Technical Appendix

Expectations, lags, and the transmission of monetary policy - speech by Catherine L. Mann given at the Resolution Foundation, 23 February 2023.

A1. Structural decomposition of the Sterling-Dollar exchange rate

The underlying setup is based on Brandt et al. (2021) who model the role of monetary policy spillovers and global risk for US and euro area financial market variables. We then adapt and extend the model for the UK.

It is a Bayesian VAR in daily frequency identified using sign restrictions (following Arias et al., 2018) and comprising financial variables in both the UK and US. The model is tightly restricted according to theoretical predictions about the direction of changes in variables following a given shock.

Within the same country, monetary policy shocks and macroeconomic shocks are disentangled by the co-movement of yields and equity prices. Ceteris paribus, monetary policy should induce a negative correlation between the two, while macroeconomic news induce a positive correlation.

Across countries, shocks are identified by magnitude restrictions on the relative size of the effect on yields, on impact. That is, a UK-domestic shock has a larger effect on UK yields (but may still affect US yields to some extent). Vice versa, a US shock is assumed to affect US yields more than UK yields.

Finally, there are two types of risk shocks in the model which are designed to reflect changes in both risk preferences and risk perceptions by global investors. Firstly, a global risk shock which captures risk-on/risk-off movements common to both countries and causes re-allocation between asset classes. It is identified as a shock which increases the attractiveness of riskless to risky assets (i.e. bond prices up, stock prices down), and leads to safe-haven flows into Dollar-denominated assets. Thus, a global risk-off shock decreases both UK and US yields (but US yields by more) and causes a depreciation of Sterling. In addition, there is a UK-specific risk shock which captures flows into or out of Sterling-denominated assets regardless of their relative riskiness. Therefore, it also causes a depreciation but, crucially, and in contrast to the global shock, it causes an increase in UK yields. This is because even less risky Sterling assets such as government bonds lose attractiveness.

A2. A UK financial conditions index

We construct another financial conditions index (FCI) for the UK using principal component analysis, inspired by Angelopoulou et al. (2013). The index uses monthly data on a range of short and long term nominal government bond yields, term spreads (the difference between some short and long term yields and Bank Rate), credit spreads and risky asset prices. This index should be seen as a complement to the Bank's Monetary and Financial Conditions Index which uses multipliers similar in principle to those used in the MPC forecast to construct its weights.[1]

In common with a lot of macroeconomic variables, some financial market variables also suffer from issues of non-stationarity which induces non-stationarity also within the FCI. To alleviate concerns about stationarity, interest rate variables in the index are de-trended using an estimate of the long run real interest rate[2], and other variables such as equity prices are stationarised using log differences.

All variables are standardised by subtracting the mean and dividing by their standard deviation. This is to avoid differences in magnitude or units of the variables unduly influencing the index. It therefore provides a relative, not an absolute measure of financial conditions. An increase in the index denotes a tightening in financial conditions, and a decrease a loosening in financial conditions but it is unclear to what extent they are tight or loose in absolute terms. In other words, financial conditions above 0 are tight conditions relative only to the average index value.

Variables are also normalised to account for the way in which the series affect financial conditions. In order for an increase in the FCI to denote a tightening in financial conditions, variables where an increase reflects a loosening in financial conditions enter the model with an inverted sign. Finally, the index is compiled using weights implied by the first three principal components (which explain almost 80% of the overall variation in the data) on the normalised variables.

