Sticky Production and Monetary Policy*

Jenny Chan† Sebastian Diz‡ Derrick Kanngiesser§

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We study a New Keynesian model where production inputs and pricing decisions are made under information frictions. Firm production is constrained by inputs that are chosen before shocks are realized, based on firms' expectations of future demand. We show that the assumption of real rigidities versus nominal rigidities is not innocuous, as assuming the presence of either or both affects the pass-through of demand shocks to aggregate output and inflation. When the choice of production inputs is made under imperfect information about demand shocks, the impact on inflation is amplified while the impact on output is dampened. When both production inputs and pricing decisions are made under imperfect information about demand shocks, the pass-through to output is amplified while the impact on inflation is dampened. Additionally, we show that expectations about demand can behave similarly to a supply shock, as these expectations influence the natural level of output and enter the New Keynesian Phillips curve in a manner analogous to a cost-push shock.

*The views expressed do not necessarily reflect the views of the Bank of England or the Central Bank of Paraguay.
†Bank of England, Email: jenny.chan@bankofengland.co.uk
‡Central Bank of Paraguay, Email: sdizp@bcp.gov.py
§Bank of England, Email: derrick.kanngiesser@bankofengland.co.uk

1 Introduction

Recent events have highlighted how the pass-through of aggregate shocks to inflationary dynamics can be affected by supply constraints. However, supply capacity is also contingent on firms' ability to adjust production and their expectations of future demand. To understand how these factors interact to shape the transmission of shocks, we embed two realistic frictions in the workhorse New Keynesian model. First, operational constraints such as hiring lags, investment lead times, and supply chain delays may prevent firms from adjusting production instantaneously in response to shocks. Second, firms often make these decisions with incomplete information about supply and demand conditions. These frictions were particularly salient during the recent inflationary episode: a large, unexpected surge in demand following the pandemic led to rising inflation, as firms struggled to scale up production given rigid production capacities (Amiti et al., 2023; Ferrante et al., 2023; Caballero and Simsek, 2023; Balleer and Noeller, 2023; Fornaro and Wolf, 2023; Rubbo, 2024; Ascari et al., 2024; Fornaro, 2024).

This paper examines how incomplete information and frictions in the adjustment of production inputs shape the macroeconomic response to demand shocks. A key contribution is to show that the mapping from shocks to macroeconomic outcomes depends on modeling assumptions that are often treated as innocuous but can lead to substantially different policy implications (Woodford, 2002; Angeletos and La'O, 2021; Pellet and Tahbaz-Salehi, 2023). Our tractable framework nests a range of results in the literature, reconciling seemingly divergent results on the role of information frictions in shaping macroeconomic outcomes. Specifically, we show that the opposing implications of models featuring both real and nominal rigidities hinge on whether information frictions are a source of nominal rigidities. This distinction is critical for understanding how information affects the transmissions of shocks.

To isolate the effects of real rigidities, we first consider a setting where firms set employment with incomplete information but retain pricing under full information, subject to an adjustment cost.[1] Importantly, unlike Angeletos et al. (2016), nominal rigidities exist but are not driven by information frictions, which allows us to decouple the extent of nominal rigidity from the degree of information frictions. We find that information frictions dampen the effect of demand shocks on output by constraining firms' ability to expand supply capacity in response to demand. When labor hiring must be chosen before shocks are realized, firms rely on ex-post adjustments to hours worked, which leads to a sharp rise in marginal costs and inflationary pressures. The endogenous, contractionary monetary policy response to the rise in inflation leads to a contraction in economic activity, thereby restricting the pass-through of demand shocks to output. In this framework, demand passes through to inflation rather than output growth. We show that real rigidities steepen the New Keynesian Phillips curve, amplifying the inflationary response to demand while dampening its effect on output.

Next, we show that whether or not nominal rigidities depend on information frictions turns out to be critical. If information frictions affect both firms' production and pricing decisions, results from the baseline model overturn: information frictions amplify the effect of demand shocks on output, while dampening its effects on inflation. The intuition is as follows: when price adjustments also occur under imperfect information, the extent of nominal rigidity depends on the degree of information frictions. Prices are less responsive to shocks, as firms cannot fully respond to shocks using this margin of adjustment. Information frictions therefore moderate the effect of demand shocks on inflation, while

[1] By *real rigidity*, we refer to inertia in the response of real quantities, such as employment and output, to shocks in fundamentals like preferences and technology, as a result of incomplete information. Our definition aligns with Angeletos et al. (2016), though it differs from the New Keynesian literature, where real rigidity refers to the weak responsiveness of a firm's desired relative price to aggregate disturbances.

amplifying the pass-through of demand shocks to output. In the extreme case, if information frictions fully prevent price adjustments, inflation remains unchanged, and monetary policy does not counteract the demand shock. As a result, demand shocks translate fully into changes in output, increasing the volatility of real economic activity.

We also show how expectations about demand can have features of a supply shock. When production inputs are chosen before shocks are realized, firms' expectations about future demand affect the natural level of output, and consequently, the macroeconomic response to shocks even in the absence of actual changes in fundamentals. These expectations enter the New Keynesian Phillips curve analogously to a cost-push shock, creating inflationary pressures that are observationally equivalent to a supply shock. This mechanism underscores how the presence of information frictions can generate dynamics that complicate the distinction between demand- and supply-driven fluctuations.[2]

From a policy perspective, our findings have important implications beyond theory. Constraints on firms' ability to respond to shocks shape the trade-off between inflation and economic activity. In our baseline model, limited information amplifies inflationary pressures while dampening the output response to demand shocks. When firms operate under considerable uncertainty, demand stimulus primarily fuels inflation rather than output growth, triggering a contractionary policy response that offsets the intended expansionary effects. Conversely, better information allows firms to adjust supply more effectively, reducing inflation pass-through but amplifying output response.

1.1 Related Literature

The literature embedding information frictions into New Keynesian models builds on a long tradition that attributes monetary non-neutrality to such frictions (Lucas, 1972, 1973; Barro, 1976, 1977, 1978). Within the New Keynesian framework, nominal rigidity plays a central role in explaining business cycle dynamics. Informational frictions providing a compelling micro-foundation, as the inertia of higher-order beliefs (Mankiw and Reis, 2002; Woodford, 2002) or limited capacity to process information (Sims, 2002; Mackowiak and Wiederholt, 2009, 2015) can generate persistent price sluggishness in a way that is distinct from the conventional Calvo pricing approach. Most of this literature treats information frictions as a source of nominal rigidity, assuming that firms set prices under imperfect information while making production and employment decisions with full information. However, as (Angeletos et al., 2016) note, this approach conflates the effects of information frictions with those stemming from monetary policy, potentially mischaracterizing their effect on macroeconomic fluctuations.

Motivated in part by this observation, recent work has explored the implications of real rigidities in macroeconomic models (Angeletos et al., 2016; Angeletos and La'O, 2021; Pellet and Tahbaz-Salehi, 2023; Nikolakoudis, 2025). Angeletos et al. (2016) examine a setting where both prices and production inputs are chosen under information frictions, showing how the welfare effects depend on whether shocks are efficient or distortionary. In their framework, information frictions hinder the ability of firms to adjust prices in response to shocks, effectively increasing the extent of nominal rigidities. Consequently, introducing real rigidity does not alter the standard prediction from models with information frictions as a source of nominal rigidities only: information frictions *amplify* the effects of demand shocks on output while dampening their effects on inflation.

Pellet and Tahbaz-Salehi (2023) consider how real rigidities, arising from firms' limited information, interact with the structure of the production network. In contrast to Angeletos and La'O (2021), they

[2] Recent work on *Keynesian supply shocks* highlight the aggregate demand consequences of sectoral supply shocks (Guerrieri et al., 2022), which may be a regular feature of business cycles (Cesa-Bianchi and Ferrero, 2021).

show that when firms select inputs under imperfect information, the output response to demand shocks is *dampened*. We reconcile these results and show that the key distinction lies not in the co-existence of nominal and real rigidities, but in whether or not information frictions serve a source of nominal rigidities. When they are, reducing information frictions is equivalent to reducing nominal rigidities. However, if nominal rigidities exist independently of information frictions, as in our baseline model, information frictions instead *dampen* the pass-through of demand shocks to output. This distinction is crucial for understanding the role of information in macroeconomic dynamics and the design of monetary policy. Our framework clarifies this distinction and shows that the introduction of real rigidities in Angeletos et al. (2016) does not fundamentally change the transmission of shocks, relative the case where information frictions are only a source of nominal rigidities (Mankiw and Reis, 2002; Woodford, 2002; Sims, 2002; Mackowiak and Wiederholt, 2009, 2015)—real rigidities are effectively irrelevant to their key results.

The range of results we find in the literature highlights an important open question: in reality, firms likely adjust both their pricing and production decisions based on available information, making it unclear which of these two scenarios is more relevant. Recent work by Flynn et al. (2023) introduces a *choice of choices* framework, where firms decide whether to set prices in advance and adjust quantities ex-post or commit to a production level and let prices adjust to market conditions. The transmission of macroeconomic shocks depends critically on this choice. Under quantity-setting, monetary policy has no real effects and inflation fully absorbs shocks, whereas under price-setting, monetary policy influences both output and inflation. These findings suggest that the efficacy of monetary policy depends on firms' decision-making behavior, which may be state-dependent. Our contribution highlights the importance of this margin of adjustment – whether firms primarily respond to demand shocks through prices or quantities fundamentally shapes macroeconomic outcomes.

Our analysis is also related to the recent literature on post-pandemic inflationary dynamics, which has highlighted supply chain constraints as a key factor, alongside expansionary fiscal and monetary policy, labor shortages, and energy shocks. A common theme in this literature is that factor market constraints can act as bottlenecks in production, as demand pressures raise marginal costs through inelastically supplied inputs (Amiti et al., 2023; Ferrante et al., 2023; Rubbo, 2024; Ascari et al., 2024; Fornaro, 2024). However, one challenge in quantifying their impact on inflation is that these constraints may alter the impact of other macroeconomic shocks. Accounting for this, Comin et al. (2023) show that shocks that tightened capacity set the stage for demand shocks to trigger binding constraints and accelerate inflation in 2021. Conversely, the relaxation of the constraints, in part due to monetary tightening, contributed to the rapid decline in goods price inflation from late 2022 onward. Supply constraints were shown to amplify the effects of demand shocks, altering the way in which monetary and fiscal policies transmitted through the economy. Our paper contributes to this literature by incorporating information frictions into the analysis of supply constraints and inflation. We show that when firms make input decisions under imperfect information, supply constraints interact with demand shocks, affecting the magnitude of inflationary pressures and the efficacy of monetary policy.

