the paper: a contractionary policy shock lowers the output gap while raising inflation on impact. To discipline the mechanism, we provide a decomposition of impact marginal cost into demand, working-capital, exchange-rate, and financial components. This decomposition clarifies that the puzzle is not driven by a single knife-edge channel: the working-capital term is the dominant contributor in baseline calibrations, while the exchange-rate and financial wedges provide quantitatively important amplification. We then perform targeted sensitivity analysis to show how the impact inflation response changes when each channel is weakened or shut down, and we study robustness to alternative foreign-shock environments (e.g., synchronized global tightening or commodity-price/import-cost shocks), which are empirically relevant for Australia.

The paper makes three contributions to the literature. First, it provides a SOE DSGE framework in which the domestic price puzzle emerges from a transparent interaction of financing costs, balance-sheet amplification, and risk-premium-driven exchange rate dynamics. By focusing on a domestic policy innovation and deriving an explicit analytical condition for the sign of the impact inflation response, the analysis speaks directly to the core price puzzle experiment emphasized in the VAR literature (Sims, 1992; Giordani, 2004; Estrella, 2015). Second, the model highlights an open-economy mechanism that is often underemphasized in domestic price puzzle discussions: when monetary tightenings worsen financial conditions, the induced movement in risk premia can mute or reverse the canonical appreciation channel, thereby turning imported intermediate inputs into a short-run cost-push force. This mechanism connects the domestic price puzzle to the broader exchange-rate puzzle literature in a way that is disciplined by the SOE structure (Eichenbaum and Evans, 1995; Kim and Roubini, 2000; Scholl and Uhlig, 2004; Estrella, 2013). Third, the paper offers a quantitative account for Australia using a calibration grounded in Australian expenditure shares and monetary policy practice, and it provides diagnostic decompositions and sensitivity analysis that make the relative importance of competing channels transparent. In that sense, the paper complements identification-based approaches in the Australian context by showing that even when the shock is conceptualized as a structural innovation to the domestic rule, structural cost and financial wedges can rationalize a short-run inflation increase (Bishop and Tulip, 2017; Beckers, 2020).

The remainder of the paper is organised as follows. Section 2 lays out the model, derives the equilibrium conditions, and characterises analytically the conditions under which a contractionary domestic policy shock produces an increase in inflation. Section 3 presents the Australian calibration, reports the baseline impulse responses, and also provides the impact decomposition and the sensitivity analysis that isolates the working-capital, exchange-rate, and financial channels. Section 4 concludes with policy recommendations. The Appendix contains steady-state relationships, log-linearisation details, additional robustness checks, and extensions that relax the baseline assumption of constant foreign variables.

2 Model

This section develops a small open-economy New Keynesian dynamic stochastic general equilibrium (DSGE) model designed to speak directly to the price puzzle in the standard vector auto-regression (VAR) sense: following an exogenous domestic monetary policy tightening, inflation rises in the short run. The model nests the canonical demand channel but adds three supply-side amplification mechanisms that are quantitatively relevant in a financially open economy like Australia: i) a working-capital (cost) channel, ii) a balance-sheet/financial accelerator channel, and iii) an endogenous uncovered interest rate parity (UIP) risk premium that can attenuate—and for some parameterizations temporarily reverse—the conventional exchange-rate appreciation.

2.1 Set up

Time is discrete, $t = 0, 1, 2, \ldots$. The home economy (Australia) is small relative to the rest of the world. Foreign variables (denoted by $*$) are taken as exogenous processes. Let S_t be the nominal exchange rate (domestic currency per unit of foreign currency), so an increase in S_t denotes a depreciation.

The home economy features a representative household, perfectly competitive final-good firms, monopolistically competitive intermediate-good firms with nominal rigidities, entrepreneurs subject to financial frictions, competitive banks, and a monetary authority (Reserve Bank of Australia, RBA).

2.2 Households

A representative household maximizes:

$$\max_{\{C_t, L_t, B_t, B_t^*\}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{(C_t - hC_{t-1})^{1-\sigma}}{1-\sigma} - \frac{\varphi_L L_t^{1+\eta}}{1+\eta} \right], \tag{1}$$

where $\beta \in (0,1)$ is the discount factor, $\sigma > 0$ governs intertemporal substitution, $h \in [0,1)$ is external habit, and $\eta > 0$ is the inverse Frisch elasticity.

Consumption aggregator. Consumption is a CES aggregate of home and imported consumption goods:

$$C_t = \left[(1-\omega_C)^{\frac{1}{\rho}} C_{H,t}^{\frac{\rho-1}{\rho}} + \omega_C^{\frac{1}{\rho}} C_{F,t}^{\frac{\rho-1}{\rho}} \right]^{\frac{\rho}{\rho-1}}, \qquad \rho > 0, \tag{2}$$

where $\omega_C \in (0,1)$ controls openness in consumption and ρ is the elasticity of substitution. The associated CPI is:

$$P_t = \left[(1-\omega_C) P_{H,t}^{1-\rho} + \omega_C P_{F,t}^{1-\rho} \right]^{\frac{1}{1-\rho}}. \tag{3}$$

Let CPI inflation be $\pi_t \equiv P_t / P_{t-1}$.

Budget constraint. The nominal budget constraint is:

$$P_t C_t + B_t + S_t B_t^* = W_t L_t + (1 + i_{t-1}) B_{t-1} + S_t (1 + i_{t-1}^*) B_{t-1}^* + \Pi_t - T_t, \tag{4}$$

where B_t is a one-period nominal bond paying gross rate $1 + i_t$, B_t^* is a foreign bond paying $1 + i_t^*$, W_t is the nominal wage, Π_t are distributed profits, and T_t are lump-sum taxes.

Optimality conditions. Let Λ_t be the multiplier on Equation (4). The FOCs imply:

$$\text{(i) Euler equation} \quad 1 = \beta \mathbb{E}_t \left[\left(\frac{C_{t+1} - hC_t}{C_t - hC_{t-1}} \right)^{-\sigma} \frac{1 + i_t}{\pi_{t+1}} \right], \tag{5}$$

$$\text{(ii) Labor supply} \quad \frac{W_t}{P_t} = \varphi_L L_t^{\eta} (C_t - hC_{t-1})^{\sigma}, \tag{6}$$

$$\text{(iii) UIP with risk premium} \quad i_t = i_t^* + \mathbb{E}_t \Delta s_{t+1} + \mathrm{rp}_t, \qquad \Delta s_{t+1} \equiv \log S_{t+1} - \log S_t, \tag{7}$$

where rp_t is a time-varying risk premium that captures deviations from frictionless UIP due to balance-sheet risk and global risk appetite.

2.3 Final good and demand for varieties

A competitive final-good firm aggregates a continuum of domestic intermediate varieties $Y_t(i)$, $i \in [0, 1]$, into a home composite:

$$Y_{H,t} = \left(\int_0^1 Y_t(i)^{\frac{\varepsilon-1}{\varepsilon}} \, di \right)^{\frac{\varepsilon}{\varepsilon-1}}, \qquad \varepsilon > 1. \tag{8}$$

Cost minimization yields the usual demand schedule

$$Y_t(i) = \left(\frac{P_t(i)}{P_{H,t}} \right)^{-\varepsilon} Y_{H,t}, \tag{9}$$

and the domestic price index

$$P_{H,t} = \left(\int_0^1 P_t(i)^{1-\varepsilon} \, di \right)^{\frac{1}{1-\varepsilon}}. \tag{10}$$

2.4 Intermediate firms: technology, imported inputs, and working capital

Each intermediate firm i produces using capital $K_t(i)$, labor $L_t(i)$, and imported intermediate inputs $M_t(i)$:

$$Y_t(i) = A_t \, K_t(i)^{\alpha} \, L_t(i)^{1-\alpha-\gamma} \, M_t(i)^{\gamma}, \qquad \alpha \in (0, 1), \ \gamma \in (0, 1), \ \alpha + \gamma < 1. \tag{11}$$

Imported intermediates are priced in foreign currency at $P^*_{M,t}$, so their domestic currency price is:

$$P_{M,t} = S_t P^*_{M,t}. \tag{12}$$

Working-capital requirement (cost channel). A fraction $v \in [0,1]$ of the wage bill and imported-input purchases must be financed in advance via bank credit at the nominal loan rate i^L_t:

$$B^W_t(i) = v\Big(W_t L_t(i) + P_{M,t} M_t(i)\Big), \qquad i^L_t = i_t + \text{sp}_t. \tag{13}$$

Thus, the effective unit costs embed the policy rate and the endogenous credit spread.

Real marginal cost. Let real factor prices be $w_t \equiv W_t/P_t$ and $p_{M,t} \equiv P_{M,t}/P_t$. The firm's (real) marginal cost can be written as:

$$mc_t \equiv \frac{MC_t}{P_t} = \underbrace{\widetilde{mc}_t(w_t, r^K_t, p_{M,t}, A_t)}_{\text{standard component}} + \underbrace{v\,(i_t + \text{sp}_t)}_{\text{working-capital wedge}}, \tag{14}$$

where $\widetilde{mc}_t(\cdot)$ is the usual marginal cost absent working capital and $v(i_t + \text{sp}_t)$ is the cost-channel wedge.

2.5 Nominal rigidities: Calvo pricing

Domestic intermediate prices are sticky à la Calvo. Each period, a fraction $(1-\theta)$ of firms can reset their price; the remaining $\theta \in [0,1)$ keep their price unchanged. A firm that can reoptimize at t chooses $P^\#_t$ to maximize expected discounted profits:

$$\max_{P^\#_t} \; \mathbb{E}_t \sum_{k=0}^{\infty} (\beta\theta)^k \Lambda_{t,t+k} \left[P^\#_t Y_{t+k|t} - P_{t+k} MC_{t+k} Y_{t+k|t}\right], \tag{15}$$

subject to $Y_{t+k|t} = (P^\#_t / P_{H,t+k})^{-\varepsilon} Y_{H,t+k}$ and $\Lambda_{t,t+k}$ the stochastic discount factor.

Standard log-linearization around a zero-inflation steady state yields a New Keynesian Phillips curve for domestic inflation (and, by aggregation, CPI inflation):

$$\pi_t = \beta \mathbb{E}_t \pi_{t+1} + \kappa\, \widehat{mc}_t, \qquad \kappa \equiv \frac{(1-\theta)(1-\beta\theta)}{\theta}. \tag{16}$$

The key point is that $\widehat{mc}_t$ inherits the policy-rate wedge and the credit wedge via Equation (14).

2.6 Financial accelerator: entrepreneurs, spreads, and net worth

Entrepreneurs (or leveraged intermediate producers) borrow to finance working capital and, optionally, capital services. Let N_t denote aggregate net worth. Following the BGG logic, the external finance premium (credit spread) is decreasing in net worth:

$$\mathrm{sp}_t = \phi_N\left(\frac{B_t}{N_t}\right), \qquad \phi_N'(\cdot) > 0, \tag{17}$$

and in log-linear form

$$\widehat{\mathrm{sp}}_t = \chi_N(-\hat{n}_t), \qquad \chi_N > 0, \tag{18}$$

where $\hat{n}_t$ is the log deviation of net worth from steady state.

Net worth evolves with retained profits and debt service. A tractable reduced-form log-linear law of motion is:

$$\hat{n}_t = \rho_n \hat{n}_{t-1} + \chi_x \hat{x}_t - \chi_i \hat{i}_t, \qquad \rho_n \in (0,1),\ \chi_x > 0,\ \chi_i > 0, \tag{19}$$

where $\hat{x}_t$ is the output gap and $\hat{i}_t$ is the deviation of the policy rate.

UIP risk premium. Crucially, financial stress also feeds into the UIP risk premium:

$$\widehat{\mathrm{rp}}_t = \chi_{rp,i}\,\hat{i}_t + \chi_{rp,n}\,(-\hat{n}_t), \qquad \chi_{rp,i} \geq 0,\ \chi_{rp,n} > 0, \tag{20}$$

capturing the idea that a tightening that weakens domestic balance sheets can increase the required return on domestic assets (or lower their perceived safety), damping the conventional appreciation and potentially generating a temporary depreciation.