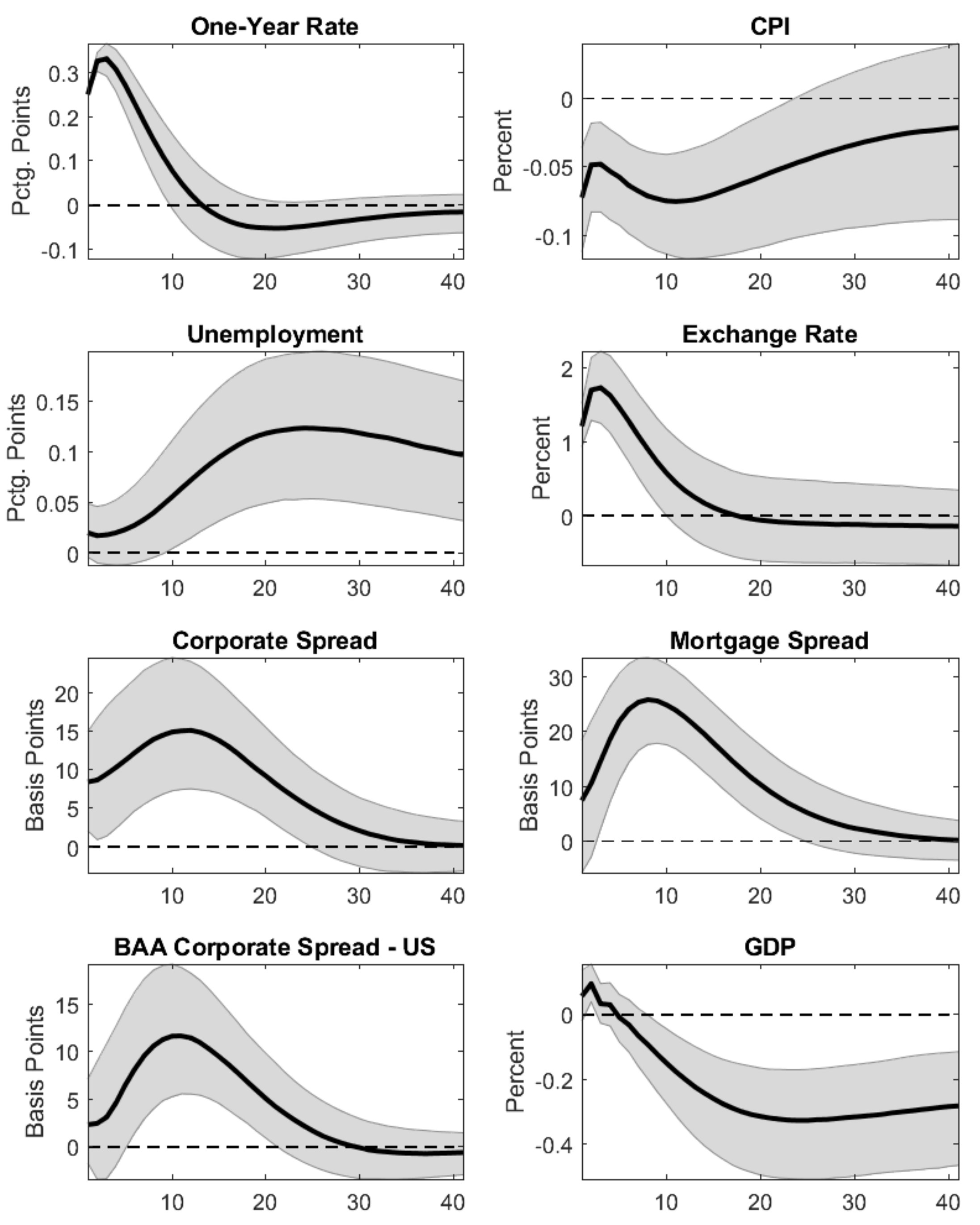
[1] For more information, see Bank of England (2021).
[2] For more information, see Bailey et al. (2022).

A3. Updated estimates of the effect of UK monetary policy

We build upon the specification of Cesa-Bianchi et al. (2020) by extending the sample until the end of 2019 and re-estimating both reduced and structural form using updated data. We find that the results in the paper are robust to the inclusion of additional data and an alternative proxy.

Chart A3.1 shows the full set of impulse response functions for the specification shown in Chart 7 of the speech. To note, the results presented here are for a 25 basis point contractionary monetary policy shock (as in Cesa-Bianchi et al., 2020). There is a significant effect on financial and credit variables, such as corporate bond and mortgage spreads, but also on US corporate spreads. This is in line with the literature (such as Gerko and Rey, 2017 and Gertler and Karadi, 2015) which highlights the importance of the financial channel in the transmission of monetary policy.