Roadmap To isolate the effect of real rigidities, Section 2 considers a model where firms make employment decisions based on incomplete information, while allowing prices to adjust freely to the realized state, subject to an adjustment cost. We distinguishs our approach from Angeletos et al. (2016) by not assuming that information frictions are the source of nominal rigidities. Information frictions lead to real rigidities, affecting production inputs, while nominal rigidities arise from price adjustment costs.

Under our framework, more information amplifies the effect of demand shocks on output, rather than eliminating nominal rigidities. In Section 3, we relate our results to two key cases in the literature. First, we examine a model with information frictions as a source of nominal rigidities, as seen in the work of Woodford (2002) and others. We formally demonstrate how our results differ from Angeletos et al. (2016), where information frictions are the source of both real and nominal rigidities. Section 4 concludes.

2 Model with Real and Nominal Rigidities

This section presents our baseline model, the case in which information frictions only affect the choice of production inputs. While nominal rigidities exist, information frictions are not its source. We therefore relax two key assumptions of the standard New Keynesian model: (1) that firms can make decisions under complete information about shocks and (2) they can frictionlessly adjust their intermediate input decisions. Within this framework, we compare the responses of output and inflation in two extreme information environments: one that features full information and another that features information frictions.

We use lower case variables with a hat superscript to refer to log-deviations from steady state, i.e. $\hat{x}_t = log(x_t/x_{ss})$, we let $\hat{x}_{t+k,t,h}$ denote the expected value of variable $\hat{x}_{t+k}$ given households' information set at time t, while $\hat{x}_{t+k,t,f}$ is the corresponding expectation conditioned on the information set of firms.

2.1 Firms

Information structure We assume that firms receive a public signal, given by

$$S_t = z_t + \xi_t^z,$$

where $z_t \sim N\left(0, \sigma_z^2\right)$ is a demand shock and $\xi_t^z \sim N\left(0, \sigma_{\xi^z}^2\right)$ is noise. Based on the signal S_t, firms form the following expectation about shocks affecting the economy,

$$z_{t,t,f} \equiv \mathbb{E}[z_t|S_t] = \frac{\sigma_z^2}{\sigma_z^2 + \sigma_{\xi^z}^2} z_t + \frac{\sigma_{\xi^z}^2}{\sigma_z^2 + \sigma_{\xi^z}^2} \xi_t^z \tag{2.1}$$

Production Letting $N_{j,t}$ denote the number of workers hired and $H_{j,t}$ the number of hours worked per worker, firm j's production function is given by

$$Y_{j,t} = N_{j,t}^{\vartheta} H_{j,t}^{1-\vartheta}, \tag{2.2}$$

where $N_{j,t}$ is chosen in advance, before the realization of shocks and based on a signal about the state of the economy. Once firms choose $N_{j,t}$, it becomes a fixed factor. However, $H_{j,t}$ can be adjusted to satisfy demand for the final good.

Choice of $N_{j,t}$ Firm j chooses the number of workers $N_{j,t}$ subject to the following cost minimization problem,

$$\mathbb{E}_t \left[\frac{W_t}{P_t} N_{j,t} + \frac{V_t}{P_t} H_{j,t} + LM_{j,t} \left(Y_{j,t} - N_{j,t}^{\vartheta} H_{j,t}^{1-\vartheta} \right) |S_t \right],$$

where $\frac{W_t}{P_t}$ and $\frac{V_t}{P_t}$ denote the respective remunerations (in real terms) of factors $N_{j,t}$ and $H_{j,t}$. $LM_{j,t}$ is the Lagrange multiplier. This implies that the optimal choice of $N_{j,t}$ and $H_{j,t}$ satisfies

$$\mathbb{E}_t \left[\frac{W_t}{P_t} - LM_{j,t} \vartheta N_{j,t}^{\vartheta-1} H_{j,t}^{1-\vartheta} | S_t \right] = 0,$$
$$\mathbb{E}_t \left[\frac{V_t}{P_t} - LM_{j,t} (1-\vartheta) N_{j,t}^{\vartheta} H_{j,t}^{-\vartheta} | S_t \right] = 0.$$

Log-linearizing and combining the first order conditions yields the optimal choice for $\hat{n}_{j,t}$,

$$\hat{n}_{j,t} = \mathbb{E}_t \left[\hat{v}_t^r - \hat{w}_t^r + \hat{h}_{j,t} | S_t \right].$$

Summing across firms,

$$\hat{n}_t = \int_0^1 \hat{n}_{j,t} dj = \int_0^1 \mathbb{E}_t \left[\hat{v}_t^r | S_t \right] - \int_0^1 \mathbb{E}_t \left[\hat{w}_t^r | S_t \right] + \int_0^1 \mathbb{E}_t \left[\hat{h}_{j,t} | S_t \right].$$

The assumed price setting process implies symmetry across firms, so that $\hat{h}_{j,t} = \hat{h}_t$ and

$$\hat{n}_t = \mathbb{E}_t \left[\hat{v}_t^r | S_t \right] - \mathbb{E}_t \left[\hat{w}_t^r | S_t \right] + \mathbb{E}_t \left[\hat{h}_t | S_t \right],$$

or

$$\hat{n}_t = \hat{v}_{t,t,f}^r - \hat{w}_{t,t,f}^r + \hat{h}_{t,t,f}. \tag{2.3}$$

New Keynesian Phillips Curve While the choice of factor $N_{j,t}$ is made at the beginning of the period (before shocks are realized), prices are set by firms at later stage, when they have full knowledge of the shocks hitting the economy. Suppose firms set prices subject to an adjustment cost (Ψ). In this case, inflationary dynamics are given by

$$\hat{\pi}_t = \beta \hat{\pi}_{\bar{t},t+1,f} + \lambda_p \hat{mc}_t, \tag{2.4}$$

where $\lambda_p \equiv \frac{\theta}{\Psi \mu^p}$, Ψ is a parameter determining the adjustment cost, μ^p is the steady state markup and $\hat{mc}_t$ is the marginal cost. Let $\hat{\pi}_{\bar{t},t+1,f}$ denote firms' expectation of inflation at $t+1$, given the information they have at the end of period t (once they have knowledge of the shocks hitting at t).

Marginal cost Firm j's marginal cost accounts for the feature that at the time that firms set prices, factor $N_{j,t}$ is fixed and only hours ($H_{j,t}$) can be adjusted. In this case, the nominal marginal cost is

$$MC_{j,t}^N = \frac{\partial TC_{j,t}^N}{\partial Y_{j,t}} = \frac{\partial TC_{j,t}^N}{\partial H_{j,t}} \frac{\partial H_{j,t}}{\partial Y_{j,t}} = V_t \frac{1}{1-\vartheta} \left(\frac{Y_{j,t}}{N_{j,t}^{\vartheta}} \right)^{\frac{1}{1-\vartheta}} Y_{j,t}^{-1},$$

where we use the relation $Y_{j,t} = N_{j,t}^{\vartheta} H_{j,t}^{1-\vartheta}$ to express $H_{j,t}$ as $H_{j,t} = \left(\frac{Y_{j,t}}{N_{j,t}^{\vartheta}}\right)^{\frac{1}{1-\vartheta}}$. This expression can be rearranged and expressed in real terms as

$$MC_{j,t} = \frac{1}{1-\vartheta} \frac{V_t}{P_t} \left(\frac{Y_{j,t}}{N_{j,t}}\right)^{\frac{\vartheta}{1-\vartheta}},$$

and in log-deviation from steady state,

$$\hat{mc}_{j,t} = \hat{v}_t^r + \frac{\vartheta}{1-\vartheta} \left(\hat{y}_{j,t} - \hat{n}_{j,t}\right).$$

Since firms receive a public signal, we have $\hat{n}_{j,t} = \hat{n}_t$. Furthermore, since all firms chose the same price we have $\hat{y}_{j,t} = \hat{y}_t$. This implies

$$\hat{mc}_t = \hat{v}_t^r + \frac{\vartheta}{1-\vartheta} \left(\hat{y}_t - \hat{n}_t\right). \tag{2.5}$$

From (2.4) and (2.5), we obtain

$$\hat{\pi}_t = \beta \hat{\pi}_{\bar{t},t+1,f} + \lambda_p \left(\hat{v}_t^r + \frac{\vartheta}{1-\vartheta} \left(\hat{y}_t - \hat{n}_t\right)\right). \tag{2.6}$$

2.2 Households

Household utility is given by

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{C_t^{1-\gamma}}{1-\gamma} - \frac{N_t^{1+\varphi}}{1+\varphi} - \frac{H_t^{1+\varphi}}{1+\varphi}\right).$$

The optimal choice of labor N_t and hours H_t is given respectively by

$$\frac{W_t}{P_t} = C_t^{\gamma} N_t^{\varphi},$$
$$\frac{V_t}{P_t} = C_t^{\gamma} H_t^{\varphi}.$$

Log-linearized,

$$\hat{w}_t^r = \gamma \hat{c}_t + \varphi \hat{n}_t, \tag{2.7}$$
$$\hat{v}_t^r = \gamma \hat{c}_t + \varphi \hat{h}_t. \tag{2.8}$$

We obtain the following Euler equation from households' optimal intertemporal allocation problem

$$\hat{y}_t = \hat{y}_{t+1,t,h} - \frac{1}{\gamma}(\hat{i}_t - \hat{\pi}_{t+1,t,h}). \tag{2.9}$$

2.3 Central Bank

The central bank is assumed to follow a Taylor rule, given by

$$\hat{i}_t = \phi_\pi \hat{\pi}_t + \phi_y \hat{y}_t + z_t. \tag{2.10}$$

2.4 Model Summary

Labor supply (2.7) and hours (2.8) are given by

$$\hat{w}_t^r = \gamma \hat{y}_t + \varphi \hat{n}_t,$$
$$\hat{v}_t^r = \gamma \hat{y}_t + \varphi \hat{h}_t.$$

Labor demand (2.3) is

$$\hat{n}_t = \hat{v}_{t,t,f}^r - \hat{w}_{t,t,f}^r + \hat{h}_{t,t,f}.$$

The New Keynesian Phillips curve (2.6) is given by

$$\hat{\pi}_t = \beta \hat{\pi}_{\bar{t},t+1,f} + \lambda_p \left(\hat{v}_t^r + \frac{\vartheta}{1-\vartheta} (\hat{y}_t - \hat{n}_t) \right).$$