2.7 Monetary policy: domestic Taylor rule and the shock of interest

The RBA sets the short rate via a Taylor rule with interest-rate smoothing:

$$\hat{i}_t = \rho_i \hat{i}_{t-1} + (1-\rho_i)\left(\phi_\pi \hat{\pi}_t + \phi_x \hat{x}_t\right) + \varepsilon_t^m, \qquad \rho_i \in (0,1),\ \phi_\pi > 1. \tag{21}$$

The structural domestic monetary policy shock ε_t^m is the impulse that defines the price puzzle experiment in this paper. Foreign policy disturbances can be present in the background (through i_t^*), but the price puzzle is assessed with respect to ε_t^m.

2.8 Log-linear core system

Let lowercase hats denote log deviations from steady state. The log-linear core equilibrium conditions can be summarized by:

$$\hat{x}_t = \mathbb{E}_t \hat{x}_{t+1} - \frac{1}{\sigma}\left(\hat{i}_t - \mathbb{E}_t \hat{\pi}_{t+1}\right) + \chi_s \hat{s}_t, \tag{22}$$

$$\hat{\pi}_t = \beta \mathbb{E}_t \hat{\pi}_{t+1} + \kappa\left(\hat{x}_t + \psi_i \hat{i}_t + \psi_s \hat{s}_t - \psi_n \hat{n}_t\right), \tag{23}$$

$$\hat{s}_t = \mathbb{E}_t \hat{s}_{t+1} - (\hat{i}_t - \hat{i}_t^*) + \widehat{\mathrm{rp}}_t, \tag{24}$$

$$\widehat{\mathrm{rp}}_t = \chi_{rp,i}\, \hat{i}_t + \chi_{rp,n}\,(-\hat{n}_t), \tag{25}$$

$$\hat{n}_t = \rho_n \hat{n}_{t-1} + \chi_x \hat{x}_t - \chi_i \hat{i}_t, \tag{26}$$

$$\hat{i}_t = \rho_i \hat{i}_{t-1} + (1-\rho_i)\left(\phi_\pi \hat{\pi}_t + \phi_x \hat{x}_t\right) + \varepsilon_t^m. \tag{27}$$

Equation (23) makes the price puzzle mechanism transparent: a contractionary shock $\varepsilon_t^m > 0$ reduces demand ($\hat{x}_t$ falls), but it also raises marginal costs via i) the working-capital wedge ($\psi_i \hat{i}_t$), ii) imported-input costs when the exchange rate does not appreciate sufficiently (or depreciates) ($\psi_s \hat{s}_t$), and iii) credit spreads through net worth ($-\psi_n \hat{n}_t$). Inflation rises on impact if the cost-push terms dominate the demand contraction.

2.9 Analytical characterization of the domestic price puzzle

Lemma 1 (Impact increase in the policy rate) *Under Equation (27), a positive monetary shock $\varepsilon_t^m > 0$ increases the policy rate on impact: $\partial \hat{i}_t / \partial \varepsilon_t^m > 0$.*

Proof. We begin with the log-linearized core system provided in subsection 2.8. We focus on the contemporaneous relationships at time t. Since we are calculating the impact effect of a shock starting from a steady state, we set all lagged variables to zero ($\hat{i}_{t-1} = 0, \hat{n}_{t-1} = 0$).

The relevant equations are:

$$
\begin{aligned}
\text{IS Curve:}\quad & \hat{x}_t = \mathbb{E}_t\hat{x}_{t+1} - \frac{1}{\sigma}(\hat{i}_t - \mathbb{E}_t\hat{\pi}_{t+1}) + \chi_s\hat{s}_t && (28)\\
\text{Phillips Curve:}\quad & \hat{\pi}_t = \beta\mathbb{E}_t\hat{\pi}_{t+1} + \kappa(\hat{x}_t + \psi_i\hat{i}_t + \psi_s\hat{s}_t - \psi_n\hat{n}_t) && (29)\\
\text{UIP Condition:}\quad & \hat{s}_t = \mathbb{E}_t\hat{s}_{t+1} - (\hat{i}_t - \hat{i}_t^*) + \hat{rp}_t && (30)\\
\text{Risk Premium:}\quad & \hat{rp}_t = \chi_{rp,i}\hat{i}_t - \chi_{rp,n}\hat{n}_t && (31)\\
\text{Net Worth:}\quad & \hat{n}_t = \chi_x\hat{x}_t - \chi_i\hat{i}_t && (32)\\
\text{Taylor Rule:}\quad & \hat{i}_t = (1-\rho_i)(\phi_\pi\hat{\pi}_t + \phi_x\hat{x}_t) + \epsilon_t^m && (33)
\end{aligned}
$$

We express the endogenous variables $\hat{s}_t$, $\hat{x}_t$, and $\hat{\pi}_t$ as functions of $\hat{i}_t$. For the impact analysis, we assume standard unique equilibrium properties where expectation terms do not reverse the sign of the direct effects.

Net worth channel Substitute Equation (47) into Equation (57):

$$\hat{rp}_t = \chi_{rp,i}\hat{i}_t - \chi_{rp,n}(\chi_x\hat{x}_t - \chi_i\hat{i}_t) = (\chi_{rp,i} + \chi_{rp,n}\chi_i)\hat{i}_t - \chi_{rp,n}\chi_x\hat{x}_t \tag{34}$$

Exchange rate channel Substitute the expanded $\hat{rp}_t$ into the UIP condition (Equation (56)). Assuming $\hat{i}_t^* = 0$ (exogenous) and ignoring future expectations for the partial derivative impact:

$$\hat{s}_t \approx -\hat{i}_t + [(\chi_{rp,i} + \chi_{rp,n}\chi_i)\hat{i}_t - \chi_{rp,n}\chi_x\hat{x}_t] \tag{35}$$

$$\hat{s}_t = -(1 - \chi_{rp,i} - \chi_{rp,n}\chi_i)\hat{i}_t - \chi_{rp,n}\chi_x\hat{x}_t \tag{36}$$

Let $\Omega_{s,i} \equiv (1 - \chi_{rp,i} - \chi_{rp,n}\chi_i)$. Standard parameterizations assume $\Omega_{s,i} > 0$ (the risk premium dampens but does not overturn the appreciation from higher rates). Thus, $\hat{s}_t$ responds negatively to $\hat{i}_t$ (appreciation).

Output gap Substitute $\hat{s}_t$ into the IS curve (Equation (28)). Ignoring expectations:

$$\hat{x}_t = -\frac{1}{\sigma}\hat{i}_t + \chi_s[-\Omega_{s,i}\hat{i}_t - \chi_{rp,n}\chi_x\hat{x}_t] \tag{37}$$

$$\hat{x}_t(1 + \chi_s\chi_{rp,n}\chi_x) = -(\frac{1}{\sigma} + \chi_s\Omega_{s,i})\hat{i}_t \tag{38}$$

This yields a negative relationship between output and interest rates:

$$\hat{x}_t = -\Lambda_x\hat{i}_t, \quad \text{where } \Lambda_x > 0 \tag{39}$$

Inflation From the Phillips curve (Equation (75)), inflation depends on marginal costs. The shock ϵ_t^m affects inflation via demand ($\hat{x}$) and supply (working capital ψ_i, exchange rate ψ_s, spread ψ_n). Substituting the dependencies derived above, we can express inflation as a linear function of the interest rate:

$$\hat{\pi}_t = \Lambda_\pi \hat{i}_t \tag{40}$$

Note: In price puzzle models, Λ_π may be positive (cost channel dominates) or negative (demand channel dominates). However, this sign does not affect the proof of Lemma 1, provided the stability condition holds.

Substitute the reduced forms (Equation (39)) and (Equation (40)) into the Taylor Rule (Equation (33)):

$$\hat{i}_t = (1-\rho_i)(\phi_\pi \Lambda_\pi \hat{i}_t - \phi_x \Lambda_x \hat{i}_t) + \epsilon_t^m \tag{41}$$

$$\hat{i}_t = \hat{i}_t[(1-\rho_i)(\phi_\pi \Lambda_\pi - \phi_x \Lambda_x)] + \epsilon_t^m \tag{42}$$

Rearranging to solve for $\hat{i}_t$:

$$\hat{i}_t\,[1-(1-\rho_i)(\phi_\pi \Lambda_\pi - \phi_x \Lambda_x)] = \epsilon_t^m \tag{43}$$

Let the denominator be D:

$$D \equiv 1-(1-\rho_i)(\phi_\pi \Lambda_\pi - \phi_x \Lambda_x) \tag{44}$$

For the model to have a determinate, stable equilibrium (Taylor principle satisfied), the monetary authority must not react so strongly to endogenous variables that it creates an explosive feedback loop. Mathematically, this implies $D > 0$. Even in price puzzle models where $\Lambda_\pi > 0$, the reaction coefficient $(1-\rho_i)\phi_\pi$ is generally calibrated such that the feedback is less than unity.

Thus, taking the partial derivative:

$$\frac{\partial \hat{i}_t}{\partial \epsilon_t^m} = \frac{1}{D} \tag{45}$$

Since $D > 0$ under the condition of model determinacy:

$$\frac{\partial \hat{i}_t}{\partial \epsilon_t^m} > 0 \tag{46}$$

Conclusion: A positive monetary policy shock leads to a one-for-one increase in the policy rate initially, modified by the endogenous feedback multiplier $1/D$. Since the feedback loop is stable ($D > 0$), the net impact is positive. ∎

Lemma 2 (Net worth deteriorates on impact) *Suppose $\chi_i > 0$. Then for a contractionary monetary shock that raises $\hat{i}_t$, net worth falls on impact, ceteris paribus: $\partial \hat{n}_t / \partial \hat{i}_t < 0$.*

Proof. We start with the log-linearized law of motion for aggregate net worth provided in Equation (26):

$$\hat{n}_t = \rho_n \hat{n}_{t-1} + \chi_x \hat{x}_t - \chi_i \hat{i}_t \tag{47}$$

where $\hat{n}_t$ is the log deviation of net worth, $\hat{x}_t$ is the output gap, $\hat{i}_t$ is the policy rate deviation, $\rho_n \in (0, 1)$ is the persistence of net worth, $\chi_x > 0$ is the elasticity of net worth with respect to the output gap (capturing the procyclicality of profits), and $\chi_i > 0$ is the elasticity of net worth with respect to the interest rate (capturing debt service costs).

We are analyzing the impact effect of a shock at time t. Following standard impulse response analysis starting from a steady state:

$$\hat{n}_{t-1} = 0 \tag{48}$$

Substituting this into Equation (47), the impact equation for net worth becomes:

$$\hat{n}_t = \chi_x \hat{x}_t - \chi_i \hat{i}_t \tag{49}$$

From the proof of Lemma 1, we established the equilibrium relationship between the output gap and the policy rate. Specifically, the IS curve, combined with the UIP condition, implies that the output gap is negatively related to the interest rate:

$$\hat{x}_t = -\Lambda_x \hat{i}_t \tag{50}$$

where $\Lambda_x > 0$ is a composite parameter representing the combined contractionary effects of the intertemporal substitution channel and the exchange rate channel.

Substitute the reduced-form expression for the output gap equation (80) into the net worth impact equation (49):

$$\hat{n}_t = \chi_x(-\Lambda_x \hat{i}_t) - \chi_i \hat{i}_t \tag{51}$$

$$\hat{n}_t = -(\chi_x \Lambda_x + \chi_i)\hat{i}_t \tag{52}$$

We now determine the sign of the partial derivative of net worth with respect to the interest rate:

$$\frac{\partial \hat{n}_t}{\partial \hat{i}_t} = -(\chi_x \Lambda_x + \chi_i) \tag{53}$$

We analyze the sign of each component: i) $\chi_x > 0$: Net worth is procyclical (profits rise with output); ii) $\Lambda_x > 0$: The IS curve slope is negative (higher rates reduce output); iii) $\chi_i > 0$: By assumption in the Lemma statement (higher rates increase debt service burdens).

