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DISINFLATIONARY SHOCKS AND INFLATION TARGET UNCERTAINTY

by Stefano Neri[*] and Tiziano Ropele[**]

Abstract

In New Keynesian models favourable cost-push shocks lower inflation and increase output. Yet, when the central bank's inflation target is not perfectly observed these shocks turn contractionary as agents erroneously perceive a temporary reduction in the target. This effect is amplified when monetary policy is constrained by the effective lower bound on the policy rate.

JEL Classification: E31, E52, E58.
Keywords: inflation target, imperfect information, monetary policy.

Contents

[*] Banca d'Italia, Economic Outlook and Monetary Policy Directorate.
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1. Introduction[1]

Nowadays many central banks rely on a formalized inflation-targeting framework based on the belief and the theoretical predictions that an explicit and clearly communicated target helps anchoring long-term inflation expectations and making monetary policy more effective (Bernanke and Mishkin, 1997).[2] However, not all central banks have or have had a precise inflation target. The Federal Open Market Committee of the Federal Reserve clarified that its long-run inflation target was 2 per cent only in January 2012. The European Central Bank has never clarified the meaning of "*below, but close to 2 per cent*" in its definition of price stability.[3] Several studies have shown that in countries that adopted inflation targeting, inflation and inflation expectations react less and in less persistent manner to oil or food price shocks than in non-inflation targeting countries (Mishkin and Schmidt-Hebbel, 2007; Davis, 2014; Gelos and Ustyugova, 2017).

In this paper we ask the following question: What is the impact of a favourable cost-push shock on the economy when the inflation target is imperfectly observed (or not communicated precisely by the central bank)? We answer this question using a small-scale New Keynesian model featuring symmetric imperfect information (II, henceforth) about the state of the economy, including the inflation target. We show that under II, the transmission of a favourable cost-push shock changes substantially compared with the case of perfect information (PI, henceforth). Rather than moving output and inflation in opposite directions (i.e. inflation down and output up), under II both variables fall. In this case, agents misperceive the occurrence of shocks and erroneously believe that also negative shocks to preference and to the inflation target have materialized, which in turn give rise to a decline in inflation and output. Output and inflation fall even more if the central bank cannot reduce its policy rate due to the effective lower bound (ELB). More generally, and in line with the existing literature, under II on the state of the economy agents and the central bank respond less aggressively to the shocks.

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[1] The opinions expressed in this paper are those of the authors and do not reflect those of Banca d'Italia. The authors would like to thank an anonymous referee, Guido Ascari and participants at the workshop on "*Low inflation and its implications for monetary policy*", held at Banca d'Italia on 23 March 2015 and at the 11th Dynare conference held at the National Bank of Belgium on 28-29 September 2015. A shorter version can be found in Economics Letters (Vol. 181, 2019).

[2] Capistrán and Ramos-Francia (2007) show that in inflation targeting regimes inflation, forecasts by professional forecasters are less dispersed.

[3] Several central banks with an inflation targeting framework have a target range (e.g. the Reserve Bank of New Zealand) rather than a point target for inflation.

The literature has extensively studied monetary policy under PI. Few studies, however, have examined the macroeconomic implications of imperfect information about inflation target. Erceg and Levine (2003) set up a New Keynesian model in which private agents have limited information about the central bank's objectives and must disentangle persistent shifts in the inflation target from transitory monetary policy shocks. They show that disinflationary monetary policies generate larger output costs in this setting than under PI. Using a similar model, Melecky, Palenzuela and Söderström (2009) show that the announcement of an inflation target yields substantial macroeconomic gains when the private sector overestimates the volatility of the target. This paper contributes to this literature along two dimensions. First, we document that imperfect observability of the inflation target changes the transmission of cost-push shocks. Second, we consider the interaction between this imperfect observability and the ELB.

2. Theoretical framework

2.1 A small-scale new Keynesian model

In this section we describe the key features of a small-scale new Keynesian DSGE model that we use for the purposes of our analysis. The economy is populated by a representative household that consumes and supplies labour, finished-goods-producing firms, intermediate-goods-producing firms and a central bank in charge of monetary policy. For many aspects the model is similar to Clarida, Galí and Gertler (1999), Galí (2003) and Woodford (2003). The two main differences pertain to a generalization of the quadratic adjustment cost mechanism à la Rotemberg (1982) and to the presence of a time-varying inflation target. Furthermore, the model is solved under two alternative information settings regarding the knowledge of the state of the economy: either under PI or symmetric II, as in Svensson and Woodford (2003).