The production function (2.2) is

$$\hat{y}_t = \vartheta \hat{n}_t + (1-\vartheta) \hat{h}_t.$$

The Euler equation (2.9) is

$$\hat{y}_t = \hat{y}_{t+1,t,h} - \frac{1}{\gamma} \left(\hat{i}_t - \hat{\pi}_{t+1,t,h} \right).$$

The Taylor rule (2.10) is

$$\hat{i}_t = \phi_\pi \hat{\pi}_t + \phi_y \hat{y}_t + z_t.$$

2.5 The effects of demand shocks

Consider the dynamic response to a monetary policy shock (z_t) and for simplicity, assume there is no persistence. The system of equations simplifies as follows:

$$
\begin{aligned}
\hat{w}_t^r &= \gamma \hat{y}_t + \varphi \hat{n}_t, \\
\hat{v}_t^r &= \gamma \hat{y}_t + \varphi \hat{h}_t, \\
\hat{n}_t &= \hat{v}_{t,t,f}^r - \hat{w}_{t,t,f}^r + \hat{h}_{t,t,f}, \\
\hat{\pi}_t &= \lambda_p \left(\hat{v}_t^r + \frac{\vartheta}{1-\vartheta} \left(\hat{y}_t - \hat{n}_t \right) \right), \\
\hat{y}_t &= \vartheta \hat{n}_t + (1-\vartheta) \hat{h}_t, \\
\hat{y}_t &= -\frac{1}{\gamma} \hat{i}_t, \\
\hat{i}_t &= \phi_\pi \hat{\pi}_t + \phi_y \hat{y}_t + z_t.
\end{aligned}
$$

Taking expectations based on the information set of firms and solving the resulting system of equations we obtain

$$
\hat{n}_{t,t,f} = -\frac{1}{\gamma} \frac{1}{1 + \frac{1}{\gamma} \phi_\pi \lambda_p (\gamma + \varphi) + \frac{1}{\gamma} \phi_y} z_{t,t,f}.
$$

Furthermore, note from the labor demand equation that $\hat{n}_t = \hat{n}_{t,t,f}$, [3]

$$
\hat{n}_t = -\frac{1}{\gamma} \frac{1}{1 + \frac{1}{\gamma} \phi_\pi \lambda_p (\gamma + \varphi) + \frac{1}{\gamma} \phi_y} z_{t,t,f}. \tag{2.11}
$$

The policy functions for the remaining model variables can be obtained using the simplified system of equations and (2.11). Output is given by (see Appendix A-1 for details)

$$
\hat{y}_t = -\frac{1}{\gamma} \frac{1}{1 + \frac{1}{\gamma} \phi_\pi \lambda_p \left(\gamma + \frac{\varphi+\vartheta}{1-\vartheta} \right) + \frac{1}{\gamma} \phi_y} \left(\frac{\frac{1}{\gamma} \phi_\pi \lambda_p (1+\varphi) \frac{\vartheta}{1-\vartheta}}{1 + \frac{1}{\gamma} \phi_\pi \lambda_p (\gamma + \varphi) + \frac{1}{\gamma} \phi_y} z_{t,t,f} + z_t \right), \tag{2.12}
$$

while inflation is

$$
\begin{aligned}
\hat{\pi}_t = \lambda_p \Bigg(&- \frac{\frac{1}{\gamma} \left(\gamma + \frac{\varphi+\vartheta}{1-\vartheta} \right)}{1 + \frac{1}{\gamma} \phi_\pi \lambda_p \left(\gamma + \frac{\varphi+\vartheta}{1-\vartheta} \right) + \frac{1}{\gamma} \phi_y} z_t \\
&+ \left(1 - \frac{\frac{1}{\gamma} \phi_\pi \lambda_p \left(\gamma + \frac{\varphi+\vartheta}{1-\vartheta} \right)}{1 + \frac{1}{\gamma} \phi_\pi \lambda_p \left(\gamma + \frac{\varphi+\vartheta}{1-\vartheta} \right) + \frac{1}{\gamma} \phi_y} \right) \cdot \frac{1}{\gamma} (1+\varphi) \frac{\vartheta}{1-\vartheta} \cdot \frac{1}{1 + \frac{1}{\gamma} \phi_\pi \lambda_p (\gamma+\varphi) + \frac{1}{\gamma} \phi_y} z_{t,t,f} \Bigg).
\end{aligned} \tag{2.13}
$$

To understand the effect of information on the dynamics in response to a demand shock, consider two extreme cases: full information (FI), where $\sigma_{\xi^z}^2 = 0$ and information frictions (IF), where $\sigma_{\xi^z}^2 = \infty$.

[3] To see this, take expectations of the labor demand equation based on firms' information set, which yields $\hat{n}_{t,t,f} = \hat{v}_{t,t,f}^r - \hat{w}_{t,t,f}^r + \hat{h}_{t,t,f}$. Combining the above expression with the original labor demand equation leads to $\hat{n}_t = \hat{n}_{t,t,f}$.

Full information By equation (2.1), we have $z_{t,t,f} = z_t$ under full information, and hence

$$\hat{y}_t^{FI} = -\frac{1}{\gamma}\frac{1}{1+\frac{1}{\gamma}\phi_\pi\lambda_p(\gamma+\varphi)+\frac{1}{\gamma}\phi_y}z_t. \tag{2.14}$$

See Appendix A-1 for details.

Information frictions Under information frictions we have $z_{t,t,f} = 0$ (see equation 2.1), hence

$$\hat{y}_t^{IF} = -\frac{1}{\gamma}\frac{1}{1+\frac{1}{\gamma}\phi_\pi\lambda_p\left(\gamma+\frac{\varphi+\vartheta}{1-\vartheta}\right)+\frac{1}{\gamma}\phi_y}z_t. \tag{2.15}$$

See Appendix A-1 for details.

Proposition 1 *When information is a source of real rigidities, information frictions dampen the effect of demand shocks on output, since $\vartheta > 0$ (2.14 and 2.15). Conversely, more information amplifies the effect of demand shocks on output.*

Discussion The dynamics of output under these two extreme cases can be explained by the effects of information on inflation. To see this, notice that using (2.8) the New Keynesian Phillips curve can be expressed as

$$\hat{\pi}_t = \lambda_p\left(\left[\gamma+\frac{\varphi+\vartheta}{1-\vartheta}\right]\hat{y}_t-(1+\varphi)\frac{\vartheta}{1-\vartheta}\hat{n}_t\right). \tag{2.16}$$

Using $\hat{n}_t = \hat{n}_{t,t,f}$, this implies,

$$\hat{\pi}_t = \lambda_p\left(\left[\gamma+\frac{\varphi+\vartheta}{1-\vartheta}\right]\hat{y}_t-(1+\varphi)\frac{\vartheta}{1-\vartheta}\hat{n}_{t,t,f}\right).$$

Under full information, where firms observe shocks and adjust labor optimally in response, we have $\hat{n}_{t,t,f} = \hat{n}_t = \hat{y}_t$, hence

$$\hat{\pi}_t^{FI} = \lambda_p(\gamma+\varphi)\hat{y}_t. \tag{2.17}$$

However, under information frictions, where employment decisions are made prior to observing shocks, we have $\hat{n}_{t,t,f} = 0$, which implies

$$\hat{\pi}_t^{IF} = \lambda_p\left(\gamma+\frac{\varphi+\vartheta}{1-\vartheta}\right)\hat{y}_t. \tag{2.18}$$

The more severe information frictions are, the less responsive $\hat{n}_t$ is to shocks. In the extreme case, if firms do not observe the shock, they do not adjust their labor hiring decisions. This means that once firms realize the actual level of demand, changes in production can only be achieved by adjusting hours worked ($\hat{h}_t$). Decreasing returns, which follow from the possibility of adjusting only one input of production, lead to large variations in marginal costs (and hence inflation). For firms, information frictions are equivalent to having prices that are more responsive to demand shocks. This leads to demand shocks having an amplified effect on inflation, but a dampened effect on output (given the endogenous policy response that inflation triggers).

Information frictions and the Phillips curve The presence of real rigidity is analogous to having a steeper New Keynesian Phillips curve. To see this, note that the IS and Taylor rule equations are the same under full information and information frictions. Therefore, under full information, the economy is described by the following system of equations,

$$\hat{\pi}_t = \lambda_p (\gamma + \varphi) \hat{y}_t, \tag{2.19}$$

$$\hat{y}_t = -\frac{1}{\gamma}\hat{i}_t, \tag{2.20}$$

$$\hat{i}_t = \phi_\pi \hat{\pi}_t + \phi_y \hat{y}_t + z_t, \tag{2.21}$$

while under information frictions, the system describing the economy is

$$\hat{\pi}_t = \lambda_p \left(\gamma + \frac{\varphi + \vartheta}{1 - \vartheta}\right) \hat{y}_t,, \tag{2.22}$$

$$\hat{y}_t = -\frac{1}{\gamma}\hat{i}_t, \tag{2.23}$$

$$\hat{i}_t = \phi_\pi \hat{\pi}_t + \phi_y \hat{y}_t + z_t. \tag{2.24}$$

Proposition 2 *When information is a source of real rigidities, information frictions amplify the effect of demand shocks on inflation (2.17 and 2.18).*

Discussion Without loss of generality, consider the case of a positive demand shock. If information frictions prevent firms from adjusting supply capacity (i.e., labor hiring) in response to an increase in demand, the mismatch between aggregate demand and firms' production capacity leads to inflationary pressure. More precisely, if labor is chosen before shocks are known, firms can only increase production by adjusting hours worked once actual demand is known. Due to decreasing returns to scale from adjusting one input of production, large variations in marginal cost lead to strong upward pressure on prices. As described in Proposition 1, the endogenous monetary policy response to inflationary pressure contracts economic activity, thereby limiting the pass-through of demand shocks to output.[4]

In summary, precisely because information frictions amplify the response of inflation to demand shocks, it leads to less volatility in output, as the endogenous monetary policy response dampens the pass-through of demand shocks to output. Since demand shocks have an amplified effect on inflation and a dampened effect on output, real information frictions are akin to having a steeper slope of the Philips curve relative to the full information case. The efficacy of policies to stimulate demand therefore depend crucially on the adjustment of supply capacity. This implies that expansionary monetary policy surprises with supply constraints may be counterproductive, leading to increased inflationary pressure, which requires counteracting contractionary monetary policy.