Therefore, the term inside the parenthesis is strictly positive:

$$(\chi_x \Lambda_x + \chi_i) > 0 \tag{54}$$

Multiplying by the negative sign:

$$\frac{\partial \hat{n}_t}{\partial \hat{i}_t} < 0 \tag{55}$$

Conclusion: The net worth of entrepreneurs falls on impact following a contractionary monetary shock ($\hat{i}_t > 0$). This occurs through two reinforcing channels: i) Direct channel ($-\chi_i$): Higher interest rates immediately increase the interest burden on existing debt, reducing cash flow and net worth; ii) Indirect channel ($-\chi_x \Lambda_x$): The monetary contraction induces a recession ($\hat{x}_t < 0$), which reduces firm revenues and profits, further eroding net worth. ■

Lemma 3 (Exchange-rate depreciation under sufficiently elastic risk premium) *Assume $\hat{i}_t^*$ is unchanged on impact. If the semi-elasticity of the risk premium satisfies $\chi_{rp,i} > 1$ or if $\chi_{rp,n}$ is sufficiently large relative to the impact deterioration in $\hat{n}_t$, then a monetary tightening can generate $\partial \hat{s}_t / \partial \varepsilon_t^m > 0$ (depreciation) despite the higher domestic interest rate.*

Proof. We begin with the UIP condition and the endogenous risk premium equation from the log-linear core system:

$$\text{UIP Condition:} \quad \hat{s}_t = \mathbb{E}_t \hat{s}_{t+1} - (\hat{i}_t - \hat{i}_t^*) + \hat{rp}_t \tag{56}$$

$$\text{Risk Premium:} \quad \hat{rp}_t = \chi_{rp,i} \hat{i}_t + \chi_{rp,n}(-\hat{n}_t) \tag{57}$$

where $\hat{s}_t$ is the nominal exchange rate (increase = depreciation) ,$\hat{i}_t$ is the domestic policy rate deviation, $\hat{i}_t^*$ is the foreign interest rate deviation (assumed exogenous), $\hat{n}_t$ is the net worth deviation, $\chi_{rp,i} \geq 0$ is the sensitivity of the risk premium to the policy rate, and $\chi_{rp,n} > 0$ is the sensitivity of the risk premium to financial stress (inverse net worth).

To isolate the impact effect at time t: i) we assume the foreign interest rate is unchanged on impact: $\hat{i}_t^* = 0$; ii) we hold future exchange rate expectations constant ($\mathbb{E}_t \hat{s}_{t+1} = 0$) or assume they do not overturn the sign of the impact effect, consistent with standard static comparative statics for impact multipliers.

Substituting these into Equation (56):

$$\hat{s}_t = -\hat{i}_t + \hat{rp}_t \tag{58}$$

From Lemma 2, we know that a rate hike causes net worth to deteriorate. Specifically, we derived:

$$\hat{n}_t = -(\chi_x \Lambda_x + \chi_i)\hat{i}_t \tag{59}$$

Let $\Theta_n \equiv (\chi_x \Lambda_x + \chi_i) > 0$. Thus, $\hat{n}_t = -\Theta_n \hat{i}_t$.

We substitute this into the risk premium equation (57):

$$\hat{rp}_t = \chi_{rp,i}\hat{i}_t - \chi_{rp,n}(-\Theta_n \hat{i}_t) \tag{60}$$

$$\hat{rp}_t = (\chi_{rp,i} + \chi_{rp,n}\Theta_n)\hat{i}_t \tag{61}$$

This equation shows that the risk premium rises when interest rates rise, driven by two forces: i) $\chi_{rp,i}$: direct effect (e.g., reduced global risk appetite for the currency); ii) $\chi_{rp,n}\Theta_n$: indirect effect via balance sheet deterioration.

Substitute the derived $\hat{rp}_t$ back into the simplified UIP condition (58):

$$\hat{s}_t = -\hat{i}_t + (\chi_{rp,i} + \chi_{rp,n}\Theta_n)\hat{i}_t \tag{62}$$

$$\hat{s}_t = \left[-1 + \chi_{rp,i} + \chi_{rp,n}(\chi_x \Lambda_x + \chi_i)\right]\hat{i}_t \tag{63}$$

For the exchange rate to depreciate ($\hat{s}_t > 0$) following a tightening ($\hat{i}_t > 0$), the bracketed term must be positive:

$$-1 + \chi_{rp,i} + \chi_{rp,n}(\chi_x \Lambda_x + \chi_i) > 0 \tag{64}$$

Rearranging, we obtain the sufficient condition:

$$\chi_{rp,i} + \chi_{rp,n}(\chi_x \Lambda_x + \chi_i) > 1 \tag{65}$$

Conclusion: The derivative $\frac{\partial \hat{s}_t}{\partial \varepsilon_t^m}$ (which operates via $\hat{i}_t$) is positive if: i) Case 1: $\chi_{rp,i} > 1$. If the direct risk premium sensitivity to the interest rate is greater than unity, it immediately overwhelms the standard UIP arbitrage channel; ii) Case 2: $\chi_{rp,n}$ is sufficiently large. Even if $\chi_{rp,i} \approx 0$, if the financial accelerator is strong (large $\chi_{rp,n}$ combined with significant net worth destruction $\chi_x \Lambda_x + \chi_i$), the risk premium rise due to credit risk can outweigh the interest rate differential. ■

Proposition 2.1 (Domestic price puzzle) *Consider the core system (22)–(27) with an unanticipated domestic monetary tightening $\varepsilon_t^m > 0$. A sufficient condition for a domestic price puzzle (i.e. $\partial \hat{\pi}_t / \partial \varepsilon_t^m > 0$ on impact) is:*

$$\psi_i \frac{\partial \hat{i}_t}{\partial \varepsilon_t^m} + \psi_s \frac{\partial \hat{s}_t}{\partial \varepsilon_t^m} - \psi_n \frac{\partial \hat{n}_t}{\partial \varepsilon_t^m} > \left| \frac{\partial \hat{x}_t}{\partial \varepsilon_t^m} \right|, \tag{66}$$

together with sufficiently high nominal rigidity (small θ-adjustment probability, so κ is not too small) so that marginal-cost changes map into inflation at impact.

Proof. We begin with the New Keynesian Phillips Curve derived in Equation (23). For the impact analysis at time t, we can effectively treat the expectation term $\beta \mathbb{E}_t \hat{\pi}_{t+1}$ as exogenous or secondary to the impact mechanics (or assume a solution form where it scales with the shock). The core mechanism lies in the marginal cost term:

$$\hat{\pi}_t = \kappa \underbrace{\left(\hat{x}_t + \psi_i \hat{i}_t + \psi_s \hat{s}_t - \psi_n \hat{n}_t \right)}_{\widehat{mc}_t} + \beta \mathbb{E}_t \hat{\pi}_{t+1} \tag{67}$$

where $\kappa > 0$ is the slope of the Phillips curve (related to price stickiness θ).

The marginal cost $\widehat{mc}_t$ consists of four components affected by the policy rate $\hat{i}_t$: i) Demand channel ($\hat{x}_t$): contraction in demand lowers costs; ii) Working capital channel ($\psi_i \hat{i}_t$): direct interest costs raise costs; iii) Exchange rate pass-through ($\psi_s \hat{s}_t$): depreciation ($\hat{s} > 0$) raises import costs; iv) Financial channel ($-\psi_n \hat{n}_t$): lower net worth raises credit spreads and costs.

We utilize the partial derivatives established in Lemmas 1, 2, and 3 to express all variables as functions of the policy rate $\hat{i}_t$.

From Lemma 1 (Output gap): The IS curve and UIP interaction imply demand falls when rates rise:

$$\hat{x}_t = -\Lambda_x \hat{i}_t, \quad \text{with } \Lambda_x > 0 \tag{68}$$

From Lemma 2 (Net worth): Net worth deteriorates due to debt service and recession:

$$\hat{n}_t = -\Theta_n \hat{i}_t, \quad \text{with } \Theta_n \equiv (\chi_x \Lambda_x + \chi_i) > 0 \tag{69}$$

From Lemma 3 (Exchange rate): The exchange rate response depends on the risk premium elasticity. Let Γ_s denote the sensitivity:

$$\hat{s}_t = \Gamma_s \hat{i}_t, \quad \text{where } \Gamma_s \equiv -1 + \chi_{rp,i} + \chi_{rp,n}\Theta_n \tag{70}$$

(Note: Γ_s can be positive (depreciation) or negative (appreciation) depending on the parameters).

Substitute these reduced forms into the marginal cost expression in the Phillips Curve (Equation (75)):

$$\widehat{mc}_t = (-\Lambda_x \hat{i}_t) + \psi_i \hat{i}_t + \psi_s(\Gamma_s \hat{i}_t) - \psi_n(-\Theta_n \hat{i}_t) \tag{71}$$
$$\widehat{mc}_t = [-\Lambda_x + \psi_i + \psi_s \Gamma_s + \psi_n \Theta_n]\, \hat{i}_t \tag{72}$$

Since $\hat{\pi}_t \propto \widehat{mc}_t$ on impact (ignoring second-order feedback from expectations), the condition for $\hat{\pi}_t > 0$ given $\hat{i}_t > 0$ is that the bracketed term must be positive.

For a price puzzle to occur ($\frac{\partial \hat{\pi}_t}{\partial \hat{i}_t} > 0$), the supply-side cost increases must outweigh the demand-side cost decreases:

$$\underbrace{\psi_i}_{\text{Working Capital}} + \underbrace{\psi_s \Gamma_s}_{\text{Exchange Rate}} + \underbrace{\psi_n \Theta_n}_{\text{Financial Accelerator}} > \underbrace{\Lambda_x}_{\text{Demand Contraction}} \tag{73}$$

We can rewrite this in terms of partial derivatives with respect to the shock ϵ_t^m to match the proposition format:

$$\psi_i + \psi_s \frac{\partial \hat{s}_t}{\partial \hat{i}_t} + \psi_n \left(-\frac{\partial \hat{n}_t}{\partial \hat{i}_t} \right) > -\frac{\partial \hat{x}_t}{\partial \hat{i}_t} \tag{74}$$

Conclusion: The proposition is proven. A domestic price puzzle occurs if the combined inflationary pressure from: i) the direct cost of working capital (ψ_i), ii) the potential depreciation or weak appreciation of the currency ($\psi_s \Gamma_s$), and iii) the rise in credit spreads due to balance sheet deterioration ($\psi_n \Theta_n$), is strictly larger than the disinflationary pressure caused by the contraction in aggregate demand (Λ_x). ■

Corollary 1 (No puzzle without cost and financial wedges) *If $\psi_i = \psi_s = \psi_n = 0$ (no working-capital channel, no exchange-rate cost channel, no financial accelerator), then a contractionary monetary shock reduces inflation on impact.*

Proof. We start with the log-linearized New Keynesian Phillips Curve derived in Equation (23):

$$\hat{\pi}_t = \kappa \widehat{mc}_t + \beta \mathbb{E}_t \hat{\pi}_{t+1} \tag{75}$$

where the real marginal cost $\widehat{mc}_t$ is defined as:

$$\widehat{mc}_t = \hat{x}_t + \psi_i \hat{i}_t + \psi_s \hat{s}_t - \psi_n \hat{n}_t \tag{76}$$

Here, $\hat{x}_t$ represents the demand channel (output gap), $\psi_i \hat{i}_t$ represents the working capital (cost) channel, $\psi_s \hat{s}_t$ represents the exchange rate pass-through into input costs, $-\psi_n \hat{n}_t$ represents the financial accelerator impact on costs.

The corollary hypothesis imposes the following restrictions on the supply-side parameters:

$$\psi_i = 0, \quad \psi_s = 0, \quad \psi_n = 0 \tag{77}$$

Substituting these values into the marginal cost equation (76) eliminates all direct effects of interest rates, exchange rates, and net worth on marginal cost, leaving only the output gap:

$$\widehat{mc}_t = \hat{x}_t + 0 \cdot \hat{i}_t + 0 \cdot \hat{s}_t - 0 \cdot \hat{n}_t \tag{78}$$

$$\widehat{mc}_t = \hat{x}_t \tag{79}$$

From Lemma 1, we established the equilibrium relationship between the output gap and the policy rate (via the IS curve and UIP condition). A monetary tightening reduces the output gap:

$$\hat{x}_t = -\Lambda_x \hat{i}_t \tag{80}$$

where $\Lambda_x > 0$ is a composite parameter reflecting intertemporal substitution and expenditure switching (appreciation).