The representative household

The representative household lives forever and her expected lifetime utility is given by:

$$E_0 \sum_{t=0}^{\infty} d_t \beta^t \{log(C_t - \gamma \bar{C}_{t-1}) - H_t\} \tag{1}$$

where E_0 is the rational expectation operator conditional on time $t=0$ information and $\beta \in (0,1)$ is the subjective rate of time preference. The instantaneous utility function is increasing in the consumption of a final good (C_t) relative to a level of external habit defined in terms of lagged aggregate consumption ($\bar{C}_{t-1}$) and parameterized by γ, and decreasing in labour (H_t). The variable d_t represents a preference shock that evolves according to $\log(d_t) = \rho_d \log(d_{t-1}) + \varepsilon_{d,t}$, with $\rho_d \in [0,1]$ and $\varepsilon_{d,t} \sim N(0, \sigma_d^2)$.

At a given period t, the representative household faces the following budget constraint:

$$P_t C_t + B_t \leq P_t w_t H_t + (1 + i_{t-1}) B_{t-1} + F_t \tag{2}$$

where P_t is the price of the final good, B_t represents holding of bonds offering a one-period nominal return i_t, w_t is the real wage, and F_t are firms' profits that are returned to households. Solving the representative household's utility maximization yields the following first order conditions:

$$u_{c,t} = \beta(1 + i_t) E_t \left(\frac{u_{c,t+1}}{P_{t+1}/P_t} \right), \tag{3}$$

$$d_t = u_{c,t} w_t, \tag{4}$$

where $u_{c,t} \equiv (C_t - \gamma \bar{C}_{t-1})^{-1} d_t$ is the marginal utility of consumption. Equations (3) and (4) have the usual economic interpretation.

Finished-goods-producing firms

In each period a final good Y_t is produced by perfectly competitive firms using a continuum of intermediate inputs $Y_{i,t}$ indexed by $i \in (0,1)$ and a CES production function:

$$Y_t = \left[\int_0^1 Y_{i,t}^{(\theta_t - 1)/\theta_t} di \right]^{\theta_t/(\theta_t - 1)}, \tag{5}$$

where θ_t follows the stationary autoregressive process

$$\log(\theta_t) = (1 - \rho_\theta) \log(\theta) + \rho_\theta \log(\theta_t) + \varepsilon_{\theta,t}, \tag{6}$$

with $\rho_\theta \in [0,1]$ and $\varepsilon_{\theta,t} \sim N(0, \sigma_\theta^2)$. Taking prices as given the final good producer chooses intermediate good quantities $Y_{i,t}$ to maximise profits, resulting in the usual demand schedule:

$$Y_{i,t} = \left(\frac{P_{i,t}}{P_t} \right)^{-\theta_t} Y_t \,. \tag{7}$$

The zero-profit condition of final good producers leads the aggregate price index:

$$P_t = \left[\int_0^1 P_{i,t}^{1-\theta_t} di \right]^{1/(1-\theta_t)}. \tag{8}$$

Intermediate-goods-producing firms

Intermediate inputs $Y_{i,t}$ are produced by a continuum of firms indexed by $i \in (0,1)$ with the technology:

$$Y_{i,t} = H_{i,t} \quad . \tag{9}$$

Prices are sticky, with intermediate goods producers in monopolistic competition setting prices according to a generalized quadratic adjustment cost mechanism à la Rotemberg (1982). As in Ireland (2007), we assume that the quadratic adjustment cost, measured in terms of the final good, is given by the following specification:

$$\Gamma_{i,t} = \frac{\phi}{2}\left\{\frac{P_{i,t}}{[\Pi_{t-1}^{\alpha}(\Pi_t^*)^{1-\alpha}]P_{i,t-1}} - 1\right\}^2 Y_t \tag{10}$$