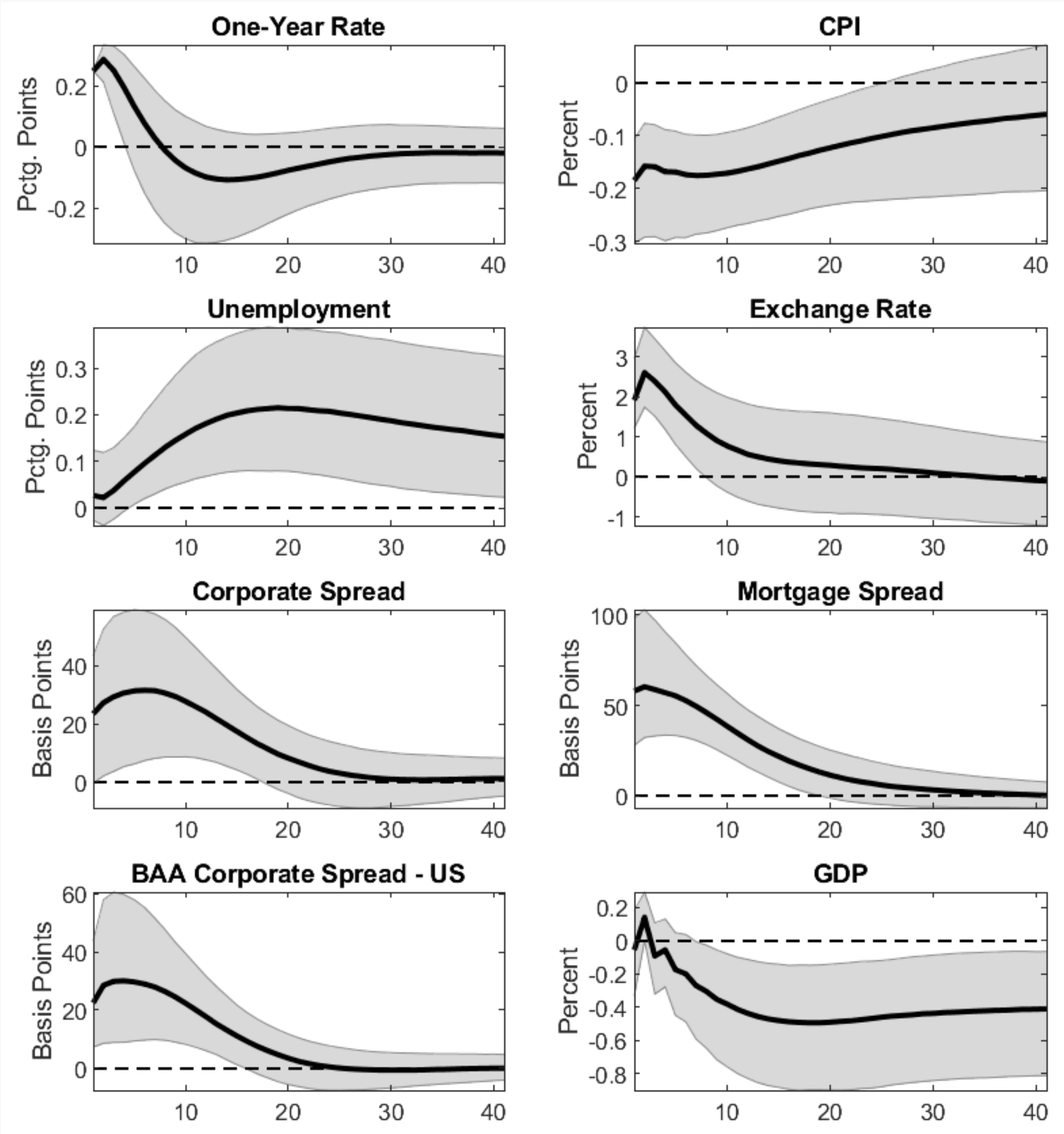
Chart A3.1: Responses of UK variables to a contractionary monetary policy shock – full specification, as in Chart 7 of the speech



We run a series of additional robustness checks on these results. First, we use a different proxy for the monetary policy shock. Cesa-Bianchi et al. create "a monetary policy surprises series from intra-day data that captures changes in expectations about the monetary policy stance in the UK for every monetary policy 'event' since 1997". Changes in expectations about monetary policy stance are calculated using the intraday change in interest rate futures at various different maturities. We verify whether the model specification is robust to using a different instrument: we use shocks derived from using intraday interest rate changes around monetary policy announcements, to capture the unexpected component of monetary policy. The methodology extracts principal components from the high-frequency surprises, and rotates these for economic interpretation.