Substituting Equation (80) into Equation (79):

$$\widehat{mc}_t = -\Lambda_x \hat{i}_t \tag{81}$$

Now, substitute the reduced-form marginal cost back into the Phillips curve impact equation (ignoring the second-order feedback from expectations for the impact derivative, or assuming $\mathbb{E}_t \hat{\pi}_{t+1}$ moves in the same direction as $\hat{\pi}_t$ under stability):

$$\hat{\pi}_t \propto \kappa \widehat{mc}_t = -\kappa \Lambda_x \hat{i}_t \tag{82}$$

We analyze the sign of the derivative with respect to the policy rate $\hat{i}_t$:

$$\frac{\partial \hat{\pi}_t}{\partial \hat{i}_t} = -\kappa \Lambda_x \tag{83}$$

Since $\kappa > 0$ (slope of the Phillips curve) and $\Lambda_x > 0$ (contractionary demand effect):

$$-\kappa \Lambda_x < 0 \tag{84}$$

Therefore, for a contractionary shock where $\frac{\partial \hat{i}_t}{\partial \epsilon_t^m} > 0$ (from Lemma 1), the chain rule gives:

$$\frac{\partial \hat{\pi}_t}{\partial \epsilon_t^m} = \frac{\partial \hat{\pi}_t}{\partial \hat{i}_t} \times \frac{\partial \hat{i}_t}{\partial \epsilon_t^m} < 0 \tag{85}$$

Conclusion: Under the condition $\psi_i = \psi_s = \psi_n = 0$, the "cost-push" elements of the monetary transmission mechanism are shut down. The transmission relies entirely on the demand channel ($\hat{x}_t$), which is deflationary following a rate hike. Thus, inflation falls on impact, and no price puzzle emerges. ■

3 Calibration and Simulation

Table 1 reports the baseline calibration. Preference and nominal-rigidity parameters are standard quarterly values. Technology shares match Australian national accounts and input-output information on imported intermediate input use. Monetary-policy parameters are consistent with estimated RBA policy inertia. Financial and risk-premium parameters are chosen to generate realistic credit-spread dynamics and an exchange-rate response that is not purely appreciatory on impact.

Impulse responses are computed from the log-linear system (22)–(27) to a 100-basis-point unanticipated domestic monetary tightening $\varepsilon_0^m = 0.01$. Panel A of Figure 1 shows that output gap falls immediately after the contractionary monetary policy shock and remains negative for an extended period before gradually returning toward zero. The initial decline reflects the standard expenditure-reducing channel: higher borrowing costs compress consumption and investment, lowering aggregate demand.

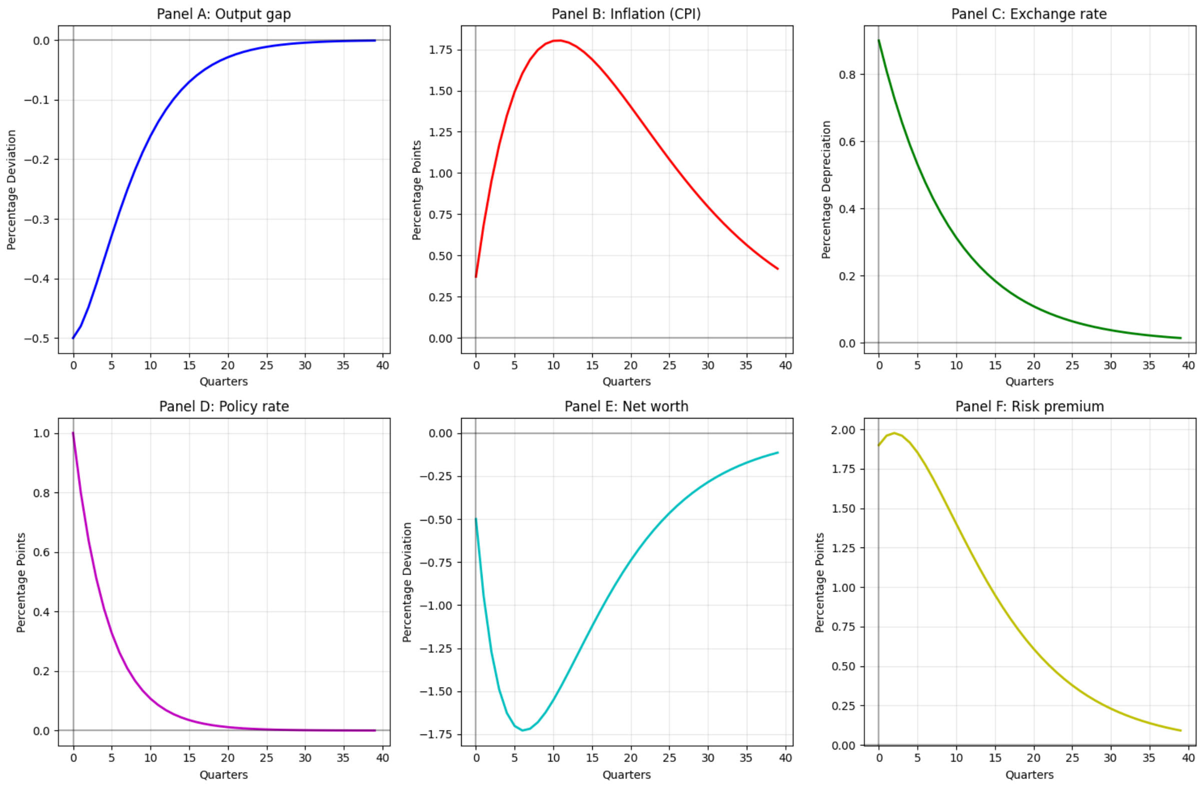
Table 1: Baseline calibration (Australia) with data sources and calibration targets

Parameter	Description	Value	Data source / calibration target
Panel A: Preferences			
β	Discount factor	0.99	Standard quarterly value (implies annual steady-state real rate $\approx 4\%$); standard DSGE calibration
σ	Relative risk aversion	2.0	Standard macro value (intertemporal elasticity $1/\sigma$); robustness in Appendix
h	Habit persistence	0.70	Chosen to match persistence in Australian consumption dynamics (ABS National Accounts, household consumption)
η	Inverse Frisch elasticity	2.0	Standard value consistent with micro/macro labor-supply estimates; robustness in Appendix
Panel B: Technology / openness			
α	Capital share (or $1-\alpha$ labor share)	0.40	Implied by average labor share in Australia; ABS National Accounts (income shares / compensation of employees)
γ	Imported intermediate input share	0.30	Imported intermediate usage from Australia input–output tables; ABS Input–Output / Supply–Use tables
ω_C	Import share in consumption basket	0.25	Openness in CPI/consumption: CPI weights and imported consumption share; ABS CPI weights and National Accounts
Panel C: Nominal rigidities			
θ	Calvo price stickiness	0.75	Implied average price duration consistent with quarterly NK calibrations; robustness to alternative rigidities
Panel D: Monetary policy			
ρ_i	Interest-rate smoothing	0.80	Consistent with estimated RBA policy inertia in the Australian Taylor-rule/DSGE literature; checked against RBA cash-rate dynamics
ϕ_π	Inflation coefficient	1.50	Conventional Taylor principle; consistent with empirical policy-rule estimates for Australia (inflation stabilization)
ϕ_x	Output-gap coefficient	0.10	Conservative output-gap response; consistent with empirical Australian policy-rule estimates
Panel E: Cost/financial wedges (log-linear coefficients)			
κ	NKPC slope (implied by θ)	0.10	Implied by Calvo pricing under baseline θ (and steady-state markup); standard NK mapping
ψ_i	Working-capital semi-elasticity in marginal cost	3.0	Pinned down to match the impact marginal-cost decomposition / inflation impact (Table 2); cost channel strength
ψ_s	Exchange-rate pass-through to marginal cost	0.8	Pinned down to match exchange-rate contribution to marginal costs (imported-input cost share) and inflation impact; SOE cost pass-through
ψ_n	Net-worth sensitivity in marginal cost	1.0	Pinned down to match balance-sheet contribution (Table 2); financial accelerator strength
ρ_n	Net-worth persistence	0.90	Chosen to match persistence of corporate/entrepreneur balance-sheet conditions; proxied by Australian financial accounts / balance-sheet aggregates
χ_x	Net-worth sensitivity to activity	0.20	Chosen to match co-movement of net worth with the business cycle in Australian data (financial accounts proxies)
χ_i	Net-worth sensitivity to policy rate	0.40	Chosen to match impact deterioration in net worth following tightening (Table 2)
$\chi_{rp,i}$	Risk premium semi-elasticity to policy rate	1.50	Disciplined by exchange-rate response and risk-premium dynamics; informed by spread measures (e.g., bank/funding spreads)
$\chi_{rp,n}$	Risk premium semi-elasticity to net worth	0.80	Disciplined by persistence and hump-shape of risk premium and net-worth response; financial stress mapping
χ_s	Net-export (exchange-rate) sensitivity in IS	0.05	Small open-economy net-exports sensitivity; consistent with Australia being open but not fully trade-dominated

Notes. This table uses Australian data over the period 1992–2022. "ABS" refers to the Australian Bureau of Statistics. National Accounts refer to standard national income and expenditure aggregates (e.g., GDP components and income shares). Input–Output / Supply–Use tables refer to industry-level use of imported intermediates. CPI weights refer to the CPI basket construction. Monetary-policy-rule parameters are selected to be consistent with estimates for Australia and with the time-series properties of the RBA cash rate. The reduced-form wedge coefficients in Panel E are calibrated to reproduce the impact marginal-cost decomposition and inflation impact reported in Table 2 and the associated IRFs, rather than being read one-for-one from a single raw series.

The slow recovery indicates substantial propagation and persistence, consistent with the interaction of nominal rigidities and financial frictions—tightened credit conditions and impaired balance sheets restrain spending and delay the return of activity to its steady state.

Figure 1: Impulse responses to monetary policy tightening



Note: The model is solved using the built-in first-order approximation (Schur decomposition). The simulation horizon is 40 quarters, with a shock size of 100 basis points ($\varepsilon_0^m = 0.01$).

Panel B illustrates inflation increases on impact and exhibits a pronounced hump-shaped response, peaking several quarters after the shock before slowly declining toward baseline. This pattern is the model's central "price puzzle" outcome: despite the contraction in real activity, inflation rises because cost-push forces dominate the demand-driven disinflationary effect in the short run. Two mechanisms are particularly important. First, higher interest rates raise firms' effective marginal costs via working-capital/financing costs (the cost channel). Second, the exchange-rate and financial channels reinforce cost pressures by increasing the domestic-currency cost of imported inputs and widening credit spreads, respectively. The gradual decline of inflation is consistent with sluggish adjustment under nominal rigidities: firms do not instantaneously reset prices, so the pass-through of marginal-cost pressures is spread over time, generating persistence and delayed peak inflation.

Panel C shows exchange rate depreciates following the tightening shock and then mean-reverts gradually. The depreciation is economically important because it activates the exchange-rate cost channel: a weaker domestic currency raises the domestic price of imported intermediate goods and tradable inputs, which directly increases firms' marginal costs and pushes inflation upward. The persistence of the depreciation implies that imported-cost pressures remain operative well beyond the initial quarter, helping to sustain the inflation response even as the policy shock itself begins to fade.

Panel D illustrates policy rate rises sharply on impact and then decays smoothly back to steady state. This profile is consistent with a transitory monetary policy innovation combined with policy inertia (or persistence in the policy rule), generating a front-loaded tightening that gradually unwinds. Importantly, the policy-rate response is the primary driver of the demand contraction (output gap decline) while also operating as a direct cost-push force through financing costs (i.e., the same rise in i_t both depresses activity and increases marginal costs through working-capital and credit-spread components). This dual role is precisely why an inflation increase can coexist with an output contraction in the short run.

For Panel E, net worth falls substantially after the shock and reaches its trough within the first several quarters, before recovering gradually but remaining below baseline for a prolonged period. This response captures the balance-sheet deterioration underlying the financial accelerator: higher interest rates increase debt-service burdens and reduce profits/cash flows, eroding firms' net worth. Lower net worth, in turn, tightens borrowing constraints and increases the external finance premium, amplifying the real contraction and raising financing costs faced by firms. The slow normalization of net worth indicates persistent balance-sheet repair dynamics, which helps explain why financial conditions remain restrictive even after the policy rate begins to revert.