where the parameter $\phi \in [0,\infty)$ measures the magnitude of the adjustment cost, $\Pi_t \equiv P_t/P_{t-1}$ so that Π_{t-1} denotes the gross inflation rate between $t - 2$ and $t - 1$, Π_t^* denotes the central bank's time-varying inflation target for period t, and the parameter $\alpha \in [0,1]$ determines to what extent intermediate firms' price setting is backward- instead of forward-looking. When $\alpha = 0$, so that firms find it costless to adjust their prices in line with the central bank's inflation target, the Phillips curve becomes purely forward-looking. When $\alpha = 1$, so that firms find it costless to adjust their prices in line with the previous period's inflation rate, the backward-looking term in the Phillips curve becomes as important as the forward-looking term. Notice that according to (10) prices are fully indexed and thus there are not distortionary effects stemming from positive levels of steady-state inflation.[4]

The problem for the intermediate firm *i* is then:

$$\max_{\{P_{i,t}\}_{t=0}^{\infty}} E_t \sum_{j=0}^{\infty} \frac{\beta^j u_{c,t+j}}{u_{c,t}} \left\{\frac{P_{i,t+j}}{P_{t+j}} Y_{i,t+j} - w_{t+j} Y_{i,t+j} - \Gamma_{i,t+j}\right\} \tag{11}$$

$$\text{subject to: } Y_{i,t+j} = \left[\frac{P_{i,t+j}}{P_{t+j}}\right]^{-\theta_t} Y_{t+j} \quad .$$

Intermediate firms can change their price in each period, subject to the payment of the adjustment cost. All firms face the same problem. Hence they will choose the same price and

[4] See, Ascari and Ropele (2009) for a discussion of the effects brought about by positive levels of steady-state inflation.

output: $P_{i,t} = P_t$ and $Y_{i,t} = Y_t$ for every i. Exploiting the symmetry of the equilibrium, the first-order condition for the above maximization yields:

$$\theta_t - 1 = \theta_t w_t - \phi \left[\frac{\Pi_t}{\Pi_{t-1}^{\alpha}(\Pi_t^*)^{1-\alpha}} - 1\right] \frac{\Pi_t}{\Pi_{t-1}^{\alpha}(\Pi_t^*)^{1-\alpha}} + \\ + \beta \frac{u_{c,t+1}}{u_{c,t}} \phi \left[\frac{\Pi_{t+1}}{\Pi_t^{\alpha}(\Pi_{t+1}^*)^{1-\alpha}} - 1\right] \frac{\Pi_{t+1}}{\Pi_t^{\alpha}(\Pi_{t+1}^*)^{1-\alpha}} \frac{Y_{t+1}}{Y_t} \quad . \tag{12}$$

Central bank

The central bank sets monetary policy according to the generalized Taylor (1993) rule:

$$1 + \mathrm{i}_t = (1 + \bar{\mathrm{i}}) \left(\frac{1 + \mathrm{i}_{t-1}}{1 + \bar{\mathrm{i}}}\right)^{\phi_i} \left(\frac{\Pi_t}{\Pi_t^*}\right)^{(1-\phi_i)\phi_\pi} \left(\frac{Y_t}{\bar{Y}}\right)^{(1-\phi_i)\phi_y} \tag{13}$$

where $\phi_i \in [0,1]$, $\phi_\pi \in [0, \infty)$ and $\phi_y \in [0, \infty)$. According to (13) the central bank increases the short-term nominal rate i_t whenever inflation rises above its target Π_t^* and/or when output is above its steady-state level $\bar{Y}$. Provided that $\phi_i \in (0,1]$ the policy rule exhibits an inertial behaviour. As in Ireland (2007), a novel feature of the generalized Taylor rule (13) is the fact that the central bank's inflation target Π_t^* is time-varying. We assume that the target evolves according to the following exogenous AR(1) process:

$$\log(\Pi_t^*) = (1 - \rho_\Pi)\log(\Pi^*) + \rho_\Pi \log(\Pi_{t-1}^*) + \varepsilon_{\Pi,t} \tag{14}$$

where Π^* represents the long-run inflation target, $\rho_\Pi \in (0,1)$ and $\varepsilon_{\Pi,t} \sim N(0, \sigma_{\pi^*}^2)$. Unlike Ireland (2007) where the central bank is allowed to systematically adjust its inflation target in response to the structural shocks hitting the economy, here we simply assume that inflation target varies exogenously in response to realizations of the disturbance $\varepsilon_{\Pi,t}$. As discussed more extensively in Section 3, we assume a very small value for $\sigma_{\pi^*}^2$ and a value close to one for ρ_Π so that the inflation target exhibits highly persistent dynamics.