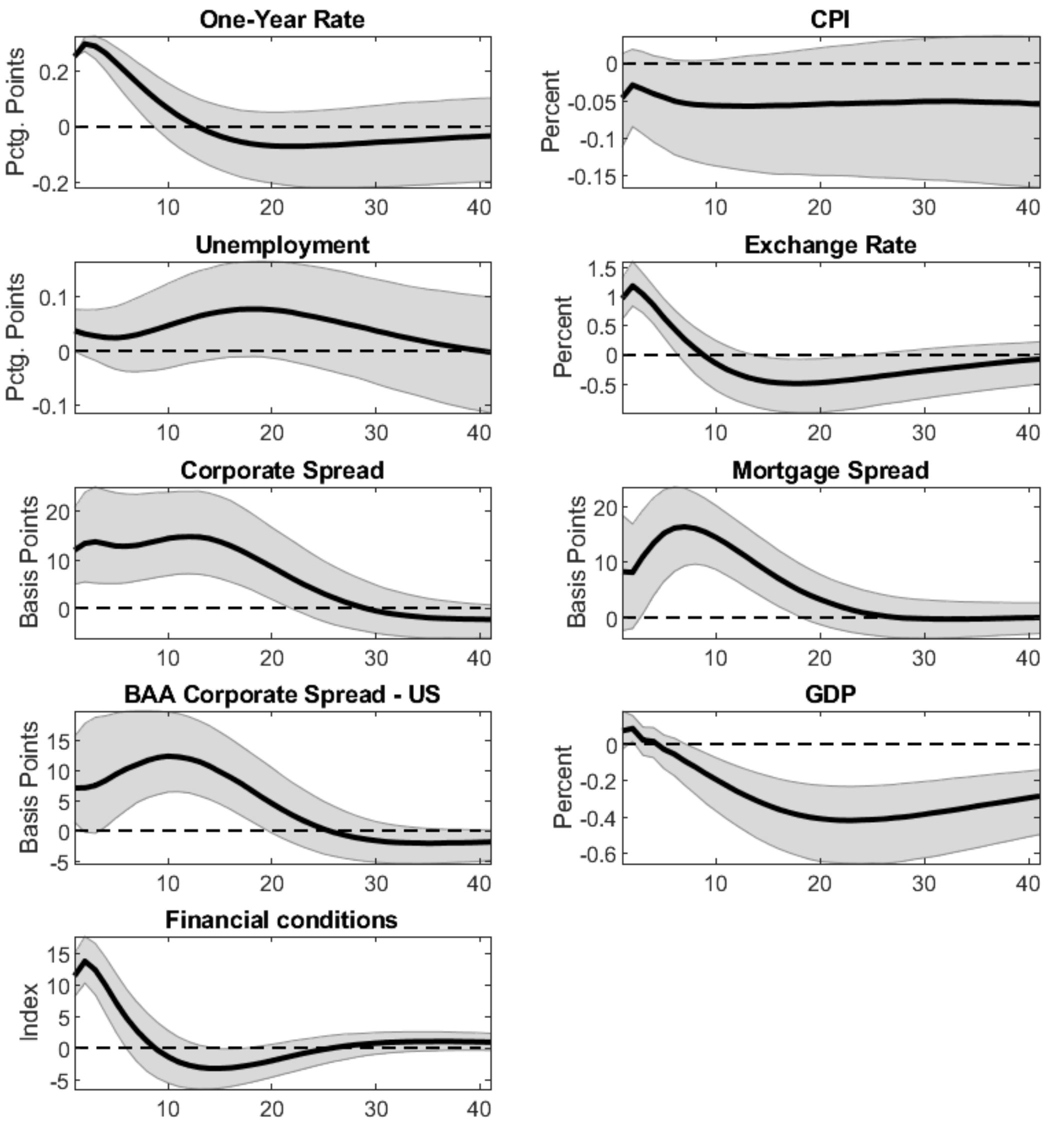
As suggested by Bauer and Swanson (2022), we clean these shocks for between-meeting surprises in macroeconomic data. **Chart A3.2** shows the results of this robustness check, where the impulse response functions are of the same specification as in Chart A3.1, but using the alternative proxy. We find that the responses to a 25 basis point shock are larger in the macroeconomic variables: CPI, unemployment and GDP, but also in some financial variables, the spreads and the exchange rate. The impact on variables also peaks sooner.

Chart A3.2: Responses of UK variables to a contractionary monetary policy shock – full specification, with a different instrument



For further robustness checks, we also include a measure of financial conditions (detailed in section A2) as a control variable in the model. We keep all other financial variables from the original specification in the model, as the FCI gives little weight to spreads, and does not include international financial variables. **Chart A3.3** shows that the reaction, and peak, occurs early in £ERI and financial conditions, though magnitudes on the movement in financial conditions are implausible. CPI falls and unemployment rises, though both are insignificant.

Chart A3.3: Responses of UK variables to a contractionary monetary policy shock – specification including monthly GDP and UK financial conditions



A4. Simple New Keynesian model with backward-looking price-setters

At its core, the model is the simple New Keynesian model described in Chapter 3 of Galí (2015) with the following three equations with all variables in logarithms:

1. **Dynamic IS curve:**

$$y_t - y_t^* = E[y_{t+1} - y_{t+1}^*] - \frac{1}{\sigma}(i_t - E[\pi_{t+1}] - r_t^*)$$

It defines today's output gap as a function of the expected output gap tomorrow and the distance of the current real interest rate $r_t = i_t - E[\pi_{t+1}]$ from its neutral rate. The neutral rate is determined by the technology used in production as well as consumer preferences for consumption and saving.

2. **Phillips curve with naïve expectations formation:**

$$\pi_t = \gamma_n \hat{\pi}_{t+1} + \gamma_f E[\pi_{t+1}] + \lambda(y_t - y_t^*) + u_t$$

Here, we extend the standard New Keynesian Phillips curve by including naïve price-setters along the argument of section 4.1 in Galí and Gertler (1999). We begin with a standard Calvo-pricing setup in which firms are able to adjust their price p with probability $(1-\theta)$. Accordingly, today's price level is a weighted average of yesterday's price level and the firms' index of desired reset prices p^*:

$$p_t = \theta p_{t-1} + (1-\theta)p_t^*$$

In the standard New Keynesian setup, this desired reset price is simply a weighted average of discounted future marginal costs. With a discount factor β, it is:

$$p_t^f = (1-\beta\theta)\sum_{k=0}^{\infty}(\beta\theta)^k E_t[\mu + \mathrm{mc}_t]$$