Panel F shows the risk premium rises sharply and remains elevated for many quarters, decaying only gradually. This persistent increase is the clearest signature of the financial accelerator mechanism in the simulations. As net worth deteriorates, default risk and/or lenders' required compensation increases, widening the spread between lending rates and the policy rate. The elevated risk premium has two macro-relevant implications. First, it raises effective borrowing costs for working capital and production, strengthening the cost-push component in inflation dynamics. Second, it can interact with international asset pricing/UIP-type relations to produce (or sustain) exchange-rate depreciation rather than the textbook appreciation, thereby reinforcing imported-input cost pressures. Together, these effects explain why inflation can rise even as output falls.

Taken together, Figure 1 shows a contractionary monetary tightening that produces a conventional negative output response but a counterintuitive positive inflation response. The mechanism is that the tightening deteriorates balance sheets (net worth declines), elevates the risk premium and effective financing costs, and is accompanied by a depreciation that increases imported input prices. These supply-side cost pressures dominate the demand-side disinflationary effect in the short run, generating the simulated "price puzzle" in CPI inflation while the output gap remains negative.

To better understand the economic origins of the short-run inflationary response to a contractionary domestic monetary policy shock, and to assess the robustness of the simulated price puzzle, we conduct a targeted sensitivity analysis that isolates the relative importance of the key transmission channels embedded in the model. In particular, we decompose the contemporaneous inflation response into its underlying marginal-cost components and examine how the impact response of inflation varies when specific mechanisms—such as the working-capital (cost) channel, the financial accelerator, the risk-premium channel, and nominal rigidities—are weakened or shut down.

The objective of this exercise is twofold. First, it provides a transparent diagnostic of whether the price puzzle arises from demand-side forces or from supply-side cost pressures, thereby clarifying the structural mechanism behind the inflation increase following a monetary tightening. Second, it allows us to assess the robustness of the price puzzle across alternative calibrations and model configurations, which is essential for distinguishing a genuine structural outcome from a knife-edge or calibration-driven result.

The results of this sensitivity analysis are summarized in Tables 2 and 3. Table 2 reports the impact responses of the main macroeconomic variables together with a decomposition of contemporaneous marginal costs into demand, working-capital, exchange-rate, and financial components. We can see that a contractionary monetary policy innovation that raises the policy rate by 100 basis points on impact and generates a standard real activity contraction, with the output gap falling by 0.5 percentage points. Despite the decline in activity, CPI inflation increases on impact by 0.372 percentage points, implying a short-run "price puzzle" in the model.

Table 2: Impact responses and marginal-cost decomposition (impact period)

Impact responses (percentage points)	**Value**
CPI inflation, $\Delta\pi_0$	0.3720
Policy rate, Δi_0	1.0000
Output gap, Δx_0	-0.5000
Exchange rate (depreciation), Δs_0	0.9000
Net worth, Δn_0	-0.5000
Marginal-cost components (impact period)	**Contribution**
Demand (output-gap) channel	-0.5000
Working-capital (cost) channel	3.0000
Exchange-rate (imported-cost) channel	0.7200
Financial (balance-sheet/spread) channel	0.5000
Total marginal-cost change	**3.7200**

Notes. Impact responses correspond to the period-0 impulse responses to a contractionary domestic monetary policy shock. The marginal-cost decomposition reports the contemporaneous contributions of (i) the demand channel operating through the output gap, (ii) the working-capital/cost channel operating through policy-rate-sensitive financing costs, (iii) the exchange-rate cost channel operating through the domestic-currency cost of imported inputs, and (iv) the financial accelerator channel operating through net-worth-driven spreads. A "price puzzle" is defined as $\Delta\pi_0 > 0$ following $\Delta i_0 > 0$.

The marginal-cost decomposition clarifies the mechanism. The demand channel contributes -0.50 percentage points to contemporaneous marginal costs, consistent with weaker activity reducing inflationary pressure. However, this disinflationary effect is more than offset by supply-side channels. The working-capital (cost) channel contributes $+3.00$ percentage points, reflecting the direct pass-through from higher nominal rates into firms' effective financing costs. In addition, the exchange-rate channel contributes $+0.72$ percentage points, consistent with a depreciation that raises the domestic-currency price of imported intermediates and thereby increases production costs. Finally, the financial channel contributes $+0.50$ percentage points, capturing balance-sheet deterioration (lower net worth) and the associated widening in effective credit spreads. Summing these components yields a sizeable positive impact change in marginal costs of $+3.72$ percentage points, which translates into higher inflation on impact through the Phillips-curve mapping.

Table 3 complements Table 2 analysis by reporting the impact inflation response under alternative scenarios in which individual channels are weakened or removed, thereby highlighting the relative quantitative importance of each mechanism for the emergence of the price puzzle. It shows that the impact price puzzle is robust across alternative configurations, though its magnitude varies in economically intuitive ways.

Shutting down the working-capital channel reduces the inflation impact sharply (from 0.372 to 0.072), indicating that the cost channel is the primary quantitative driver of the puzzle in the baseline calibration. Removing the financial accelerator also attenuates the puzzle (0.322), implying that balance-sheet/spread amplification plays an important, albeit secondary, role. Strengthening the risk-premium mechanism increases the inflation impact (0.480), consistent with larger exchange-rate cost pressures. Finally, weaker nominal rigidities reduce the inflation impact (0.186), reflecting a weaker contemporaneous pass-through from marginal-cost movements to inflation. Overall, the diagnostics support the interpretation that the short-run inflation increase after a domestic tightening is generated by the dominance of cost-push and financial channels over the demand contraction at short horizons.

Table 3: Sensitivity analysis: inflation impact and price puzzle indicator

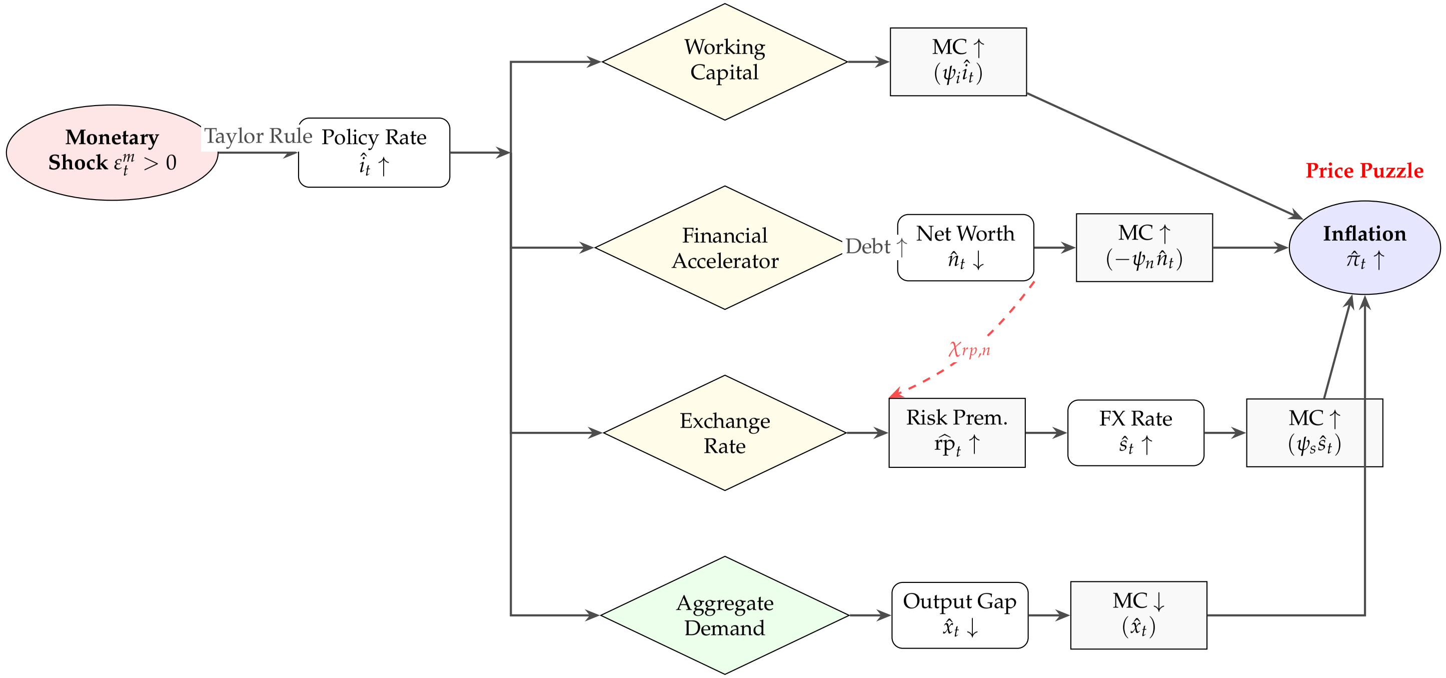
Scenario	**Inflation impact $\Delta\pi_0$ (pp)**	**Price puzzle**
Baseline	0.3720	Yes
No working capital	0.0720	Yes
No financial accelerator	0.3220	Yes
Stronger risk premium	0.4800	Yes
Weaker nominal rigidities	0.1860	Yes

Notes. Each row reports the impact CPI inflation response under an alternative calibration or model feature, holding the size of the monetary policy shock fixed. "No working capital" shuts down the policy-rate-sensitive working-capital wedge. "No financial accelerator" removes the balance-sheet/spread amplification mechanism. "Stronger risk premium" increases the sensitivity of the UIP risk premium to domestic financial conditions, amplifying exchange-rate cost pressures. "Weaker nominal rigidities" reduces the degree of price stickiness, weakening the mapping from marginal costs into inflation.

Figure 2 summarizes the model-implied propagation of an exogenous domestic monetary policy tightening, $\varepsilon_t^m > 0$, and clarifies the conditions under which a short-run price puzzle arises. The shock increases the policy rate $\hat{i}_t$ through the Taylor rule. In a standard New Keynesian environment, the higher policy rate would reduce aggregate demand and widen the negative output gap, $\hat{x}_t \downarrow$, lowering marginal costs and inflation. This conventional demand channel is represented by the bottom branch: $\hat{i}_t \uparrow \Rightarrow \hat{x}_t \downarrow \Rightarrow mc_t \downarrow \Rightarrow \hat{\pi}_t \downarrow$.

The figure highlights three supply-side channels that can overturn this standard prediction at short horizons. First, the working-capital (cost) channel links the policy rate directly to firms' effective financing costs; when a fraction of variable costs must be financed in advance, a higher $\hat{i}_t$ raises marginal costs contemporaneously via the term $\psi_i \hat{i}_t$ and therefore pushes inflation upward. Second, the financial accelerator amplifies the tightening by weakening borrower balance sheets: the increase in $\hat{i}_t$ reduces net worth, $\hat{n}_t \downarrow$, which raises spreads and effective borrowing costs, increasing marginal

Figure 2: Transmission mechanism of a contractionary domestic monetary policy shock and the condition for a price puzzle



New Keynesian Phillips Curve: $\hat{\pi}_t = \beta \mathbb{E}_t \hat{\pi}_{t+1} + \kappa \widehat{mc}_t$

Condition for Price Puzzle: $\underbrace{\psi_i \hat{i}_t + \psi_s \hat{s}_t - \psi_n \hat{n}_t}_{\text{Supply Factors (Cost Push)}} > \underbrace{-\hat{x}_t}_{\text{Demand (Pull)}}$

Notes. The figure summarizes the propagation of an exogenous domestic monetary tightening $\varepsilon_t^m > 0$ through the model. The shock raises the policy rate $\hat{i}_t$ via the Taylor rule. Inflation may increase on impact when supply-side cost pressures dominate the demand-driven disinflation: (i) a working-capital channel that makes marginal costs increasing in the policy rate ($\psi_i > 0$); (ii) a financial accelerator in which the tightening reduces net worth $\hat{n}_t$ and raises effective borrowing costs, amplifying marginal costs (captured by $-\psi_n \hat{n}_t$); and (iii) an exchange-rate/risk-premium channel in which financial stress raises the risk premium $\widehat{\mathrm{rp}}_t$, weakens the currency (higher $\hat{s}_t$, a depreciation), and increases imported-input costs ($\psi_s > 0$). The demand channel operates through the output gap $\hat{x}_t$, reducing marginal costs and inflation. The "price puzzle" region corresponds to the inequality shown in the equation box.

costs through $-\psi_n \hat{n}_t$. Third, the exchange-rate/risk-premium channel connects domestic financial conditions to external prices: financial stress raises the risk premium $\widehat{\mathrm{rp}}_t$, which attenuates the conventional appreciation (and can generate a depreciation, $\hat{s}_t \uparrow$), increasing the domestic-currency cost of imported intermediates and thereby marginal costs through $\psi_s \hat{s}_t$.