Aggregate resource constraint

It is important to note that the adjustment cost creates an inefficiency wedge between aggregate output and aggregate consumption, as the resource constraint shows:

$$\mathrm{Y}_t = \mathrm{C}_t / \left\{1 - \frac{\phi}{2}\left[\frac{\Pi_t}{\Pi_{t-1}^{\alpha}(\Pi_t^*)^{1-\alpha}} - 1\right]^2\right\}. \tag{15}$$

Note that absent any price indexation, i.e. $\Pi_{t-1}^{\alpha}(\Pi_t^*)^{1-\alpha} \equiv 1$, the inefficiency wedge would increase with inflation: the higher inflation, the higher the size of the price change and hence the higher the adjustment costs that firms have to pay. However, with full price indexation this inefficiency wedge washes out both in steady state and in the (log-)linear approximation of the model.

2.2 The log-linearized model

We now present the log-linearized version of the model approximated around the deterministic steady state.[5] Throughout, for any variable x_t we let $\hat{x}_t = \log(X)\,/\log(\bar{X})$.

The linearized model is given by the following equations:

$$\hat{y}_t = \left(\frac{\gamma}{1+\gamma}\right)\hat{y}_{t-1} + \left(\frac{1}{1+\gamma}\right)y_{t+1|t} - \left(\frac{1-\gamma}{1+\gamma}\right)\left(\hat{\imath}_t - \hat{\pi}_{t+1|t}\right) + \left(\frac{1-\gamma}{1+\gamma}\right)(1-\rho_d)\hat{d}_t, \tag{16}$$

$$\begin{aligned}\hat{\pi}_t = \left(\frac{\alpha}{1+\alpha\beta}\right)\hat{\pi}_{t-1} + \left(\frac{\beta}{1+\alpha\beta}\right)\hat{\pi}_{t+1|t} + \left[\frac{1}{\phi(1+\alpha\beta)}\right]\left(\frac{\theta-1}{1-\gamma}\right)(\hat{y}_t - \gamma\hat{y}_{t-1}) + \\ + \left[\frac{(1-\alpha)(1-\beta\rho_{\Pi})}{1+\alpha\beta}\right]\hat{\pi}_t^* + \hat{s}_t,\end{aligned} \tag{17}$$

$$\hat{\imath}_t = \phi_i\hat{\imath}_{t-1} + (1-\phi_i)\left[\phi_\pi(\hat{\pi}_t - \hat{\pi}_t^*) + \phi_y\hat{y}_t\right], \tag{18}$$

$$\hat{d}_t = \rho_d\hat{d}_{t-1} + \varepsilon_{d,t}, \tag{19}$$

$$\hat{s}_t = \rho_s\hat{s}_{t-1} + \varepsilon_{s,t}, \tag{20}$$

$$\hat{\pi}_t^* = \rho_\pi\hat{\pi}_{t-1}^* + \varepsilon_{\pi,t}, \tag{21}$$

where $\hat{s}_t \equiv \frac{1}{\phi(1+\alpha\beta)}\theta_t$.

Equation (16) is a standard hybrid IS curve in which current output depends positively on the lagged and the next period expected output and is inversely related to the ex-ante real interest rate. As the parameter γ increases the degree of persistence of output rises. The preference shock d_t acts as a demand shifter.

Equation (17) is a hybrid new-Keynesian Phillips curve (NKPC) in which current inflation is a function of past and expected inflation and also of the current and lagged output. Two

[5] The steady-state values for the main variables are: $w = (\theta-1)/\theta$, $C = 1/[w^{-1}(1-\gamma)]$, $Y = H = C$ and $1 + i = \Pi^*/\beta$.

remarks are in order. First, the time-varying inflation target enters the hybrid NKCP with a positive coefficient. This is the result of the indexation scheme according to which past prices are automatically increased by a factor that depends on Π_t^*. Hence a decline in the inflation target lowers inflation. Second, the hybrid NKPC is shifted by the cost-push shock $\hat{s}_t$, which arises from the time-varying elasticity of substitution θ_t.