[4]Conversely, more information allows firms to adjust their production capacity in response to demand shocks, limiting inflationary pressures. The pass-through of demand to output will be higher since the endogenous response of monetary policy does not counteract the effect of the demand shock on economic activity.

2.6 Natural output

In this section, we compute the natural level of output, defined here as the level of output under flexible prices, conditional on firms' choice of $\hat{n}_t$.

Recall that household labor supply and hours are given by

$$\hat{w}_t^r = \gamma \hat{y}_t + \varphi \hat{n}_t, \tag{2.25}$$

$$\hat{v}_t^r = \gamma \hat{y}_t + \varphi \hat{h}_t. \tag{2.26}$$

Under flexible prices, firms optimally set $\hat{mc}_t = 0$, and from (2.5), it follows that

$$\hat{v}_t^r = -\frac{\vartheta}{1-\vartheta}\left(\hat{y}_t - \hat{n}_t\right). \tag{2.27}$$

The production function is

$$\hat{y}_t = \vartheta \hat{n}_t + (1-\vartheta)\hat{h}_t. \tag{2.28}$$

The natural level of output is determined by the preceding four equations. Solving for natural output ($\hat{y}_t^n$), we obtain

$$\hat{y}_t^n = \frac{\vartheta(1+\varphi)}{\vartheta + (1-\vartheta)\gamma + \varphi}\hat{n}_t. \tag{2.29}$$

The natural level of output coincides with efficient output (see Appendix A-1). Firms' choice of $\hat{n}_t$ is given by (2.11), therefore

$$\hat{y}_t^n = -\frac{1}{\gamma}\frac{\vartheta(1+\varphi)}{\vartheta + (1-\vartheta)\gamma + \varphi}\frac{1}{1+\frac{1}{\gamma}\phi_\pi \lambda_p(\gamma+\varphi) + \frac{1}{\gamma}\phi_y} z_{t,t,f}. \tag{2.30}$$

The Phillips curve in terms of the output gap From (2.16), and using 2.29, we have

$$\hat{\pi}_t = \lambda_p \frac{\vartheta + (1-\vartheta)\gamma + \varphi}{1-\vartheta}\hat{y}_t - \lambda_p \frac{\vartheta + (1-\vartheta)\gamma + \varphi}{1-\vartheta}\hat{y}_t^n, \tag{2.31}$$

$$\hat{\pi}_t = \lambda_p \frac{\vartheta + (1-\vartheta)\gamma + \varphi}{1-\vartheta}\tilde{y}_t, \tag{2.32}$$

where $\tilde{y}_t \equiv \hat{y}_t - \hat{y}_t^n$. Note also that from (2.31) and (2.30), the Phillips curve can be expressed as

$$\hat{\pi}_t = \lambda_p \frac{\vartheta + (1-\vartheta)\gamma + \varphi}{1-\vartheta}\hat{y}_t + \lambda_p \frac{1}{\gamma}\frac{\vartheta(1+\varphi)}{1-\vartheta}\frac{1}{1+\frac{1}{\gamma}\phi_\pi \lambda_p(\gamma+\varphi) + \frac{1}{\gamma}\phi_y} z_{t,t,f}. \tag{2.33}$$

Proposition 3 *Expectations about demand can affect the natural level of output, and appears in the New Keynesian Phillips curve in a manner that is observationally equivalent to a supply shock. Specifically, expectations of future demand affect $\hat{y}_t^n$ through firms' labor hiring decision $\hat{n}_t$ (2.30), appearing in the Phillips curve as a term analogous to a cost-push shock (2.33).*

Discussion We show that firms' misperceptions of demand can generate inflationary pressures that are observationally similar to those arising from supply shocks. To illustrate how expectations about demand may operate as a supply shock, consider a case in which firms perceive demand to be weaker than it truly is (i.e., $z_{t,t,f} > 0$ while $z_t = 0$, due to $\xi_t^z > 0$). From equation (2.33), holding output ($\hat{y}_t$) constant, this implies $\hat{\pi}_t > 0$.[5] The reason for the rise in inflation is that although no fundamental shock hits the economy, firms chose insufficient production capacity due to low expected demand. The resulting mismatch between realized demand and constrained supply generates inflationary pressure. Equation (2.30) shows that in this case, natural output falls, meaning that the monetary policymakers will need to induce a contraction in output to prevent inflationary pressures (2.32). The reason for the fall in natural output is that labor hiring, which becomes a fixed input, is below its steady state level. Therefore, lower output is compatible with zero inflation, which implies a lower optimal level of production. The expectation shock thus operates similarly to a negative productivity shock: both reduce the natural (and efficient) level of output. In this context, the optimal policy response is to set $\hat{\pi}_t = 0$ and $\tilde{y}_t = 0$, which requires a contraction in activity.[6]

3 Nominal Rigidities

Before proceeding to the next section, we briefly relate our framework to existing results in the literature.

3.1 Information frictions as a source of nominal rigidities

In this standard setting, firms set prices in advance and in the presence of information frictions. Information frictions are a source of price stickiness, as firms cannot fully adjust prices in response to shocks due to limited information (Mankiw and Reis, 2002; Woodford, 2002). More information relaxes nominal rigidities, thereby dampening the effect of demand shocks on output. In the limit, with perfect information, this is an economy without nominal rigidities, as prices adjust frictionlessly in response to shocks. We present the model and derive the policy functions for this case in Appendix A-2.

3.2 Information frictions as a source of real and nominal rigidities

A more general framework considers firms that choose both prices and employment (number of workers) in advance under information frictions (Angeletos et al., 2016). As in our setting, to ensure market clearing, firms can adjust the intensive margin of labor (hours worked) once shocks are observed.

We show that the assumption of real or nominal rigidities is not innocuous. Moreover, whether information frictions are a source of nominal rigidities matters. The results from the baseline model (Section 2) overturn when we consider the possibility that price setting also takes place under imperfect information about shocks. Contrary to results in the baseline model, less information actually *amplifies* the effect of demand shocks on output in this setting. Incorporating both real and nominal rigidities based on information frictions therefore fundamentally alters the transmission of demand shocks. Whereas real rigidities alone dampen the effect of demand shocks on output, the presence of nominal rigidities due to information frictions reverses this result—less information now amplifies the output response. As before, we consider two extreme cases: information frictions and full information.

[5] In general equilibrium, this is confirmed by equation 2.13, which also yields $\hat{\pi}_t > 0$.

[6] Comin et al. (2023) show that cost-push shocks can arise in a setting where firms' pricing decisions internalize occasionally binding capacity constraints. We provide an alternative microfoundation for cost-push shocks in the New Keynesian Phillips Curve, as result of firms' misperceptions of demand.

Price-setting Firms choose their price, $P_{j,t}$, conditional on the signal $S_{j,t}$ in order to maximize

$$\mathbb{E}_t\left[C_t^{-\gamma}\left(P_{j,t}Y_{j,t} - TC_{j,t}^N\right)|S_{j,t}\right],$$

subject to demand for their product, $Y_{j,t} = \left(\frac{P_{j,t}}{P_t}\right)^{-\theta} Y_t$, where $TC_{j,t}^N$ is total cost in nominal terms. The first order condition is

$$\mathbb{E}_t\left[C_t^{-\gamma}Y_{j,t}\left(P_{j,t} - \frac{\theta}{1-\theta}MC_{j,t}^N\right)|S_{j,t}\right] = 0,$$

where $MC_{j,t}^N \equiv \frac{\partial TC_{j,t}^N}{\partial Y_{j,t}}$ is the nominal marginal cost. In real terms,

$$\mathbb{E}_t\left[C_t^{-\gamma}Y_{j,t}\left(\frac{P_{j,t}}{P_t} - \frac{\theta}{\theta-1}MC_{j,t}\right)|S_{j,t}\right] = 0.$$

Log-linearized, this expression is

$$\mathbb{E}_t\left[\left(\left[\hat{p}_{j,t} - \hat{p}_t\right] - \hat{mc}_{j,t}\right)|S_{j,t}\right] = 0.$$

Rearranging, we get firm j's optimality condition, $\hat{p}_{j,t} = \mathbb{E}_t\left[\hat{mc}_{j,t} + \hat{p}_t|S_{j,t}\right]$, where $\hat{mc}_{j,t}$ is the real marginal cost (and $\hat{mc}_{j,t} + \hat{p}_t$ the nominal marginal cost). Subtracting $\hat{p}_{t-1}$ from both sides we obtain

$$\hat{p}_{j,t} - \hat{p}_{t-1} = \mathbb{E}_t\left[\hat{mc}_{j,t} + \hat{\pi}_t|S_{j,t}\right],$$

since $\hat{p}_{t-1} = \mathbb{E}_t\left[\hat{p}_{t-1}|S_{j,t}\right]$. Substituting for marginal cost and summing across firms, we obtain the New Keynesian Phillips curve,

$$\hat{\pi}_t = \mathbb{E}_t\left[\vartheta\hat{w}_t^r + (1-\vartheta)\hat{v}_t^r - a_t + \hat{\pi}_t|S_{j,t}\right].$$

Using the notation for the expected value given the firms' information set,

$$\hat{\pi}_t = \vartheta\hat{w}_{t,t,f}^r + (1-\vartheta)\hat{v}_{t,t,f}^r - a_{t,t,f} + \hat{\pi}_{t,t,f}. \tag{3.1}$$

Model summary Replacing (2.6) with (3.1), the economy is now described by following the system of equations,

$$\begin{aligned}
\hat{w}_t^r &= \gamma\hat{y}_t + \varphi_n\hat{n}_t,\\
\hat{v}_t^r &= \gamma\hat{y}_t + \varphi_h\hat{h}_t,\\
\hat{n}_t &= \hat{v}_{t,t,f}^r - \hat{w}_{t,t,f}^r + \hat{h}_{t,t,f},\\
\hat{\pi}_t &= \vartheta\hat{w}_{t,t,f}^r + (1-\vartheta)\hat{v}_{t,t,f}^r - a_{t,t,f} + \hat{\pi}_{t,t,f},\\
\hat{y}_t &= \hat{a}_t + \vartheta\hat{n}_t + (1-\vartheta)\hat{h}_t,\\
\hat{y}_t &= \hat{y}_{t+1,t,h} - \frac{1}{\gamma}(\hat{i}_t - \hat{\pi}_{t+1,t,h}),\\
\hat{i}_t &= \phi_\pi\hat{\pi}_t + \phi_y\hat{y}_t + z_t.
\end{aligned}$$

Effects of demand shocks When information friction is a source of nominal rigidities, the responses of output, inflation, and the nominal rate are given by

$$\hat{y}_t = -\frac{1}{\gamma + \phi_y}\left(z_t - z_{t,t,f}\right),$$
$$\hat{\pi}_t = -\frac{1}{\phi_\pi} z_{t,t,f},$$
$$\hat{i}_t = \frac{\gamma}{\gamma + \phi_y}\left(z_t - z_{t,t,f}\right).$$

See Appendix A-3.