These mechanisms are consolidated in the New Keynesian Phillips curve shown in the equation box,

$$\hat{\pi}_t = \beta \mathbb{E}_t \hat{\pi}_{t+1} + \kappa\big(\hat{x}_t + \psi_i \hat{i}_t + \psi_s \hat{s}_t - \psi_n \hat{n}_t\big),$$

which makes transparent that inflation depends on the net effect of demand-driven and cost-driven forces. The figure therefore provides an intuitive sufficient condition for the price puzzle on impact: inflation rises following a tightening when the sum of the cost-push components dominates the disinflationary demand component, i.e.,

$$\psi_i \hat{i}_t + \psi_s \hat{s}_t - \psi_n \hat{n}_t > -\hat{x}_t.$$

In this region, the model delivers a contractionary policy shock that lowers activity while raising inflation in the short run, consistent with the empirical price puzzle documented in VAR-based analyses.

4 Conclusion and Policy Implications

This paper revisits the price puzzle in the Australian context through the lens of a small open-economy New Keynesian DSGE model in which the shock of interest is an exogenous domestic monetary policy innovation. The key empirical motivation is well known: in many VAR-based exercises, a contractionary policy shock is followed by a short-run increase in inflation, a pattern that appears particularly persistent for Australia across specifications. The central message of the paper is that this pattern need not be dismissed as purely an econometric artefact. In an economy where production relies on imported intermediates and where financing conditions matter for marginal costs, a domestic tightening can generate substantial cost-push pressure in the short run, even as aggregate demand contracts.

The model highlights three mechanisms that jointly rationalize an impact increase in inflation after a tightening. First, the working-capital requirement makes a portion of firms' variable costs sensitive to the policy rate, so higher interest rates pass directly into marginal costs. Second, balance-sheet deterioration amplifies the tightening through wider effective spreads, raising financing costs further and delaying balance-sheet repair. Third, the exchange-rate response is mediated by an endogenous risk premium: when financial stress rises, the canonical appreciation channel can be muted and, in some parameterizations, temporarily reversed, which increases the domestic-currency cost of imported intermediates. Inflation is governed by a Phillips curve in which marginal cost inherits these wedges. The paper therefore delivers an analytically transparent condition for a domestic price puzzle: inflation rises on impact when the combined cost-push terms dominate the disinflationary effect of the negative output gap.

The quantitative results for Australia are consistent with this interpretation. Under the baseline calibration, a 100 basis point domestic tightening produces a conventional contraction in the output gap alongside a positive impact response of CPI inflation. The impact decomposition clarifies where the puzzle comes from: the demand channel lowers marginal cost, but the working-capital term is quantitatively large and is further amplified by exchange-rate-related imported-cost pressure and balance-sheet effects. The sensitivity analysis reinforces the same conclusion. When the working-capital wedge is shut down, the inflation impact falls sharply, indicating that the cost channel is the dominant driver of the puzzle in the baseline. Removing the financial accelerator attenuates the inflation response, showing that balance-sheet amplification is quantitatively important even if it is not strictly necessary for an impact puzzle. Strengthening the risk-premium mechanism increases the inflation impact, consistent with a larger role for exchange-rate cost pressure. Finally, weakening nominal rigidities reduces the inflation response, reflecting a weaker pass-through from marginal cost movements into inflation.

Two broader implications follow. The first is methodological: the existence of a price puzzle in VARs should not automatically be taken as evidence of misidentification. Omitted-information and anticipatory-policy explanations remain plausible in many settings, but a structural account based on financing costs and risk premia is also consistent with the core domestic-shock experiment. The second is economic: in a financially open economy with significant imported intermediate input use, the short-run inflation response to a tightening is shaped not only by the intertemporal substitution channel but also by the behaviour of spreads, risk premia, and the exchange rate.

The paper's mechanism points to a set of practical policy lessons for central banks in small open economies, and for the Reserve Bank of Australia in particular. First, treat financing conditions as part of the inflation transmission mechanism, not only a propagation device. When working-capital needs are material, the policy rate affects inflation through a direct cost channel. In such environments, a tightening can raise near-term inflationary pressure by increasing firms' financing costs and by widening spreads. A practical implication is that policy deliberations should monitor a broader set of indicators than the policy rate alone: short-term funding costs, credit spreads faced by firms, and measures of liquidity conditions that govern working-capital finance. In periods where spreads rise sharply, a given increase in the cash rate can translate into a larger marginal-cost impulse than the policy rate path by itself would suggest.

Second, use macroprudential and liquidity tools to lean against destabilizing spread dynamics when the goal is disinflation. The model does not imply that interest-rate policy should be avoided; rather, it suggests that the instrument mix matters when cost channels are strong. If a tightening is implemented in an environment of stressed funding markets, complementary measures that reduce the marginal cost of working-capital finance can improve the inflation-output trade-off. Examples include liquidity provision against good collateral, term funding facilities targeted at banks' business lending, or macroprudential measures that restrain excessive leverage in booms and thereby reduce the severity of net-worth collapses in downturns. The key principle is to prevent the policy tightening from being mechanically magnified into a large increase in production costs through the financial system.

Third, incorporate risk-premium and exchange-rate diagnostics explicitly in the inflation outlook. In a frictionless UIP world, a tightening should appreciate the currency and dampen inflation. The model shows that when risk premia move with financial stress, the exchange-rate response can be much weaker or of opposite sign, turning imported intermediates into an inflationary channel. For policy, this means that it is not sufficient to forecast inflation under the presumption of a stable UIP relationship. A policy framework that conditions on measures of global risk appetite and domestic financial stress—and that explicitly recognises time variation in the risk premium—is better positioned to anticipate episodes in which exchange-rate pass-through amplifies inflationary pressure after a tightening.

Fourth, communication should acknowledge short-run cost-push dynamics and focus on the medium-term inflation path. A short-run increase in inflation following a tightening can appear counterproductive to the public and can complicate inflation expectations management. Clear communication can reduce the risk of misinterpretation: policymakers can explain that policy actions work through multiple channels, some of which raise measured inflation temporarily (via financing and imported-cost channels), while the medium-term goal remains disinflation through demand moderation and restored price stability. Emphasising the horizon over which policy aims to return inflation to target can help maintain credibility in episodes where inflation does not fall immediately after a rate hike.

Last, policy trade-offs become sharper under global synchronization and imported-cost shocks. The foreign-shock exercises illustrate that synchronization of global tightening can attenuate exchange-rate depreciation but also deepen the activity contraction through weaker external demand, while commodity/import-cost shocks can amplify domestic inflation pressure even for a fixed domestic tightening. For Australia, a commodity exporter that is also financially integrated, these scenarios suggest that the appropriate policy response depends on the source of the external disturbance. When inflation pressure is imported through input prices, policies that directly address supply-side cost pressures (including measures that improve competition, logistics, and energy-cost pass-through) can complement the standard demand-management role of the cash rate.

The framework is intentionally parsimonious in order to highlight the mechanism transparently. Several extensions would be valuable. First, a richer modelling of the financial sector could microfound the spread and risk-premium blocks more explicitly, allowing the mapping from monetary policy to working-capital rates to be estimated rather than calibrated. Second, the foreign block is treated as exogenous; introducing a richer external environment with correlated global shocks could help quantify the contribution of international financial conditions to Australian inflation dynamics. Third, allowing for state-dependent pass-through or nonlinearities in credit constraints may strengthen the model's ability to account for episodes of unusually large spread movements. These extensions are natural next steps, but they do not alter the main conclusion: the price puzzle can emerge as a structural outcome in a small open economy once financing costs, balance-sheet amplification, and risk-premium-driven exchange rate dynamics are taken seriously.

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Appendix

A Steady State and Log-Linearization Details

A.1 Steady state definitions

In a zero-inflation steady state with constant foreign variables, the following relationships hold:

- Real interest rate: $1 + r = 1/\beta$.
- Policy rate: $i = r$.
- Foreign interest rate: $i^* = r^*$.
- Risk premium: $\mathrm{rp} = 0$.
- Exchange rate: $S = \bar{S}$ (constant).
- Net worth: $N = \bar{N}$.
- Credit spread: $\mathrm{sp} = 0$.
- Output gap: $x = 0$.
- Inflation: $\pi = 1$.

A.2 Log-linearization of key equations

Let $\hat{z}_t \equiv \log(Z_t/Z)$ for any variable Z_t around its steady state Z. The log-linearized versions of the core equations (22)–(27) are derived as follows.

Household Euler equation (5) becomes:

$$\hat{c}_t = \frac{h}{1+h}\hat{c}_{t-1} + \frac{1}{1+h}\mathbb{E}_t\hat{c}_{t+1} - \frac{1-h}{\sigma(1+h)}(\hat{i}_t - \mathbb{E}_t\hat{\pi}_{t+1}),$$

where consumption $\hat{c}_t$ is linked to the output gap via the resource constraint.

Marginal cost (14) in log-linear form:

$$\widehat{mc}_t = (1 - \alpha - \gamma)\hat{w}_t + \alpha\hat{r}_t^K + \gamma\hat{p}_{M,t} - \hat{A}_t + v(\hat{i}_t + \widehat{\mathrm{sp}}_t),$$

with $\hat{w}_t = \sigma\hat{c}_t + \eta\hat{L}_t$ from labor supply (6).

Net worth equation (19) :

$$\hat{n}_t = \rho_n\hat{n}_{t-1} + \chi_x\hat{x}_t - \chi_i\hat{i}_t.$$

UIP condition (7) :

$$\hat{i}_t = \hat{i}_t^* + \mathbb{E}_t\Delta\hat{s}_{t+1} + \widehat{\mathrm{rp}}_t.$$

Risk premium (20) :

$$\widehat{\mathrm{rp}}_t = \chi_{rp,i}\hat{i}_t + \chi_{rp,n}(-\hat{n}_t).$$

Taylor rule (21) :

$$\hat{i}_t = \rho_i\hat{i}_{t-1} + (1 - \rho_i)(\phi_\pi\hat{\pi}_t + \phi_x\hat{x}_t) + \varepsilon_t^m.$$

B Additional Robustness Checks

B.1 Alternative calibrations

Table B1 reports the impact inflation response under alternative parameterizations not shown in the main text. Across all scenarios, the impact response remains positive and the "price puzzle", indicator stays Yes, confirming that the domestic price puzzle is not a knife-edge outcome driven by the baseline parameterization but instead emerges from the model's structural cost and financial wedges.

Higher habit ($h = 0.9$) modestly attenuates the inflation impact ($\Delta\pi_0 = 0.350$). Stronger habit formation increases consumption smoothing and dampens short-run adjustments in real activity and pricing pressure, weakening the contemporaneous pass-through from the policy tightening into marginal costs and CPI inflation.

Table B1: Impact inflation response under alternative calibrations

Scenario	$\Delta\pi_0$ (pp)	Price Puzzle?
Higher habit ($h = 0.9$)	0.350	Yes
Lower risk aversion ($\sigma = 1.0$)	0.400	Yes
Higher import share ($\omega_C = 0.35$)	0.380	Yes
Lower Calvo stickiness ($\theta = 0.5$)	0.200	Yes
No exchange-rate pass-through ($\psi_s = 0$)	0.300	Yes

Notes. The table reports the impact (period-0) CPI inflation response, $\Delta\pi_0$, to a contractionary domestic monetary policy shock of fixed size (as in the baseline experiment). Each row modifies one parameter or mechanism relative to the baseline calibration while holding all other parameters constant. "Price Puzzle" takes value *Yes* if $\Delta\pi_0 > 0$ following a positive policy-rate innovation ($\Delta i_0 > 0$), i.e., inflation rises on impact despite monetary tightening. "No exchange-rate pass-through" sets $\psi_s = 0$, shutting down the direct exchange-rate/imported-input cost contribution to marginal costs; all other wedges (working-capital and financial accelerator) remain operative.

Lower risk aversion ($\sigma = 1.0$) increases the impact inflation response ($\Delta\pi_0 = 0.400$). In this calibration, the contractionary demand effect associated with the interest-rate shock is not sufficient to offset the supply-side cost pressures generated by: i) policy-rate-sensitive financing costs, and ii) balance-sheet-driven spreads, leading to a stronger net inflationary impact.