Equation (18) is instead a generalized Taylor rule for the nominal short-term rate that exhibits inertia and is defined in terms of an inflation gap (expressed in deviation from the time-varying inflation target) and an output gap (expressed in deviation from the steady-state of output). Equations (19)-(21) describe the law of motion of the three exogenous processes, namely the preference shock, the cost-push shock and the time-varying inflation target shock. As anticipated, each of them follows an AR(1) process.

2.3 Imperfect information

As in Svensson and Woodford (2003), agents and the central bank do not perfectly observe the state of the economy, given by $X_t \equiv \{\hat{y}_{t-1}, \hat{\pi}_{t-1}, \hat{d}_t, \hat{s}_t, \hat{\pi}_t^*\}$.[6] The central bank responds, in accordance with equation (18), to the estimate of the current output gap ($\hat{y}_{t|t}$) and to the gap between inflation ($\hat{\pi}_{t|t}$) and the target ($\hat{\pi}_{t|t}^*$). The fact that the central bank does not know the inflation target might seem odd. However, this assumption is meant to capture the very realistic situation in which policy decisions taken by a committee – as is the case for monetary policy – are an outcome of members' policy choices and preferences and that these preferences may differ amongst the members (Blinder, 2007). According to (18), we let the inflation target to temporarily deviate from its steady-state (long-run) level.

The estimate of the state of the economy ($X_{t|t}$) and thus of current output and inflation (given by $x_{t|t} = \mathbf{G}^* X_{t|t}$, where $x_{t|t} \equiv \{\hat{y}_{t|t}, \hat{\pi}_{t|t}\}$ and $\mathbf{G}^*$ is computed independently from the problem of estimating $X_{t|t}$, i.e. the "separation principle" holds) are described by:

$$X_{t|t} = X_{t|t-1} + \mathbf{K}(Z_t - Z_{t|t-1}) \tag{22}$$

$$Z_t = \mathbf{L}X_t + \mathbf{M}X_{t|t} + v_t \tag{23}$$

where Z_t includes the observable but noisy indicators:

[6] Svensson and Woodford (2004) consider a framework in which the private sector and the central bank have different information sets. In this case, the separation principle between optimization and filtering does not hold.

$$Z_t \equiv \begin{bmatrix} \hat{y}_t^{obs} \\ \hat{\pi}_t^{obs} \\ \hat{\pi}_t^{*,obs} \end{bmatrix} = \begin{bmatrix} \hat{y}_t \\ \hat{\pi}_t \\ \hat{\pi}_t^{*} \end{bmatrix} + \begin{bmatrix} v_{y,t} \\ v_{\pi,t} \\ v_{\pi^*,t} \end{bmatrix} \tag{24}$$

where v's are measurement errors, which are normally distributed with zero mean and standard deviations $\sigma_{v,y}$, $\sigma_{v,\pi}$ and σ_{v,π^*}, respectively. The matrix **K** in (22) is the Kalman gain that weighs the information content of the indicators in (24) to estimate the unobserved state variables $X_{t|t}$.

Table 1 reports the calibrated parameters. The discount factor β is set at the conventional value of 0.99 (as the time unit is a quarter). The degree of indexation of prices, α, is set to 0.5. The degree of habit in consumption, γ, is set at 0.25 as in Ireland (2007). The parameter measuring the cost for adjusting prices, ϕ, and the steady-state value of the elasticity of substitution among goods, θ, are taken from Gerali, Neri, Sessa and Signoretti (2010). The degree of inertia in the monetary policy rule, ϕ_i, is set at zero, while the other parameters of the rule are taken from Taylor (1993).[7]

Turning to the parameters governing the stochastic processes of the shocks, we borrow from Neri and Ropele (2011) the estimated AR(1) coefficients of the preference and cost-push shocks (0.77 and 0.56, respectively) and the estimated standard deviations of their innovations (0.064 and 0.059 percentage points, respectively). Regarding the inflation target, we set the AR(1) coefficient at 0.9 and the standard deviation of the innovation at 0.01 percentage points. These figures are based on the estimates of an AR(1) process fitted on the five-year ahead euro-area inflation expectations taken from the ECB's Survey of Professional Forecasters (SPF). The standard deviations of the measurement errors on inflation and output are at 0.03 and 0.8 percentage points, respectively, following Coenen, Levin and Wieland (2005) while the standard deviation of the measurement error on the inflation target is calibrated at 0.16 percentage points based the standard deviation of the aggregate distribution of the SPF inflation expectations constructed using the individual replies.