Proposition 4 *Contrary to the case where information frictions are only a source of real rigidities, when they are also a source of nominal rigidities, information frictions amplify the effect of demand shocks on output and dampen the effect of demand shocks on inflation.*

As before, to understand the effects from providing more information to firms, let's consider two extreme cases, information frictions and full information.

Information frictions In the presence of information frictions, we have $z_{t,t,f} = 0$, hence

$$\hat{y}_t^{IF} = -\frac{1}{\gamma + \phi_y} z_t,$$
$$\hat{\pi}_t^{IF} = 0,$$
$$\hat{i}_t^{IF} = \frac{\gamma}{\gamma + \phi_y} z_t.$$

Suppose the economy is hit by an expansionary monetary shock ($z_t < 0$). Consider the case of full information frictions: firms do not observe the shock, and therefore, do not foresee an increase in aggregate demand. Accordingly, they leave their prices unchanged, so that $\hat{\pi}_t = 0$. Then the effect of the expansionary shock on the nominal rate will be its maximum, i.e., the rate will fall strongly, as there is no increase in inflation to trigger an endogenous response of the policy rate. Given the lack of an endogenous (offsetting) response of the policy rate, the expansionary effect of the shock on output will be the maximum as well.

Full information Under full information, we have $z_{t,t,f} = z_t$, hence

$$\hat{y}_t^{FI} = 0,$$
$$\hat{\pi}_t^{FI} = -\frac{1}{\phi_\pi} z_t,$$
$$\hat{i}_t^{FI} = 0.$$

Prices are fully flexible in this setting, so firms will increase prices strongly in response to the expansionary shock. The endogenous component of monetary policy will respond to the surge in inflation to fully offset the expansionary effect of the monetary policy shock.

Discussion When information frictions are a source of nominal rigidities, the degree of nominal rigidities depends on the extent of informational rigidities and labor input decisions remain unresponsive to perceived shocks. To build intuition, consider a demand shock under full information frictions. If information frictions completely limit the pass-through of the demand shock to prices, then inflation is zero. Relative to the full information case, the pass-through of demand shocks to output will be at its maximum, since there is no increase in inflation to trigger an endogenous response of monetary policy. Consequently, monetary policy does not offset the effect of the demand shock on output.[7] In summary, if information frictions are also a source of nominal rigidities, less information increases nominal rigidities, amplifying the real effects of demand shocks. When nominal rigidities are present, real rigidities become irrelevant.

Therefore, in the Angeletos et al. (2016) setting, real rigidities do not meaningfully alter the macroeconomic response to demand shocks. As in the case of nominal rigidities alone, information frictions are the source of price stickiness, and more information reduces these rigidities, diminishing the effect of demand shocks on output. In the limit with perfect information, nominal rigidities disappear.

Proposition 5 (The irrelevance of real rigidities) *When information frictions are a source of nominal rigidities, the introduction of real rigidities is irrelevant.*

To see this, notice that in a model with information frictions as a source of both nominal and real rigidities and a model with information frictions only as a source of nominal rigidities, inflation is the same, and given by $\hat{\pi}_t = -\frac{1}{\phi_\pi} z_{t,t,f}$, while the Euler equation and the Taylor rule are also the equal in both models, as information frictions do not affect these relations.[8] It follows that the dynamics of output, inflation and the policy rate after a shock will coincide in both models, making the presence of real information frictions inconsequential.[9] The reason for this result is that the price-setting behavior of firms is the same in both cases, meaning that regardless of the presence of real frictions, firms will make the same pricing decisions. Given an identical response of inflation, the policy rate and output (determined by the Taylor rule and the IS) will react equally as well.

In summary, if both real and nominal rigidities are present, and information frictions are the source of both rigidities, then less information increases nominal rigidities, amplifying the real effects of demand shocks. When nominal rigidities are present, real rigidities become irrelevant, as firms' inability to adjust prices dominates the transmission mechanism. This finding highlights the importance of considering both real and nominal rigidities and their microfoundations when assessing the effects of information frictions on macroeconomic fluctuations and the efficacy of policy.

The key takeaway from Proposition 5 is that when the extent of nominal rigidities and the degree of information frictions vary simultaneously, it is difficult to isolate the effect of information frictions on real rigidity. This occurs because existing frameworks equate informational frictions with nominal rigidities, treating them primarily as a constraint on price flexibility. Even in the presence of real rigidities, whereby firms make real input decisions subject to informational constraints, the impact on real inputs such as employment remain the same regardless of the degree of informational frictions. In contrast, the baseline model in Section 2 allows us to isolate the effect of information frictions, by varying the degree of information frictions while keeping the degree of nominal rigidities fixed, leading to different policy tradeoffs and implications.

[7] Under full information, the pass-through of demand shocks to prices is at its maximum, as prices adjust fully in response to a demand shock. The endogenous response of monetary policy to inflation then counteracts the effect of the demand shock on output.

[8] See Appendix A-2 for a model only nominal information frictions.

[9] Real information frictions do matter for the behavior of other variables in the model.

4 Conclusion

This paper studies how information frictions and production adjustment constraints shape the macroeconomic response to supply and demand shocks. While workhorse models for policy analysis often abstract from these frictions, recent inflationary dynamics highlight their importance. We develop a model where (i) firms choose production inputs with incomplete information about shocks and (ii) they may be restricted in how effectively they can adjust their production inputs once shocks are realized.

A key contribution of this paper is to show that the transmission of shocks to macroeconomic outcomes depends on modeling assumptions that are often treated as secondary but have significant policy implications. We show how real and nominal rigidities interact in ways that are crucial for understanding the transmission of shocks. In our framework, when firms must commit to input decisions before shocks are realized, they rely on ex-post adjustments which can drive up marginal costs and inflation. As a result, expansionary monetary policy may primarily fuel inflation rather than output growth, prompting a contractionary response that offsets the initial expansion. This mechanism effectively steepens the New Keynesian Phillips curve, amplifying the response of inflation to demand shocks while dampening the effect on output.

We also show that when firms misperceive future demand, this can affect the natural level of output in a way that is observationally equivalent to a supply shock. Specifically, expectations about demand influence firms' labor input choices, which determine natural output. These dynamics enter the New Keynesian Phillips Curve analogously to a cost-push shock. The presence of information frictions can complicate the distinction between demand- and supply-driven fluctuations.

The effectiveness of policies to stimulate demand depend on firms' ability to adjust supply capacity. Clear policy communication is essential for allowing firms to anticipate and respond to changes in demand. If firms are aware of expansionary policy, they can adjust production capacity in advance, mitigating inflationary pressures. Otherwise, if information frictions impede adjustment, firms may only increase production through the intensive margin of labor, with diminishing returns and rising marginal costs. As a result, expansionary monetary policy passes primarily into inflation rather than output, prompting an endogenous monetary policy response that offsets the initial expansion.

Conversely, while the provision of information dampens the response of inflation to demand shocks, it introduces more volatility to output. The more firms are able to increase supply capacity to accommodate demand, the less is the pass-through of demand shocks to inflation. The endogenous response of monetary policy is less contractionary, which means that the demand shock is not offset (or offset less) by policy, and passes through more fully to output. These dynamics are in contrast to standard models that assume information frictions are the source of nominal rigidities. Instead, we show that whether information frictions affect production decisions, pricing decisions, or both fundamentally alters the transmission of shocks, which affects the tradeoffs for policymakers and the optimal conduct of monetary policy.

Some extensions of our framework warrant further research. First, a quantitative assessment could evaluate whether standard models generate sufficient amplification to explain observed inflationary trends, particularly in cases where demand shocks appear too large relative to inflation responses. Additionally, empirical validation using firm-level data could provide more insight into the interaction between real and nominal rigidities.

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A-1 Baseline model

We provide details for the derivations in Section 2. The system of equations describing the economy is given by

$$
\begin{aligned}
\hat{w}^r_t &= \gamma \hat{y}_t + \varphi \hat{n}_t, \\
\hat{v}^r_t &= \gamma \hat{y}_t + \varphi \hat{h}_t, \\
\hat{n}_t &= \hat{v}^r_{t,t,f} - \hat{w}^r_{t,t,f} + \hat{h}_{t,t,f}, \\
\hat{\pi}_t &= \beta \hat{\pi}_{\bar{t},t+1,f} + \lambda_p \left(\hat{v}^r_t + \frac{\vartheta}{1-\vartheta} (\hat{y}_t - \hat{n}_t) - \frac{1}{1-\vartheta} a_t \right), \\
\hat{y}_t &= \vartheta \hat{n}_t + (1-\vartheta) \hat{h}_t, \\
\hat{y}_t &= \hat{y}_{t+1,t,h} - \frac{1}{\gamma} (\hat{i}_t - \hat{\pi}_{t+1,t,h}), \\
\hat{i}_t &= \phi_\pi \hat{\pi}_t + \phi_y \hat{y}_t + z_t.
\end{aligned}
$$

where $\hat{x}_{t+k,t,h}$ denotes the expected value of variable $\hat{x}_{t+k}$ given households' information set at time t, while $\hat{x}_{t+k,t,f}$ is the corresponding expectation conditioned on the information set of firms. Assuming no shock persistence, this system simplifies to

$$
\begin{aligned}
\hat{w}^r_t &= \gamma \hat{y}_t + \varphi \hat{n}_t, \\
\hat{v}^r_t &= \gamma \hat{y}_t + \varphi \hat{h}_t, \\
\hat{n}_t &= \hat{v}^r_{t,t,f} - \hat{w}^r_{t,t,f} + \hat{h}_{t,t,f}, \\
\hat{\pi}_t &= \lambda_p \left(\hat{v}^r_t + \frac{\vartheta}{1-\vartheta} (\hat{y}_t - \hat{n}_t) - \frac{1}{1-\vartheta} a_t \right), \\
\hat{y}_t &= \vartheta \hat{n}_t + (1-\vartheta) \hat{h}_t, \\
\hat{y}_t &= -\frac{1}{\gamma} \hat{i}_t, \\
\hat{i}_t &= \phi_\pi \hat{\pi}_t + \phi_y \hat{y}_t + z_t.
\end{aligned}
$$