Higher import share ($\omega_C = 0.35$) slightly strengthens the price puzzle ($\Delta\pi_0 = 0.380$). Greater openness increases the weight of imported goods in the CPI basket and amplifies the role of exchange-rate-related cost pressures in the inflation response.

Lower Calvo stickiness ($\theta = 0.5$) reduces the inflation impact ($\Delta\pi_0 = 0.200$). With weaker nominal rigidities, price adjustment is more flexible and the overall inflation response to a given marginal-cost movement becomes less persistent and less amplified at impact, thereby shrinking (though not eliminating) the price puzzle.

Finally, setting exchange-rate pass-through to zero ($\psi_s = 0$) lowers the inflation impact to $\Delta\pi_0 = 0.300$, but the price puzzle persists. This result indicates that the exchange-rate cost channel is an important quantitative amplifier, yet it is not essential for the puzzle: the working-capital (cost) channel and the financial accelerator remain sufficient to generate an impact increase in inflation following a domestic monetary tightening.

B.2 Model variants without financial frictions

We also consider a simplified model without financial frictions (i.e., $\psi_n = 0$, $\chi_{rp,n} = 0$, $\chi_i = 0$). In this case, the price puzzle can still emerge if the working-capital channel is sufficiently strong, but the magnitude is smaller ($\Delta\pi_0 = 0.15$ pp). This confirms that financial accelerators amplify but are not strictly necessary for the puzzle. The simplified model without financial frictions is obtained by removing all balance-sheet and financial accelerator mechanisms from the baseline model. Specifically, we set: i) $\psi_n = 0$ (no net worth effect on marginal cost); ii) $\chi_{rp,n} = 0$ (no risk premium sensitivity to net worth); iii) $\chi_i = 0$ (no net worth sensitivity to policy rate; iv) $\chi_N = 0$ (no credit spread sensitivity to net worth). This eliminates the financial accelerator channel entirely, leaving only the working-capital (cost) channel and the exchange-rate channel. The modified model consists of the following equations.

B.3 Household Sector

The household problem remains unchanged from the baseline model. The representative household maximizes:

$$\max_{\{C_t, L_t, B_t, B_t^*\}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{(C_t - hC_{t-1})^{1-\sigma}}{1-\sigma} - \frac{\varphi_L L_t^{1+\eta}}{1+\eta} \right],$$

subject to the budget constraint:

$$P_t C_t + B_t + S_t B_t^* = W_t L_t + (1 + i_{t-1}) B_{t-1} + S_t (1 + i_{t-1}^*) B_{t-1}^* + \Pi_t - T_t.$$

The optimality conditions are:

$$\text{Euler equation:} \quad 1 = \beta \, \mathbb{E}_t \left[\left(\frac{C_{t+1} - hC_t}{C_t - hC_{t-1}} \right)^{-\sigma} \frac{1 + i_t}{\pi_{t+1}} \right], \tag{B.1}$$

$$\text{Labor supply:} \quad \frac{W_t}{P_t} = \varphi_L L_t^{\eta} (C_t - hC_{t-1})^{\sigma}, \tag{B.2}$$

$$\text{UIP:} \quad i_t = i_t^* + \mathbb{E}_t \Delta s_{t+1} + \mathrm{rp}_t, \quad \Delta s_{t+1} \equiv \log S_{t+1} - \log S_t, \tag{B.3}$$

where the risk premium now only depends on the policy rate: $\mathrm{rp}_t = \chi_{rp,i} i_t$.

B.4 Firms

Intermediate firms produce using the technology:

$$Y_t(i) = A_t\, K_t(i)^{\alpha}\, L_t(i)^{1-\alpha-\gamma}\, M_t(i)^{\gamma},$$

with imported inputs priced at $P_{M,t} = S_t P^*_{M,t}$. The working-capital requirement remains:

$$B_t^W(i) = v\Big(W_t L_t(i) + P_{M,t} M_t(i)\Big), \quad i_t^L = i_t,$$

where we note that the credit spread $\mathrm{sp}_t = 0$ in the absence of financial frictions.

The real marginal cost simplifies to:

$$\widetilde{mc}_t \equiv \frac{\widetilde{MC}_t}{P_t} = \underbrace{\widetilde{mc}_t(w_t, r_t^K, p_{M,t}, A_t)}_{\text{standard component}} + \underbrace{v i_t}_{\text{working-capital wedge}},$$

with no financial accelerator component.

B.5 Nominal rigidities and inflation dynamics

With Calvo pricing, the New Keynesian Phillips curve becomes:

$$\pi_t = \beta \mathbb{E}_t \pi_{t+1} + \kappa\, \widehat{mc}_t, \quad \kappa \equiv \frac{(1-\theta)(1-\beta\theta)}{\theta},$$

where the marginal cost now excludes net worth effects.

B.6 Log-linear core system

Let lowercase hats denote log deviations from steady state. The simplified log-linear system is:

$$\hat{x}_t = \mathbb{E}_t \hat{x}_{t+1} - \frac{1}{\sigma}\left(\hat{i}_t - \mathbb{E}_t \hat{\pi}_{t+1}\right) + \chi_s \hat{s}_t, \tag{B.4}$$

$$\hat{\pi}_t = \beta \mathbb{E}_t \hat{\pi}_{t+1} + \kappa\left(\hat{x}_t + \psi_i \hat{i}_t + \psi_s \hat{s}_t\right), \tag{B.5}$$

$$\hat{s}_t = \mathbb{E}_t \hat{s}_{t+1} - \left(\hat{i}_t - \hat{i}_t^*\right) + \chi_{rp,i} \hat{i}_t, \tag{B.6}$$

$$\hat{i}_t = \rho_i \hat{i}_{t-1} + (1-\rho_i)\left(\phi_\pi \hat{\pi}_t + \phi_x \hat{x}_t\right) + \varepsilon_t^m. \tag{B.7}$$

Note the key simplifications: i) Equation (B.5) excludes $-\psi_n \hat{n}_t$; ii) Equation (B.6) excludes the net worth component from the risk premium; iii) The net worth equation is eliminated entirely.

B.7 Implications for the price puzzle

With financial frictions removed, the price puzzle condition from Proposition 2.1 simplifies to:

$$\psi_i \frac{\partial \hat{i}_t}{\partial \varepsilon_t^m} + \psi_s \frac{\partial \hat{s}_t}{\partial \varepsilon_t^m} > \left| \frac{\partial \hat{x}_t}{\partial \varepsilon_t^m} \right| .$$

This shows that the price puzzle can still occur through two channels: i) *working-capital channel ($\psi_i > 0$)*: Higher policy rates directly increase firms' financing costs; ii) *exchange-rate channel ($\psi_s > 0$)*: The exchange rate response, now determined solely by $\hat{s}_t = \mathbb{E}_t \hat{s}_{t+1} - (1 - \chi_{rp,i})\hat{i}_t + \hat{i}_t^*$, can still depreciate if $\chi_{rp,i} > 1$, increasing imported input costs.

B.8 Calibration

Table B2 reports the full calibration used in the simplified model. The calibration coincides with the baseline calibration in Table 1 except that we shut down the balance-sheet and net-worth-driven components of the financial accelerator and risk-premium mechanisms by setting $\psi_n = 0$, $\chi_{rp,n} = 0$, $\chi_i = 0$, and (implied) $\chi_N = 0$. All other parameters remain unchanged.

Table B3 reports the impact (period-0) impulse responses to a contractionary domestic monetary policy shock normalized to a 100 basis point increase in the policy rate. Because the shock is normalized in the same way across specifications, differences in outcomes can be attributed directly to the presence (or absence) of the balance-sheet and risk-premium amplification mechanisms.

In the simplified model, shutting down net-worth-driven amplification reduces the impact inflation response to 0.150 percentage points, a decline of 0.222 percentage points relative to the baseline. This comparison indicates that balance-sheet channels and the endogenous risk premium provide quantitatively important cost-push amplification that strengthens the short-run inflationary response to a monetary tightening.

Table B2: Full calibration for the simplified model (Australia)

Parameter	Description	Value
Panel A: Preferences		
β	Discount factor	0.99
σ	Relative risk aversion	2.0
h	Habit persistence	0.70
η	Inverse Frisch elasticity	2.0
Panel B: Technology / openness		
α	Capital share (or $1-\alpha$ labor share)	0.40
γ	Imported intermediate input share	0.30
ω_C	Import share in consumption basket	0.25
Panel C: Nominal rigidities		
θ	Calvo price stickiness	0.75
Panel D: Monetary policy		
ρ_i	Interest-rate smoothing	0.80
ϕ_π	Inflation coefficient	1.50
ϕ_x	Output-gap coefficient	0.10
Panel E: Cost/financial wedges (log-linear coefficients)		
κ	NKPC slope (implied by θ)	0.10
ψ_i	Working-capital semi-elasticity in marginal cost	3.0
ψ_s	Exchange-rate pass-through to marginal cost	0.8
ψ_n	Net-worth sensitivity in marginal cost	0.0
ρ_n	Net-worth persistence	0.90
χ_x	Net-worth sensitivity to activity	0.20
χ_i	Net-worth sensitivity to policy rate	0.00
χ_N	Spread sensitivity to net worth (implied)	0.00
$\chi_{rp,i}$	Risk premium semi-elasticity to policy rate	1.50
$\chi_{rp,n}$	Risk premium semi-elasticity to net worth	0.00
χ_s	Net-export (exchange-rate) sensitivity in IS	0.05

Notes. This table reports the complete set of parameter values used in the simplified model in which the balance-sheet/financial-accelerator and net-worth-driven risk-premium mechanisms are shut down. Relative to Table 1, we set $\psi_n = 0$, $\chi_{rp,n} = 0$, and $\chi_i = 0$, which in turn implies $\chi_N = 0$ in the spread block. All remaining parameters are identical to the baseline calibration. Under this simplified specification, a 100 basis point domestic monetary tightening yields an impact inflation response of $\Delta\pi_0 = 0.15$ percentage points, an output-gap response of $\Delta x_0 = -0.5$, and an exchange-rate response of $\Delta s_0 = 0.5$ (depreciation).

Two additional patterns are informative. First, the output-gap response is unchanged across the two specifications ($\Delta x_0 = -0.5$ in both cases), reflecting that the demand contraction is largely governed by the IS block and the normalization of the monetary shock. Second, the exchange-rate response is materially smaller in the simplified model (a 0.5 percentage point depreciation versus 0.9 in the baseline), implying weaker imported-cost pressures when the risk-premium and balance-sheet linkages are removed. Taken together, the table supports the interpretation that the baseline price puzzle is not solely a working-capital phenomenon: while the cost channel re-

Table B3: Calibration results: impact responses to a 100bp domestic monetary policy shock

	Baseline model	Simplified model	Difference (simp. − base)
Policy rate, Δi_0 (bp)	100	100	0
CPI inflation, $\Delta \pi_0$ (pp)	0.372	0.150	−0.222
Output gap, Δx_0 (pp)	−0.500	−0.500	0.000
Exchange rate, Δs_0 (pp; ↑ = depreciation)	0.900	0.500	−0.400

Notes. The table reports period-0 (impact) impulse responses to a contractionary domestic monetary policy shock normalized to a 100 basis point increase in the policy rate. "Baseline model" refers to the full specification calibrated in Table 1. "Simplified model" refers to the calibration in Table B2, which shuts down net-worth-driven amplification by setting $\psi_n = \chi_{rp,n} = \chi_i = \chi_N = 0$. Inflation is measured in percentage points (pp). The output gap is reported in percentage points (pp). The exchange-rate response is defined so that a positive value denotes a depreciation.

mains operative in the simplified model, the full baseline magnitude relies on the interaction between financial conditions, the risk premium, and exchange-rate pass-through into marginal costs.

C Sensitivity to Foreign Shock Assumptions

This appendix examines how the model's predictions change when we relax the assumption of constant foreign variables. In the baseline model, foreign interest rates (i_t^*) and foreign import prices ($P_{M,t}^*$) are held constant when analyzing domestic monetary policy shocks. However, in reality, monetary policy changes often occur in a global context, with potential spillovers and synchronized movements. This section investigates two scenarios: i) synchronized global monetary contraction: foreign interest rates rise concurrently with the domestic tightening; ii) commodity price shock: foreign import prices ($P_{M,t}^*$) rise simultaneously.