Here, we assume, however, that there exists a second type of firm which determines its desired reset price according to some naïve rule of thumb. Assume that the share of naïve firms is a constant ω, then the index of optimal reset prices is a weighted average of desired prices of those firms and the fundamental, rational expectations-implied price:

$$p_t^* = \omega p_t^n + (1-\omega)p_t^f$$

In the following we impose that these naïve firms just extrapolate last period's inflation rate (i.e. $\hat{\pi}_t = \pi_{t-1}$) but the model is general enough to capture more sophisticated ways of expectations formation. The optimal reset price of the naïve firm is therefore:

$$p_t^n = p_{t-1}^* + \pi_{t-1}$$

We then assume that there exists a linear mapping between real marginal costs and the output gap. Finally, u is a persistent cost-push shock which increases mark-ups over and above price inflation implied by demand conditions.

This gives rise to the above Phillips curve with weights that are non-linear functions of the share of naïve firms, discount factors, and the degree of price-stickiness. We obtain:

$$\gamma_n = \frac{\omega}{\theta + \omega[1 - \theta(1 - \beta)]}, \quad \gamma_f = \frac{\beta\theta}{\theta + \omega[1 - \theta(1 - \beta)]}$$

3. **Contemporaneous Taylor rule**

$$i_t = \phi_\pi \pi_t + \phi_y (y_t - y_t^*) + \nu_t$$

Finally, we assume the central bank sets policy according to a simple contemporaneous policy rule with fixed parameters which trades-off inflation and the output gap subject to a monetary policy shock ν. For the balanced policy rule, we choose $\phi_\pi = 1.5$ and $\phi_y = 0.5$ while in the inflation-biased rule, these parameters are 1.8 and 0.2 respectively.

Depending on the share of naïve, backward-looking firms, shocks lead to more persistent deviations of inflation from target. See **Chart A4.1** for the response to a persistent cost-push shock and **Chart A4.2** for the response to a monetary policy shock. In both charts, the shock is normalised to yield an increase in the nominal interest rate of 100 basis points under the fully forward-looking baseline.

Charts A4.3 and **A4.4** explore the gains from an inflation-biased policy rule given varying degrees of backward-looking expectations formation. In order to summarise the trade-off under the two rules, we specify a discounted squared-error loss function following Carney (2017):

$$\mathrm{Loss}^2 = \sum_{h=1}^{16} \beta^h [(\pi_{t+h} - \pi^*)^2 + \lambda(y_{t+h} - y_{t+h}^*)^2]$$

We find that the inflation-biased Taylor rule delivers a lower aggregate loss for a wide range of choices of λ with disproportionately higher gains at higher degrees of backward-lookingness. For example, when we evaluate the above function for $\beta = 0.99$ and $\lambda = 0.5$, we obtain the following values:

	$\omega = 0$	$\omega = 0.4$	$\omega = 0.8$
Balanced rule	1.61	16.27	57.99
Inflation-biased rule	1.54	15.11	44.85
Ratio	1.05	1.08	1.29

So, while the gains from putting a high weight on inflation in the policy rule are small in cases in which backward-lookingness is modest, there are large gains when there are many backward-looking agents.

Note, however, that these are all cases in which ω is exogenously chosen. Therefore, we conclude that in a world in which ω actually depends on realised inflation deviations from target (and therefore on the chosen policy path), there is value in insuring against bad outcomes by adopting an inflation-biased rule even before ω is known to the policymaker (or is unknown altogether).

Chart A4.1: Responses to a cost-push shock in a New Keynesian model given varying degrees of backward-lookingness