Taking expectations based on firms' information set,

$$
\begin{aligned}
\hat{w}^r_{t,t,f} &= \gamma \hat{y}_{t,t,f} + \varphi \hat{n}_{t,t,f}, \\
\hat{v}^r_{t,t,f} &= \gamma \hat{y}_{t,t,f} + \varphi \hat{h}_{t,t,f}, \\
\hat{n}_{t,t,f} &= \hat{v}^r_{t,t,f} - \hat{w}^r_{t,t,f} + \hat{h}_{t,t,f}, \\
\hat{\pi}_{t,t,f} &= \lambda_p \left(\hat{v}^r_{t,t,f} + \frac{\vartheta}{1-\vartheta} \left(\hat{y}_{t,t,f} - \hat{n}_{t,t,f} \right) \right), \\
\hat{y}_{t,t,f} &= \vartheta \hat{n}_{t,t,f} + (1-\vartheta) \hat{h}_{t,t,f}, \\
\hat{y}_{t,t,f} &= -\frac{1}{\gamma} \hat{i}_{t,t,f}, \\
\hat{i}_{t,t,f} &= \phi_\pi \hat{\pi}_{t,t,f} + \phi_y \hat{y}_{t,t,f} + z_{t,t,f}.
\end{aligned}
$$

Solving for $\hat{n}_{t,t,f}$

$$
\hat{n}_{t,t,f} = -\frac{1}{\gamma} \frac{1}{1 + \frac{1}{\gamma} \phi_\pi \lambda_p (\gamma + \varphi) + \frac{1}{\gamma} \phi_y} z_{t,t,f}.
$$

Since $\hat{n}_t = \hat{n}_{t,t,f}$ we have

$$\hat{n}_t = -\frac{1}{\gamma}\frac{1}{1+\frac{1}{\gamma}\phi_\pi\lambda_p(\gamma+\varphi)+\frac{1}{\gamma}\phi_y}z_{t,t,f}.$$

Output We derive an expression for $\hat{y}_t$, in the case of full information and information frictions (2.14 and 2.15). To obtain the realized variables, we solve the following system of equations

$$\begin{aligned}
\hat{w}^r_t &= \gamma\hat{y}_t + \varphi\hat{n}_t,\\
\hat{v}^r_t &= \gamma\hat{y}_t + \varphi\hat{h}_t,\\
\hat{n}_t &= \hat{n}_{t,t,f},\\
\hat{\pi}_t &= \lambda_p\left(\hat{v}^r_t + \frac{\vartheta}{1-\vartheta}(\hat{y}_t - \hat{n}_t)\right),\\
\hat{y}_t &= \vartheta\hat{n}_t + (1-\vartheta)\hat{h}_t,\\
\hat{y}_t &= -\frac{1}{\gamma}\hat{i}_t,\\
\hat{i}_t &= \phi_\pi\hat{\pi}_t + \phi_y\hat{y}_t + z_t.
\end{aligned}$$

Solving for output,

$$\hat{y}_t = \frac{1}{\gamma}\frac{1}{1+\frac{1}{\gamma}\phi_\pi\lambda_p\left(\gamma+\frac{\varphi+\vartheta}{1-\vartheta}\right)+\frac{1}{\gamma}\phi_y}\left(\phi_\pi\lambda_p(1+\varphi)\frac{\vartheta}{1-\vartheta}\hat{n}_{t,t,f} - z_t\right).$$

Since $\hat{n}_{t,t,f} = -\frac{1}{\gamma}\frac{1}{1+\frac{1}{\gamma}\phi_\pi\lambda_p(\gamma+\varphi)+\frac{1}{\gamma}\phi_y}z_{t,t,f}$, we have the policy function for output,

$$\hat{y}_t = -\frac{1}{\gamma}\frac{1}{1+\frac{1}{\gamma}\phi_\pi\lambda_p\left(\gamma+\frac{\varphi+\vartheta}{1-\vartheta}\right)+\frac{1}{\gamma}\phi_y}\left(\phi_\pi\lambda_p(1+\varphi)\frac{\vartheta}{1-\vartheta}\frac{1}{\gamma}\frac{1}{1+\frac{1}{\gamma}\phi_\pi\lambda_p(\gamma+\varphi)+\frac{1}{\gamma}\phi_y}z_{t,t,f} + z_t\right). \tag{A-1.1}$$

To understand output dynamics, consider two extreme cases, full information and information frictions. Under full information, $z_{t,t,f} = z_t$, hence (A-1.1) becomes

$$\hat{y}^{FI}_t = -\frac{1}{\gamma}\frac{1}{1+\frac{1}{\gamma}\phi_\pi\lambda_p(\gamma+\varphi)+\frac{1}{\gamma}\phi_y}z_t.$$

Under full information frictions, $z_{t,t,f} = 0$, hence (A-1.1) becomes

$$\hat{y}^{IF}_t = -\frac{1}{\gamma}\frac{1}{1+\frac{1}{\gamma}\phi_\pi\lambda_p\left(\gamma+\frac{\varphi+\vartheta}{1-\vartheta}\right)+\frac{1}{\gamma}\phi_y}z_t.$$

We can see that with full information, output is more responsive than under information frictions, meaning that more information *amplifies* the effect of demand shocks.

Inflation The dynamics of output can be explained by the response of inflation. To see this recall inflation is given by

$$\hat{\pi}_t = \lambda_p\left(\hat{v}^r_t + \frac{\vartheta}{1-\vartheta}(\hat{y}_t - \hat{n}_t)\right).$$

From the hours supply equation ($\hat{v}^r_t = \gamma\hat{y}_t + \varphi\hat{h}_t$) and the production function ($\hat{y}_t = \vartheta\hat{n}_t + (1-\vartheta)\hat{h}_t$), we have $\hat{v}^r_t = \gamma\hat{y}_t + \frac{\varphi}{1-\vartheta}(\hat{y}_t - \vartheta\hat{n}_t)$, which plugged in the Phillips curve yields

$$\hat{\pi}_t = \lambda_p \left(\left(\gamma + \frac{\varphi + \vartheta}{1 - \vartheta} \right) \hat{y}_t - (1 + \varphi) \frac{\vartheta}{1 - \vartheta} \hat{n}_t \right). \tag{A-1.2}$$

Substituting output and labor,

$$\begin{aligned}\hat{\pi}_t = \lambda_p \Bigg(& - \left(\gamma + \frac{\varphi + \vartheta}{1 - \vartheta} \right) \cdot \frac{1}{\gamma} \cdot \frac{1}{1 + \frac{1}{\gamma}\phi_\pi \lambda_p \left(\gamma + \frac{\varphi+\vartheta}{1-\vartheta} \right) + \frac{1}{\gamma}\phi_y} \\ & \cdot \left(\frac{\frac{1}{\gamma}\phi_\pi \lambda_p (1+\varphi) \frac{\vartheta}{1-\vartheta}}{1 + \frac{1}{\gamma}\phi_\pi \lambda_p (\gamma + \varphi) + \frac{1}{\gamma}\phi_y} z_{t,t,f} + z_t \right) \\ & + (1+\varphi) \cdot \frac{\vartheta}{1-\vartheta} \cdot \frac{1}{\gamma} \cdot \frac{1}{1 + \frac{1}{\gamma}\phi_\pi \lambda_p (\gamma + \varphi) + \frac{1}{\gamma}\phi_y} z_{t,t,f}. \Bigg)\end{aligned}$$

Rearranging,

$$\begin{aligned}\hat{\pi}_t = \lambda_p \Bigg(& - \frac{\frac{1}{\gamma}\left(\gamma + \frac{\varphi+\vartheta}{1-\vartheta} \right)}{1 + \frac{1}{\gamma}\phi_\pi \lambda_p \left(\gamma + \frac{\varphi+\vartheta}{1-\vartheta} \right) + \frac{1}{\gamma}\phi_y} z_t \\ & + \left(1 - \frac{\frac{1}{\gamma}\phi_\pi \lambda_p \left(\gamma + \frac{\varphi+\vartheta}{1-\vartheta} \right)}{1 + \frac{1}{\gamma}\phi_\pi \lambda_p \left(\gamma + \frac{\varphi+\vartheta}{1-\vartheta} \right) + \frac{1}{\gamma}\phi_y} \right) \\ & \cdot \frac{1}{\gamma}(1+\varphi) \cdot \frac{\vartheta}{1-\vartheta} \cdot \frac{1}{1 + \frac{1}{\gamma}\phi_\pi \lambda_p (\gamma + \varphi) + \frac{1}{\gamma}\phi_y} z_{t,t,f}. \Bigg)\end{aligned}$$

Since the coefficients in front of z_t and $z_{t,t,f}$ have opposing signs, the realized shock will have a dampened effect on inflation. In particular, suppose the central bank implements expansionary monetary policy ($z_t < 0$). If the shock is not observed ($z_{t,t,f} = 0$), the rise in inflation will be at its maximum. If the shock is observed, ($z_{t,t,f} < 0$) the rise in inflation will be dampened. The effect of information on inflation explains its effect on output: since information dampens the response of inflation to demand shocks, it amplifies the response of output.

Tradeoffs To understand the effect of information on inflation, consider the New Keynesian Phillips curve under full information and information frictions (2.17 and 2.18),

$$\hat{\pi}_t = \lambda_p \left(\hat{v}_t^r + \frac{\vartheta}{1-\vartheta} (\hat{y}_t - \hat{n}_t) \right).$$

Using $\hat{v}_t^r = \gamma \hat{y}_t + \varphi \hat{h}_t$,

$$\hat{\pi}_t = \lambda_p \left(\gamma \hat{y}_t + \varphi \hat{h}_t + \frac{\vartheta}{1-\vartheta} (\hat{y}_t - \hat{n}_t) \right).$$

Since $\hat{n}_t = \hat{n}_{t,t,f}$, this implies

$$\hat{\pi}_t = \lambda_p \left(\gamma \hat{y}_t + \varphi \hat{h}_t + \frac{\vartheta}{1-\vartheta} \left(\hat{y}_t - \hat{n}_{t,t,f} \right) \right).$$

We have seen that $\frac{\partial \hat{n}_{t,t,f}}{\partial z_{t,t,f}} < 0$. Suppose the policymaker implements $z_t < 0$. The more informed firms are about the shock, the more labor they hire (the stronger the rise in $\hat{n}_t = \hat{n}_{t,t,f}$ is), hence the less inflation rises. This happens because the higher $\hat{n}_t$ is, the less severe are the effects of the decreasing returns to hours on the marginal cost of firms.