3. Results

In this Section we assess the implications of an imperfectly observed inflation target for the transmission of the shocks, with a special focus on a favourable cost-push shock.[8]

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[7] The results are robust to setting ϕ_i at values consistent with the empirical literature.
[8] The model is solved using the Matlab toolkit developed in Gerali and Lippi (2003).

Favourable cost-push shocks

Figure 1 shows the path of the actual cost-push shock to a unit innovation (upper-left panel) and the perceived shocks (other panels) for different levels of measurement precision on the target. As shown, agents underestimate the magnitude of the actual cost-push shock and erroneously perceive the materialization of negative innovations to the preference and inflation target shocks too.[9] The hump-shaped responses of the perceived inflation target and preference shocks mirror the hump-shaped adjustments of output and inflation due to habit formation in consumption and the indexation of prices to past inflation.

The charts in the left column of Figure 2 show the responses of output, inflation and the policy rate to a favourable cost-push shock under PI. In this case, the shock lowers inflation and the central bank cuts the policy rate to stimulate output and bring inflation back to steady state. The charts in the middle column show the responses under II. Misperception of the shocks leads to different dynamics of output and inflation compared with PI. Both inflation and output fall as agents erroneously perceive the occurrence of negative shocks to preferences and to the inflation target, the latter being equivalent to a contractionary monetary policy shock. The peak decline in output is about 0.05 per cent, compared with an increase of 4 per cent under PI. Were inflation perfectly measured (i.e. $\sigma_{v,\pi} = 0$), the drop in output would be even larger.[10] The charts in the right column show the responses in a scenario in which the economy is at the ELB.[11] All previous results strengthen since monetary policy fails to offset the perceived negative shocks to preferences and to the inflation target. Output falls substantially regardless of the degree of noise on the target.

Preference and inflation target shocks

Agents misperceive the occurrence of shocks also when a negative preference shock hits the economy lowering both inflation and output (Figure 3). Agents perceive that a negative shock to the inflation target and a negative cost-push shock have occurred. Compared with the PI case, the perception of a much smaller preference shock leads to a much lower decline in inflation and a somewhat smaller fall in output (Figure 4). The central bank lowers the policy rate by a smaller amount, given that inflation responds less to the milder, perceived negative

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[9] Misperception occurs also when the economy is hit by preference or inflation target shocks.

[10] The fall in output also occurs when the inflation target is the only indicator measured with error (i.e. if $\sigma_{v,y} = \sigma_{v,\pi} = 0$).

[11] We do not model how the ELB is reached. We assume that the economy is at the ELB and it is not expected to leave this state. In order to "neutralize" the endogenous response of the central bank to $(\hat{\pi}_{t|t} - \hat{\pi}^*_{t|t})$ and $\hat{y}_{t|t}$ we let the policy rule be highly inertial, i.e. $\hat{\imath}_t = 0.999\hat{\imath}_{t-1} + (1 - 0.999)\left[\phi_\pi\left(\hat{\pi}_{t|t} - \hat{\pi}^*_{t|t}\right) + \phi_y \hat{y}_{t|t}\right]$. This ensures that the Taylor principle is not violated.

preference shock. When monetary policy is at the ELB, output and inflation decline slightly more than away from the constraint.

Agents perceive the occurrence of a negative preference shock and a negative cost-push shock also when the economy is hit by a negative shock to the inflation target (Figure 5). When the target is imperfectly observed, output and inflation barely decline compared with the PI case, since agents perceive a much smaller shock to the target (Figure 6). When monetary policy is constrained by the ELB, the decline of output and inflation is very similar to the case in which the central banks can adjust the policy rate.