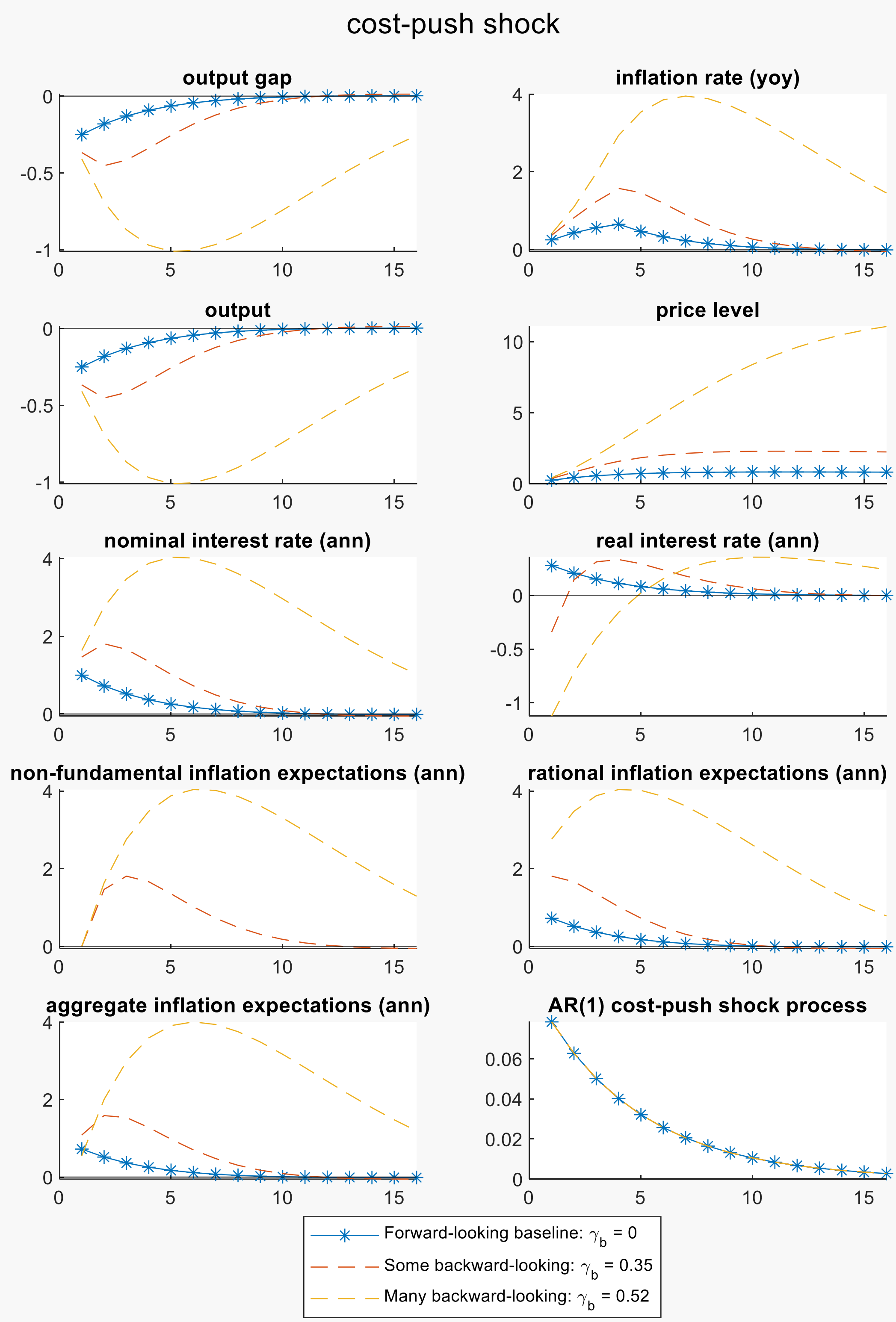


Chart A4.2: Responses to a monetary policy shock in a New Keynesian model given varying degrees of backward-lookingness