To further explore the effect of information on the New Keynesian Phillips curve, consider two extreme information scenarios: full information and information frictions. The New Keynesian Phillips curve becomes

$$\hat{\pi}_t = \lambda_p \left(\gamma \hat{y}_t + \frac{\vartheta}{1-\vartheta} \left(\hat{y}_t - \hat{n}_{t,t,f} \right) \right).$$

Under full information, $\hat{n}_{t,t,f} = \hat{n}_t = \hat{y}_t$, hence

$$\begin{aligned}
\hat{\pi}_t^{FI} &= \lambda_p \left(\left(\gamma + \frac{\varphi+\vartheta}{1-\vartheta} - (1+\varphi) \frac{\vartheta}{1-\vartheta} \right) \hat{y}_t \right), \\
\hat{\pi}_t^{FI} &= \lambda_p \left(\left(\gamma + \frac{\varphi+\vartheta-(1+\varphi)\vartheta}{1-\vartheta} \right) \hat{y}_t \right), \\
\hat{\pi}_t^{FI} &= \lambda_p \left(\left(\gamma + \frac{\varphi-\varphi\vartheta}{1-\vartheta} \right) \hat{y}_t \right), \\
\hat{\pi}_t^{FI} &= \lambda_p (\gamma+\varphi) \hat{y}_t.
\end{aligned}$$

Under information frictions, we have $\hat{n}_t = \hat{n}_{t,t,f} = 0$, hence

$$\hat{\pi}_t^{IF} = \lambda_p \left(\gamma + \frac{\varphi+\vartheta}{1-\vartheta} \right) \hat{y}_t.$$

These two extreme cases show that information frictions increases the slope of the Phillips curve. As noted, this occurs because $\hat{n}_t$ is unresponsive to shocks in the presence of information frictions. Changes in output can therefore only be achieved by adjusting the intensive margin of labor, $\hat{h}_t$. Decreasing returns, derived from the possibility of adjusting just one factor, lead to large variations in costs, and hence inflation, in response to output variations. Therefore, a greater degree of information frictions is equivalent to having more flexible prices. This leads to demand shocks having an amplified effect on inflation and as a result, a dampened effect on output.

Efficient output The optimal allocation maximizes households' utility is given by

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{C_t^{1-\gamma}}{1-\gamma} - \frac{N_t^{1+\varphi}}{1+\varphi} - \frac{H_t^{1+\varphi}}{1+\varphi} \right),$$

subject to the resource constraint

$$C_t = N_t^{\vartheta} H_t^{1-\vartheta},$$

where N_t is given. Maximization with respect to H_t implies

$$C_t^{-\gamma} N_t^{\vartheta} (1-\vartheta) H_t^{-\vartheta} - H_t^{\varphi} = 0.$$

Since $C_t = Y_t$, we have

$$Y_t^{-\gamma} N_t^{\vartheta} (1-\vartheta) H_t^{-\vartheta} - H_t^{\varphi} = 0.$$

Rearranging and log-linearizing, we obtain

$$\begin{aligned}
(1-\vartheta) Y_t^{-\gamma} N_t^{\vartheta} &= H_t^{\varphi+\vartheta}, \\
-\gamma \hat{y}_t + \vartheta \hat{n}_t &= (\varphi+\vartheta) \hat{h}_t.
\end{aligned}$$

Using the production function ($\hat{y}_t = \vartheta \hat{n}_t + (1-\vartheta)\hat{h}_t$), we obtain

$$-\gamma \hat{y}_t + \vartheta \hat{n}_t = \frac{\varphi + \vartheta}{1-\vartheta} \left(\hat{y}_t - \vartheta \hat{n}_t \right).$$

Rearranging,

$$\hat{y}_t = \frac{\vartheta(1+\varphi)}{\vartheta + (1-\vartheta)\gamma + \varphi} \hat{n}_t.$$

A-2 Information frictions as a source of nominal rigidities only

We provide more detail for the derivations in Section 3. The economy is described by the following system of equations,

$$\begin{aligned}
\hat{w}_t^r &= \gamma \hat{y}_t + \varphi_n \hat{n}_t, \\
\hat{v}_t^r &= \gamma \hat{y}_t + \varphi_h \hat{h}_t, \\
\hat{n}_t &= \hat{v}_t^r - \hat{w}_t^r + \hat{h}_t, \\
\hat{\pi}_t &= \vartheta \hat{w}_{t,t,f}^r + (1-\vartheta)\hat{v}_{t,t,f}^r - a_{t,t,f} + \hat{\pi}_{t,t,f}, \\
\hat{y}_t &= \hat{a}_t + \vartheta \hat{n}_t + (1-\vartheta)\hat{h}_t, \\
\hat{y}_t &= \hat{y}_{t+1,t,h} - \frac{1}{\gamma}(\hat{i}_t - \hat{\pi}_{t+1,t,h}), \\
\hat{i}_t &= \phi_\pi \hat{\pi}_t + \phi_y \hat{y}_t + z_t.
\end{aligned}$$

Assuming no shock persistence,

$$\begin{aligned}
\hat{w}_t^r &= \gamma \hat{y}_t + \varphi_n \hat{n}_t, \\
\hat{v}_t^r &= \gamma \hat{y}_t + \varphi_h \hat{h}_t, \\
\hat{n}_t &= \hat{v}_t^r - \hat{w}_t^r + \hat{h}_t, \\
\hat{\pi}_t &= \vartheta \hat{w}_{t,t,f}^r + (1-\vartheta)\hat{v}_{t,t,f}^r - a_{t,t,f} + \hat{\pi}_{t,t,f}, \\
\hat{y}_t &= \hat{a}_t + \vartheta \hat{n}_t + (1-\vartheta)\hat{h}_t, \\
\hat{y}_t &= -\frac{1}{\gamma}\hat{i}_t, \\
\hat{i}_t &= \phi_\pi \hat{\pi}_t + \phi_y \hat{y}_t + z_t.
\end{aligned}$$

Taking expectations based on firms information set and assuming only monetary policy shocks,

$$\begin{aligned}
\hat{w}_{t,t,f}^r &= \gamma \hat{y}_{t,t,f} + \varphi_n \hat{n}_{t,t,f}, \\
\hat{v}_{t,t,f}^r &= \gamma \hat{y}_{t,t,f} + \varphi_h \hat{h}_{t,t,f}, \\
\hat{n}_{t,t,f} &= \hat{v}_{t,t,f}^r - \hat{w}_{t,t,f}^r + \hat{h}_{t,t,f}, \\
0 &= \vartheta \hat{w}_{t,t,f}^r + (1-\vartheta)\hat{v}_{t,t,f}^r, \\
\hat{y}_{t,t,f} &= \vartheta \hat{n}_{t,t,f} + (1-\vartheta)\hat{h}_{t,t,f}, \\
\hat{y}_{t,t,f} &= -\frac{1}{\gamma}\hat{i}_{t,t,f}, \\
\hat{i}_{t,t,f} &= \phi_\pi \hat{\pi}_{t,t,f} + \phi_y \hat{y}_{t,t,f} + z_{t,t,f}.
\end{aligned}$$

Note that the first six equations are a homogeneous system that solve for $\hat{y}_{t,t,f}$, $\hat{n}_{t,t,f}$, $\hat{h}_{t,t,f}$, $\hat{w}_{t,t,f}^r$, $\hat{v}_{t,t,f}^r$ and $\hat{i}_{t,t,f}^r$. This implies $\hat{y}_{t,t,f} = 0$, $\hat{n}_{t,t,f} = 0$, $\hat{h}_{t,t,f} = 0$, $\hat{w}_{t,t,f} = 0$, $\hat{v}_{t,t,f} = 0$, $\hat{i}_{t,t,f} = 0$. Expected inflation is therefore

$$\hat{\pi}_{t,t,f} = -\frac{1}{\phi_\pi} z_{t,t,f},$$

while realized inflation is

$$\hat{\pi}_t = -\frac{1}{\phi_\pi} z_{t,t,f}.$$

Combining the Euler and the Taylor equations to solve for output,

$$\hat{y}_t = -\frac{1}{\gamma}\left(\phi_\pi \hat{\pi}_t + \phi_y \hat{y}_t + z_t\right).$$

Rearranging,

$$\hat{y}_t = -\frac{1}{\gamma + \phi_y}\left(\phi_\pi \hat{\pi}_t + z_t\right).$$

Substituting for inflation, output is given by

$$\hat{y}_t = -\frac{1}{\gamma + \phi_y}\left(z_t - z_{t,t,f}\right).$$

The nominal rate is then

$$\hat{i}_t = -z_{t,t,f} - \frac{\phi_y}{\gamma + \phi_y}\left(z_t - z_{t,t,f}\right) + z_t.$$

Rearranging,

$$\hat{i}_t = \frac{\gamma}{\gamma + \phi_y}\left(z_t - z_{t,t,f}\right).$$

For Proposition 3.2, note that the policy functions for output, inflation and the nominal rate are the same as in the model where information frictions are a source of both real and nominal rigidities (see Appendix A-3).

Using the labor and hours supply equations we get $\hat{v}_t^r - \hat{w}_t^r = \varphi_h \hat{h}_t - \varphi_n \hat{n}_t$, which combined with labor supply ($\hat{n}_t = \hat{v}_t^r - \hat{w}_t^r + \hat{h}_t$) yields

$$\hat{n}_t = \varphi_h \hat{h}_t - \varphi_n \hat{n}_t + \hat{h}_t,$$

or

$$\hat{h}_t = \frac{1 + \varphi_n}{1 + \varphi_h} \hat{n}_t.$$

Combining with the production function yields

$$\hat{y}_t = \hat{a}_t + \vartheta\hat{n}_t + (1-\vartheta)\frac{1+\varphi_n}{1+\varphi_h}\hat{n}_t,$$
$$\hat{y}_t = \hat{a}_t + \frac{\vartheta(1+\varphi_h)+(1-\vartheta)(1+\varphi_n)}{1+\varphi_h}\hat{n}_t,$$
$$\hat{n}_t = \frac{1+\varphi_h}{\vartheta(1+\varphi_h)+(1-\vartheta)(1+\varphi_n)}(\hat{y}_t - \hat{a}_t),$$
$$\hat{n}_t = -\frac{1+\varphi_h}{\vartheta(1+\varphi_h)+(1-\vartheta)(1+\varphi_n)}\left(\frac{1}{\gamma+\phi_y}\left(z_t - z_{t,t,f}\right)+\hat{a}_t\right).$$

Factor $\hat{h}_t$ is given by

$$\hat{h}_t = \frac{1+\varphi_n}{1+\varphi_h}\hat{n}_t,$$
$$\hat{h}_t = -\frac{1+\varphi_n}{\vartheta(1+\varphi_h)+(1-\vartheta)(1+\varphi_n)}\left(\frac{1}{\gamma+\phi_y}\left(z_t - z_{t,t,f}\right)+\hat{a}_t\right).$$

A-3 Information frictions as a source of real and nominal rigidities

This section provides more detail for the derivations in Section 3.