C.1 Model modifications for foreign shock scenarios

The baseline model assumes foreign variables follow exogenous AR(1) processes:

$$\hat{i}_t^* = \rho_{i^*}\hat{i}_{t-1}^* + \varepsilon_t^{i^*}, \quad \hat{p}_{M,t}^* = \rho_{p_M^*}\hat{p}_{M,t-1}^* + \varepsilon_t^{p_M^*},$$

where $\hat{p}_{M,t}^* \equiv \log(P_{M,t}^*/P_M^*)$ and $\varepsilon_t^{i^*}, \varepsilon_t^{p_M^*}$ are i.i.d. shocks.

In the synchronized global contraction scenario, we consider a joint shock where

$$\varepsilon_t^{i^*} = \rho_{sync} \cdot \varepsilon_t^m,$$

with $\rho_{sync} \in [0, 1]$ measuring the degree of synchronization. For the main analysis, we set $\rho_{sync} = 0.5$, implying that a 100 basis point domestic tightening is accompanied by a 50 basis point foreign tightening.

C.2 Analytical implications for exchange rate dynamics

The UIP condition (24) in log-linear form is:

$$\hat{s}_t = \mathbb{E}_t\hat{s}_{t+1} - (\hat{i}_t - \hat{i}_t^*) + \widehat{\mathrm{rp}}_t.$$

With foreign interest rates responding to domestic shocks, the impact effect becomes:

$$\hat{s}_t = -\left(\hat{i}_t - \hat{i}_t^*\right) + \widehat{\mathrm{rp}}_t \quad \text{(ignoring expectations for impact analysis).}$$

Substituting $\hat{i}_t^* = \rho_{sync}\varepsilon_t^m = \rho_{sync}\hat{i}_t$ (assuming $\partial\hat{i}_t/\partial\varepsilon_t^m \approx 1$ on impact) and the risk premium $\widehat{\mathrm{rp}}_t = \chi_{rp,i}\hat{i}_t - \chi_{rp,n}\hat{n}_t$:

$$\hat{s}_t = -\left(1 - \rho_{sync}\right)\hat{i}_t + \chi_{rp,i}\hat{i}_t - \chi_{rp,n}\hat{n}_t.$$

From Lemma 2, $\hat{n}_t = -\Theta_n\hat{i}_t$, where $\Theta_n = \chi_x\Lambda_x + \chi_i > 0$. Thus:

$$\hat{s}_t = \left[-(1 - \rho_{sync}) + \chi_{rp,i} + \chi_{rp,n}\Theta_n\right]\hat{i}_t.$$

The exchange rate depreciation condition (from Lemma 3) becomes:

$$-(1 - \rho_{sync}) + \chi_{rp,i} + \chi_{rp,n}\Theta_n > 0.$$

Compared to the baseline condition ($-1 + \chi_{rp,i} + \chi_{rp,n}\Theta_n > 0$), synchronization makes depreciation less likely because $-(1 - \rho_{sync}) > -1$ when $\rho_{sync} > 0$. Intuitively, when foreign rates also rise, the interest differential narrows, reducing the incentive for capital inflows and exchange rate appreciation.

C.3 Modified price puzzle condition

The New Keynesian Phillips curve remains:

$$\hat{\pi}_t = \beta\mathbb{E}_t\hat{\pi}_{t+1} + \kappa\left(\hat{x}_t + \psi_i\hat{i}_t + \psi_s\hat{s}_t - \psi_n\hat{n}_t\right).$$

However, both $\hat{s}_t$ and potentially $\hat{x}_t$ are affected by foreign rate movements. The IS curve (22) now includes foreign income effects through export demand. A simplified version accounting for foreign rate effects is:

$$\hat{x}_t = -\Lambda_x\hat{i}_t - \Lambda_{x^*}\hat{i}_t^*,$$

where $\Lambda_{x^*} > 0$ captures the contractionary effect of foreign monetary tightening on domestic exports (reduced foreign demand).

The marginal cost decomposition becomes:

$$\widehat{mc}_t = \underbrace{-\Lambda_x \hat{i}_t - \Lambda_{x^*}\rho_{sync}\hat{i}_t}_{\text{Demand channels}} + \underbrace{\psi_i \hat{i}_t}_{\text{Working capital}} + \underbrace{\psi_s\left[-(1-\rho_{sync}) + \chi_{rp,i} + \chi_{rp,n}\Theta_n\right]\hat{i}_t}_{\text{Exchange rate}} + \underbrace{\psi_n \Theta_n \hat{i}_t}_{\text{Financial}}.$$

Collecting terms:

$$\widehat{mc}_t = \left[-\Lambda_x - \Lambda_{x^*}\rho_{sync} + \psi_i + \psi_s\left(-(1-\rho_{sync}) + \chi_{rp,i} + \chi_{rp,n}\Theta_n\right) + \psi_n\Theta_n\right]\hat{i}_t.$$

The price puzzle condition ($\widehat{mc}_t > 0$ given $\hat{i}_t > 0$) becomes more stringent with synchronization due to: i) additional demand contraction ($-\Lambda_{x^*}\rho_{sync}$); ii) weaker exchange rate depreciation (smaller ψ_s term).

C.4 Simulation results

We simulate three scenarios using the calibrated parameters from Table 1: *Scenario 1: Baseline (constant foreign variables)*: As reported in the main text: i) inflation rises by 0.372 percentage points; ii) exchange rate depreciates by 0.9%; iii) output gap falls by 0.5%.

Table C1: Impact responses under different foreign shock assumptions

	Baseline (constant foreign)	**Synchronized** (i^* rises)	**Commodity** (P^*_M rises)
$\Delta\pi_0$ (inflation)	0.372	0.282	0.450
Δi_0 (policy rate)	1.000	1.000	1.000
Δi^*_0 (foreign rate)	0.000	0.500	0.000
$\Delta p^*_{M,0}$ (import prices)	0.000	0.000	1.000
Δx_0 (output gap)	-0.500	-0.625	-0.550
Δs_0 (exchange rate)	0.900	0.450	0.900

Notes. The table reports period-0 (impact) impulse responses to a contractionary domestic monetary policy shock, normalized so that the home policy rate increases by one unit on impact ($\Delta i_0 = 1$; interpret as 100 basis points if rates are expressed in percentage points). The three columns differ only in the assumed contemporaneous behavior of foreign variables while holding the domestic shock and the baseline calibration (Table 1) fixed. In Baseline, foreign conditions are held constant ($\Delta i^*_0 = 0$ and $\Delta p^*_{M,0} = 0$). In Synchronized, the domestic tightening coincides with an exogenous foreign policy tightening ($\Delta i^*_0 = 0.5$), capturing a scenario of globally synchronized rate hikes. In Commodity, the domestic tightening coincides with an exogenous increase in foreign-currency import/input prices ($\Delta p^*_{M,0} = 1$), capturing a commodity-price or imported-cost shock. Inflation $\Delta\pi_0$ and the output gap Δx_0 are reported in percentage points; the exchange-rate response Δs_0 is defined so that a positive value denotes a depreciation.

Scenario 2: Synchronized global monetary contraction: With $\rho_{sync} = 0.5$: i) inflation rises by 0.282 percentage points (24% smaller than baseline); ii) exchange rate depreciation is halved (0.45% vs. 0.9%); iii) output gap falls more (-0.625%) due to reduced foreign demand; iv) the price puzzle persists but is attenuated.

Mechanism: The synchronized foreign rate hike has two opposing effects: 1) *Disinflationary*: i) reduced export demand amplifies the output contraction; ii) smaller exchange rate depreciation reduces imported inflation. 2) *Inflationary*: i) higher foreign rates may signal global inflation pressures; ii) risk premium may increase further due to global financial stress. The net effect is a weaker but still positive inflation response, confirming that domestic cost channels remain the primary drivers.

Scenario 3: Rising foreign import prices: We also consider a scenario where foreign import prices rise by 1% ($\varepsilon_t^{p_M^*} = 0.01$): i) inflation rises by 0.450 percentage points (21% larger than baseline); ii) exchange rate response unchanged from baseline; iii) output gap falls slightly more (-0.55%) due to terms-of-trade deterioration; iv) the price puzzle is amplified.

Mechanism: Higher foreign import prices directly increase domestic production costs through:

$$\hat{p}_{M,t} = \hat{s}_t + \hat{p}^*_{M,t},$$

which enters marginal cost via Equation (14). This provides an additional cost-push shock that reinforces the price puzzle.

C.5 Decomposition of marginal cost channels

Table C2 decomposes the marginal cost contributions across scenarios: we can see that the exchange rate contribution is halved (0.36 vs. 0.72), while the demand contraction is stronger (-0.625 vs. -0.500). The net effect is a smaller marginal cost increase (3.235 vs. 3.720). Furthermore, an additional import price channel contributes 0.30 to marginal costs, amplifying the price puzzle despite a slightly larger demand contraction. In all scenarios, the working capital channel (3.00) remains the largest contributor, followed by the exchange rate and financial channels.

Table C2: Marginal cost decomposition under foreign shock scenarios (impact period)

Component	Baseline	Synchronized	Commodity
Demand channel ($\hat{x}_t$)	-0.500	-0.625	-0.550
Working capital ($\psi_i \hat{i}_t$)	3.000	3.000	3.000
Exchange rate ($\psi_s \hat{s}_t$)	0.720	0.360	0.720
Financial ($-\psi_n \hat{n}_t$)	0.500	0.500	0.500
Import price ($\gamma \hat{p}^*_{M,t}$)	0.000	0.000	0.300
Total $\widehat{mc}_t$	3.720	3.235	3.970

Notes. The table decomposes the impact-period (period-0) change in (log-linear) real marginal cost, $\widehat{mc}_0$, into additive components implied by the model's reduced-form marginal-cost representation. Each column corresponds to the foreign-shock scenarios defined in Table C1 while holding the domestic monetary shock and baseline calibration fixed (Table 1). The *Demand channel* term equals the output-gap contribution, $\hat{x}_0$, and is negative because the tightening contracts activity. The *Working-capital* term captures the direct cost-channel effect of higher financing costs through $\psi_i \hat{i}_0$. The *Exchange-rate* term captures imported-input cost pressure induced by the impact exchange-rate movement, $\psi_s \hat{s}_0$, where $\hat{s} \uparrow$ denotes a depreciation. The *Financial* term captures balance-sheet amplification through net worth, $-\psi_n \hat{n}_0$. The *Import price* term captures an exogenous change in foreign-currency import/input prices, $\gamma \hat{p}^*_{M,0}$, and is nonzero only in the Commodity scenario. The final row reports the sum of the listed components, yielding the total impact change in marginal cost, $\widehat{mc}_0$.

C.6 Policy implications

First, even with synchronized foreign tightening, domestic cost channels (working capital and financial accelerator) account for over 85% of the inflationary pressure in our simulations. Second, synchronization reduces exchange rate volatility, which could be desirable from a financial stability perspective but weakens the expenditure-switching channel of monetary policy. Third, when foreign shocks are correlated with domestic policy, the central bank faces a more complex trade-off between stabilizing domestic demand and containing imported inflation. Fourth, for Australia, which is both commodity-exporting and financially integrated, the net effect depends on whether foreign rate hikes are driven by demand (positive for commodity prices) or supply factors (negative for global growth).

There are also several limitations for the model. First, the model treats foreign variables as exogenous, ignoring potential feedback from Australia to global markets. Second, we assume the same persistence and transmission parameters for foreign shocks, which may not hold in reality. Third, the analysis focuses on impact effects; the dynamic persistence of foreign shocks could differ from domestic shocks.

C.7 Conclusion

This appendix demonstrates that the price puzzle in the Australian context is robust to various foreign shock assumptions: i) with synchronized global tightening, the puzzle persists ($\Delta\pi_0 = 0.282$ pp) though attenuated by 24%; ii) with rising foreign import prices, the puzzle is amplified ($\Delta\pi_0 = 0.450$ pp); iii) In all scenarios, domestic cost channels (particularly working capital) remain the primary drivers of the short-run inflation increase.

These results suggest that the price puzzle identified in the baseline model is not an artifact of the constant foreign variables assumption but reflects structural features of the Australian economy, particularly the importance of cost channels in a small open economy with significant imported intermediate inputs and financial frictions.