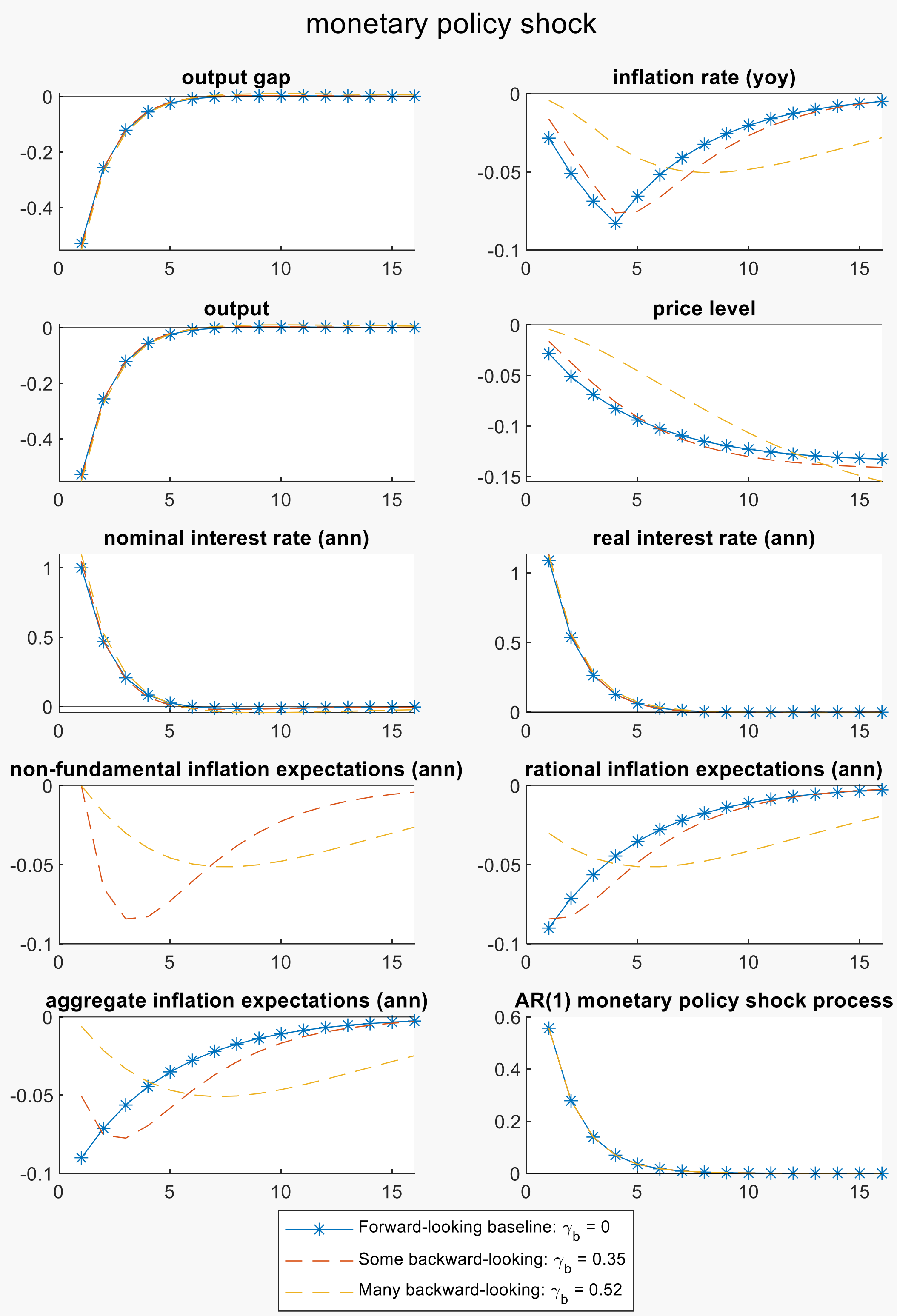


Chart A4.3: Responses to a cost-push shock under different policy rules given modest degree of backward-lookingness ($\omega = 0.4$)