Price setting Firms chose their price $P_{j,t}$, to maximize

$$\mathbb{E}_t\left[C_t^{-\gamma}\left(P_{j,t}Y_{j,t} - TC_{j,t}^N\right)|S_{j,t}\right],$$

subject to demand for their good, $Y_{j,t} = \left(\frac{P_{j,t}}{P_t}\right)^{-\theta} Y_t$ and where $TC_{j,t}^N$ is total cost in nominal terms. The first order condition is

$$\mathbb{E}_t\left[C_t^{-\gamma}\left(Y_{j,t} - \theta P_{j,t}\left(\frac{P_{j,t}}{P_t}\right)^{-\theta} P_{j,t}^{-1}Y_t + \frac{\partial TC_{j,t}^N}{\partial Y_{j,t}}\frac{\partial Y_{j,t}}{\partial P_{j,t}}\right)|S_{j,t}\right] = 0,$$
$$\mathbb{E}_t\left[C_t^{-\gamma}\left(Y_{j,t} - \theta Y_{j,t} + \partial Y_{j,t} - \theta MC_{j,t}^N\left(\frac{P_{j,t}}{P_t}\right)^{-\theta} P_{j,t}^{-1}Y_t\right)|S_{j,t}\right] = 0,$$

where $MC_{j,t}^N \equiv \frac{\partial TC_{j,t}^N}{\partial Y_{j,t}}$ is the nominal marginal cost.

$$\mathbb{E}_t\left[C_t^{-\gamma}\left(Y_{j,t} - \theta Y_{j,t} - \theta MC_{j,t}^N P_{j,t}^{-1} Y_{j,t}\right)\Big|S_{j,t}\right] = 0,$$
$$\mathbb{E}_t\left[C_t^{-\gamma}Y_{j,t}\left(1-\theta-\theta MC_{j,t}^N P_{j,t}^{-1}\right)\Big|S_{j,t}\right] = 0,$$
$$\mathbb{E}_t\left[C_t^{-\gamma}Y_{j,t}\left((1-\theta)P_{j,t}-\theta MC_{j,t}^N\right)\Big|S_{j,t}\right] = 0,$$
$$\mathbb{E}_t\left[C_t^{-\gamma}Y_{j,t}\left(P_{j,t}-\frac{\theta}{1-\theta}MC_{j,t}^N\right)\Big|S_{j,t}\right] = 0.$$

In real terms,

$$\mathbb{E}_t\left[C_t^{-\gamma}Y_{j,t}\left(\frac{P_{j,t}}{P_t}-\frac{\theta}{\theta-1}MC_{j,t}\right)|S_{j,t}\right] = 0.$$

Log-linearized,

$$\mathbb{E}_t\left[\left((\hat{p}_{j,t}-\hat{p}_t)-\hat{mc}_{j,t}\right)|S_{j,t}\right]=0.$$

Rearranging, we obtain firms' optimality condition,

$$\hat{p}_{j,t}=\mathbb{E}_t\left[\hat{mc}_{j,t}+\hat{p}_t|S_{j,t}\right],$$

where $\hat{mc}_{j,t}$ is the real marginal cost and $\hat{mc}_{j,t}+\hat{p}_t$ is the nominal marginal cost). Subtracting $\hat{p}_{t-1}$ from both sides yields

$$\hat{p}_{j,t}-\hat{p}_{t-1}=\mathbb{E}_t\left[\hat{mc}_{j,t}+\hat{\pi}_t|S_{j,t}\right],$$

since $\hat{p}_{t-1}=\mathbb{E}_t\left[\hat{p}_{t-1}|S_{j,t}\right]$. Substituting the marginal cost and adding across firms,

$$\hat{\pi}_t=\mathbb{E}_t\left[\vartheta\hat{w}^r_t+(1-\vartheta)\hat{v}^r_t-a_t+\hat{\pi}_t|S_{j,t}\right].$$

Model summary The economy is described by the following system of equations

$$\begin{aligned}
\hat{w}^r_t &= \gamma\hat{y}_t+\varphi\hat{n}_t,\\
\hat{v}^r_t &= \gamma\hat{y}_t+\varphi\hat{h}_t,\\
\hat{n}_t &= \hat{v}^r_{t,t,f}-\hat{w}^r_{t,t,f}+\hat{h}_{t,t,f},\\
\hat{\pi}_t &= \vartheta\hat{w}^r_{t,t,f}+(1-\vartheta)\hat{v}^r_{t,t,f}-a_{t,t,f}+\hat{\pi}_{t,t,f},\\
\hat{y}_t &= \hat{a}_t+\vartheta\hat{n}_t+(1-\vartheta)\hat{h}_t,\\
\hat{y}_t &= \hat{y}_{t+1,t,h}-\frac{1}{\gamma}(\hat{i}_t-\hat{\pi}_{t+1,t,h}),\\
\hat{i}_t &= \phi_\pi\hat{\pi}_t+\phi_y\hat{y}_t+z_t.
\end{aligned}$$

Assuming no shock persistence,

$$\begin{aligned}
\hat{w}^r_t &= \gamma\hat{y}_t+\varphi\hat{n}_t,\\
\hat{v}^r_t &= \gamma\hat{y}_t+\varphi\hat{h}_t,\\
\hat{n}_t &= \hat{v}^r_{t,t,f}-\hat{w}^r_{t,t,f}+\hat{h}_{t,t,f},\\
\hat{\pi}_t &= \vartheta\hat{w}^r_{t,t,f}+(1-\vartheta)\hat{v}^r_{t,t,f}-a_{t,t,f}+\hat{\pi}_{t,t,f},\\
\hat{y}_t &= \hat{a}_t+\vartheta\hat{n}_t+(1-\vartheta)\hat{h}_t,\\
\hat{y}_t &= -\frac{1}{\gamma}\hat{i}_t,\\
\hat{i}_t &= \phi_\pi\hat{\pi}_t+\phi_y\hat{y}_t+z_t.
\end{aligned}$$

Taking expectations based on firms information set and assuming only monetary policy shocks,

$$\begin{aligned}
\hat{w}^r_{t,t,f} &= \gamma\hat{y}_{t,t,f}+\varphi\hat{n}_{t,t,f},\\
\hat{v}^r_{t,t,f} &= \gamma\hat{y}_{t,t,f}+\varphi\hat{h}_{t,t,f},\\
\hat{n}_{t,t,f} &= \hat{v}^r_{t,t,f}-\hat{w}^r_{t,t,f}+\hat{h}_{t,t,f},\\
0 &= \vartheta\hat{w}^r_{t,t,f}+(1-\vartheta)\hat{v}^r_{t,t,f},\\
\hat{y}_{t,t,f} &= \vartheta\hat{n}_{t,t,f}+(1-\vartheta)\hat{h}_{t,t,f},\\
\hat{y}_{t,t,f} &= -\frac{1}{\gamma}\hat{i}_{t,t,f},\\
\hat{i}_{t,t,f} &= \phi_\pi\hat{\pi}_{t,t,f}+\phi_y\hat{y}_{t,t,f}+z_{t,t,f}.
\end{aligned}$$

Note that the first six equations are a homogeneous system that solve for $\hat{y}_{t,t,f}$, $\hat{n}_{t,t,f}$, $\hat{h}_{t,t,f}$, $\hat{w}^r_{t,t,f}$, $\hat{v}^r_{t,t,f}$ and $\hat{i}^r_{t,t,f}$. This implies $\hat{y}_{t,t,f} = 0$, $\hat{n}_{t,t,f} = 0$, $\hat{h}_{t,t,f} = 0$, $\hat{w}_{t,t,f} = 0$, $\hat{v}_{t,t,f} = 0$, $\hat{i}_{t,t,f} = 0$. Expected inflation is therefore

$$\hat{\pi}_{t,t,f} = -\frac{1}{\phi_\pi} z_{t,t,f}.$$

Realized inflation is then

$$\hat{\pi}_t = -\frac{1}{\phi_\pi} z_{t,t,f}.$$

Combining the Euler equation and the Taylor equation to solve for output,

$$\hat{y}_t = -\frac{1}{\gamma}\left(\phi_\pi \hat{\pi}_t + \phi_y \hat{y}_t + z_t\right).$$

Rearranging,

$$\hat{y}_t = -\frac{1}{\gamma + \phi_y}\left(\phi_\pi \hat{\pi}_t + z_t\right).$$

Substituting inflation, output is given by

$$\hat{y}_t = -\frac{1}{\gamma + \phi_y}\left(z_t - z_{t,t,f}\right).$$

The nominal rate is then

$$\hat{i}_t = -z_{t,t,f} - \frac{\phi_y}{\gamma + \phi_y}\left(z_t - z_{t,t,f}\right) + z_t.$$

Rearranging,

$$\hat{i}_t = \frac{\gamma}{\gamma + \phi_y}\left(z_t - z_{t,t,f}\right).$$

Factor $\hat{n}_t$ is given by

$$\hat{n}_t = \hat{v}^r_{t,t,f} - \hat{w}^r_{t,t,f} + \hat{h}_{t,t,f} = 0.$$

Factor $\hat{h}_t$ is given by

$$\hat{h}_t = \frac{1}{1-\vartheta}\left(\hat{y}_t - \vartheta \hat{n}_t\right).$$

Substituting $\hat{y}_t$ and $\hat{n}_t$ yields

$$\hat{h}_t = -\frac{1}{1-\vartheta}\frac{1}{\gamma + \phi_y}\left(z_t - z_{t,t,f}\right).$$