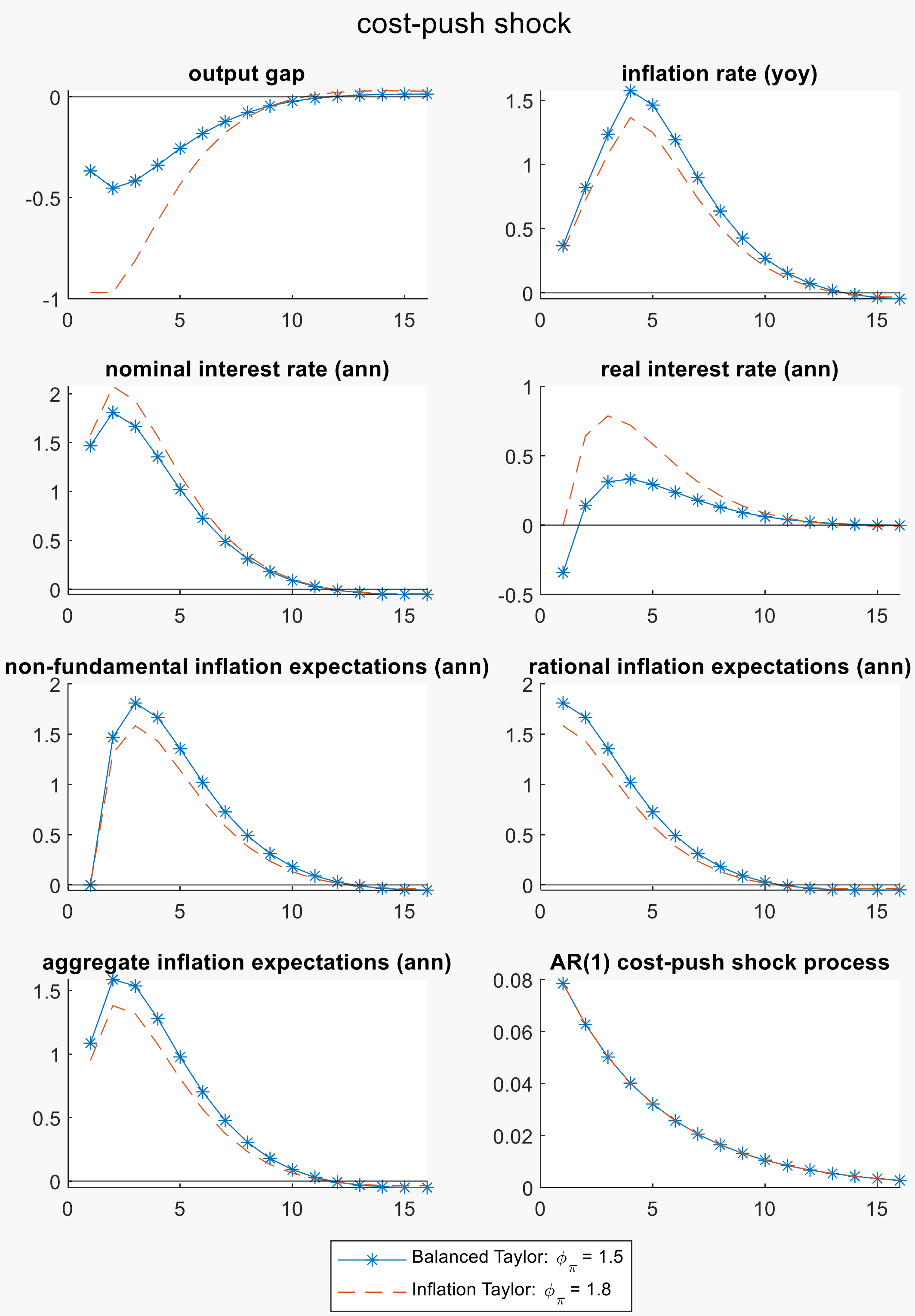
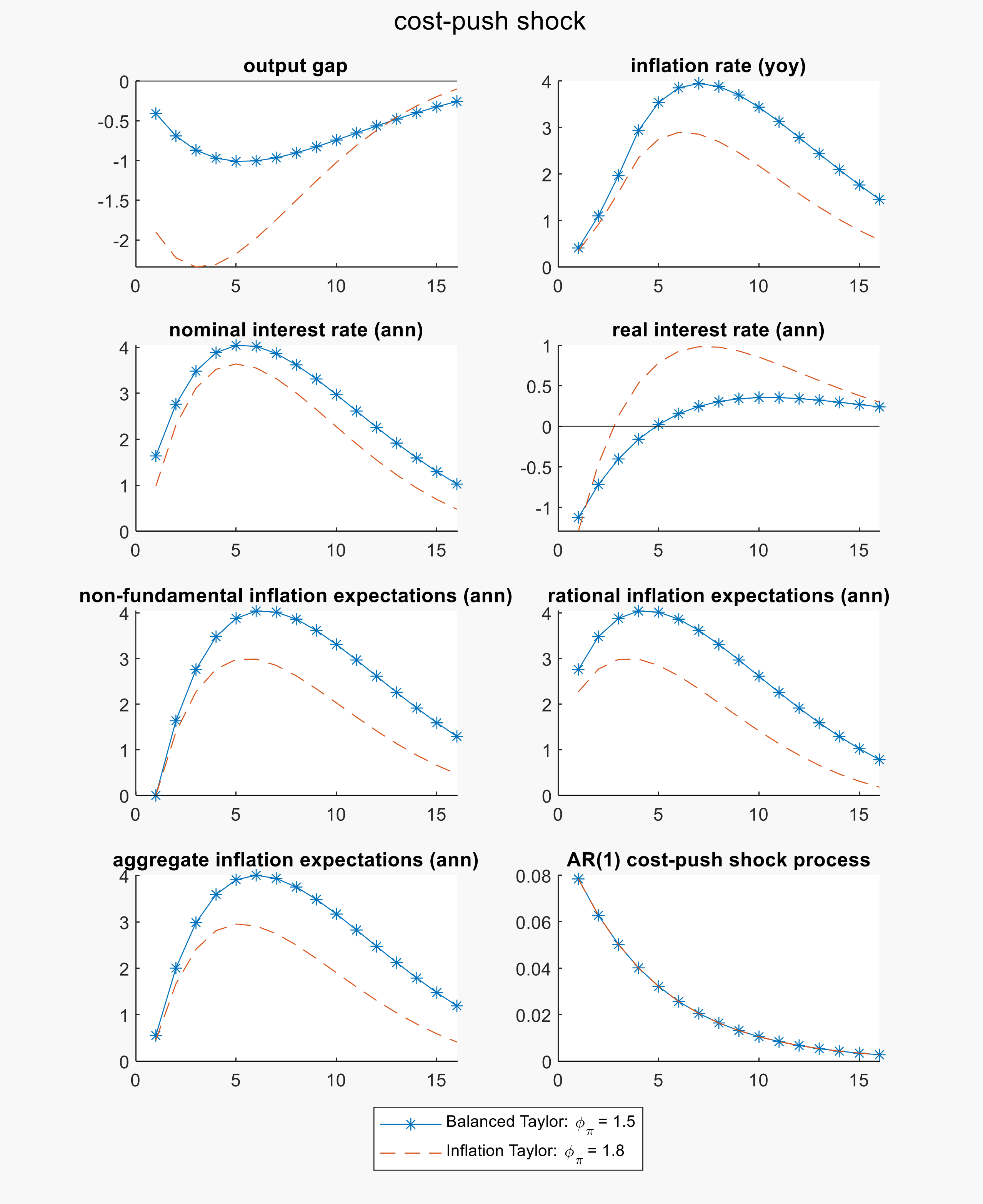


Chart A4.4: Responses to a cost-push shock under different policy rules given high degree of backward-lookingness ($\omega = 0.8$)



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