Robustness checks

The results concerning the transmission of cost-push shocks are robust to assuming a larger or a smaller degree of habit in consumption, γ. In the case of $\gamma = 0.5$, which is twice larger the value used in the baseline simulations, the effects on output are somewhat stronger (Figure 7). The opposite occurs when the parameter is set to zero, although the results still hold from a qualitative point of view (Figure 8). In the case of no indexation of prices to past inflation (α = 0), the effects of a favourable cost-push shock are larger than in the baseline case and the response of output displays a more hump-shaped pattern (Figure 9). In all the three cases, the larger is the noise on the inflation target, the larger is the impact of the cost-push shock on output.

4. Conclusions

A small-scale New Keynesian model is used to study the effects of cost-push shocks when agents and the central bank do not perfectly observe the inflation target. Favourable cost-push shocks have a negative impact on output. The effects are larger when monetary policy is at the effective lower bound. Reducing the noise on the perceived inflation target can mitigate the negative effects of cost-push shocks. The results are robust to varying the degree of habit in consumption and indexation of prices to past inflation.

Future research may test the implications of the results shown here using data on countries with different degrees of inflation target transparency and exploiting the effects of a common shock, such as to the supply of oil, for identification purpose.

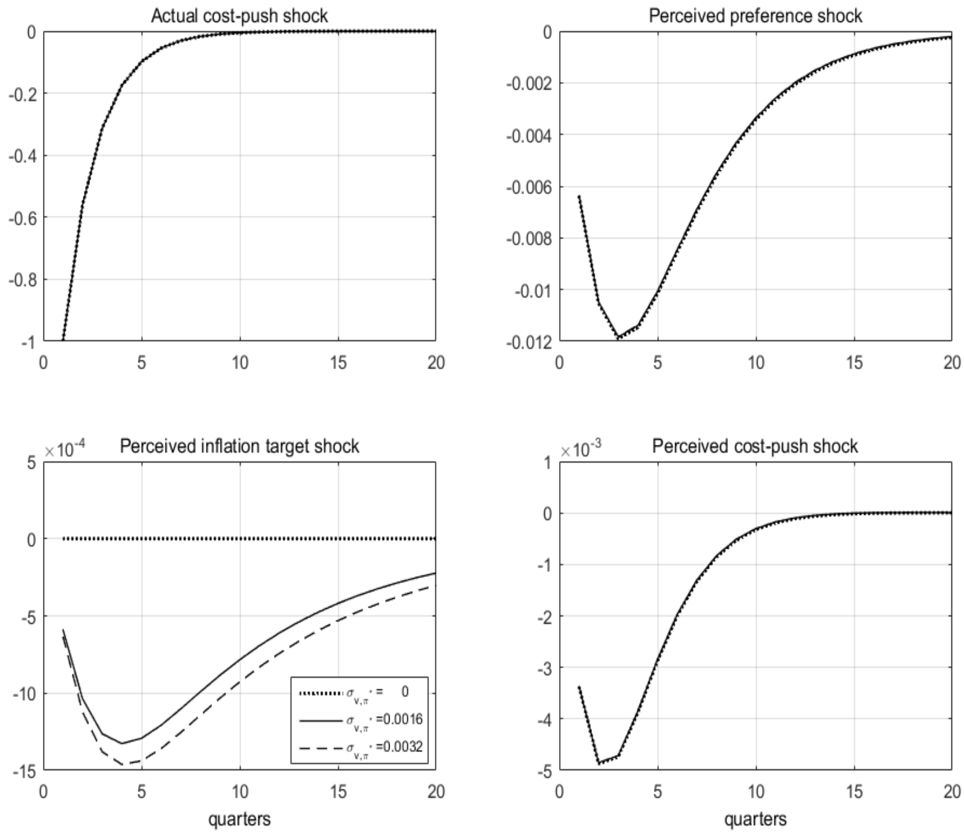
Tables and figures

Table 1. Calibrated parameters

Parameter	*Value*	*Description*	*Source*
β	0.99	Discount factor	Authors' calibration
α	0.50	Prices indexation to past inflation	Authors' calibration
γ	0.25	Habit formation in consumption	Ireland (2007)
ϕ	30	Price adjustment cost	Gerali et al. (2010)
θ	6	Elasticity of substitution among goods	Gerali et al. (2010)
ϕ_π	1.5	Response to inflation gap in monetary rule	Taylor (1993)
ϕ_y	0.5	Response to output gap in monetary rule	Taylor (1993)
ρ_d	0.77	AR(1) coefficient: preference shock	Neri and Ropele (2011)
ρ_s	0.56	AR(1) coefficient: cost-push shock	Neri and Ropele (2011)
ρ_{π^*}	0.90	AR(1) coefficient: inflation target shock	Authors' calibration using SPF data
σ_d	0.00064	Std. dev. innovation: preference shock	Neri and Ropele (2011)
σ_s	0.00059	Std. dev. innovation: cost-push shock	Neri and Ropele (2011)
σ_{π^*}	0.0001	Std. dev. innovation: inflation target shock	Authors' calibration using SPF data
$\sigma_{v,y}$	0.008	Std. dev. meas. error: output	Coenen, Levin and Wieland (2005)
$\sigma_{v,\pi}$	0.0003	Std. dev. meas. error: inflation	Coenen, Levin and Wieland (2005)
σ_{v,π^*}	0.0016	Std. dev. meas. error: inflation target	Authors' calibration using SPF data

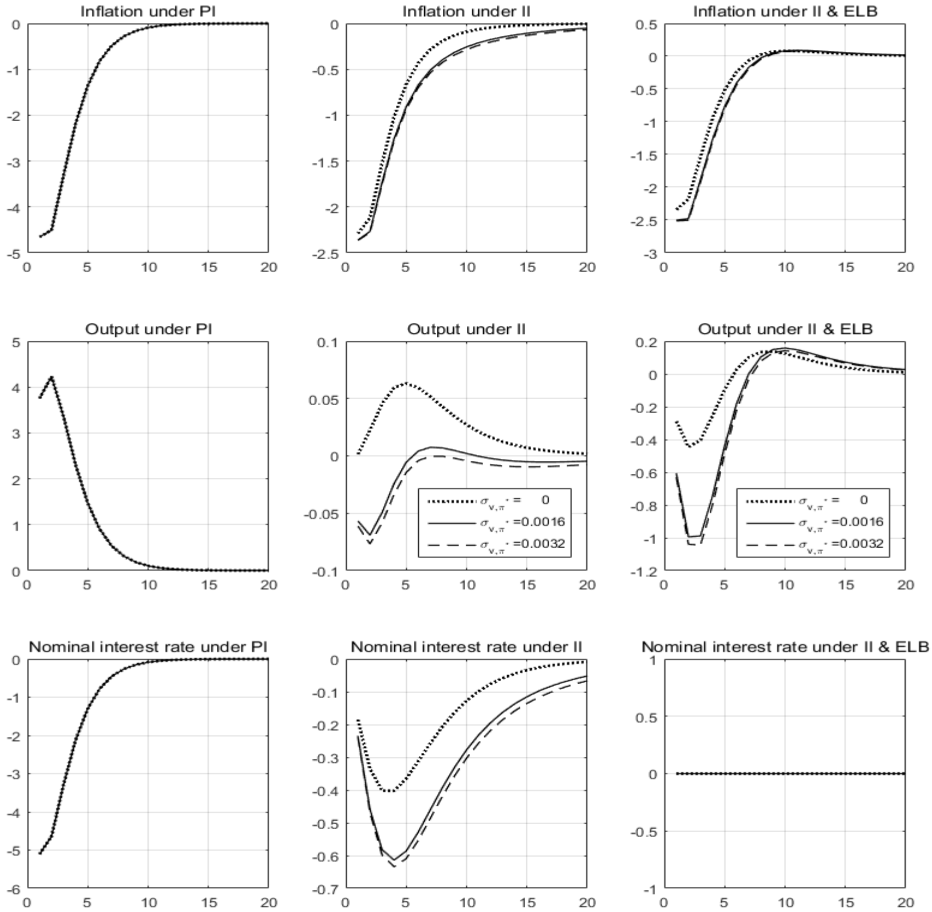
Notes: calibration of ρ_{π^*}, σ_{π^*} and σ_{v,π^*} is based on the five-year ahead inflation expectations from the ECB's Survey of Professional Forecasters.

Figure 1. Impulse responses to a favorable cost-push shock



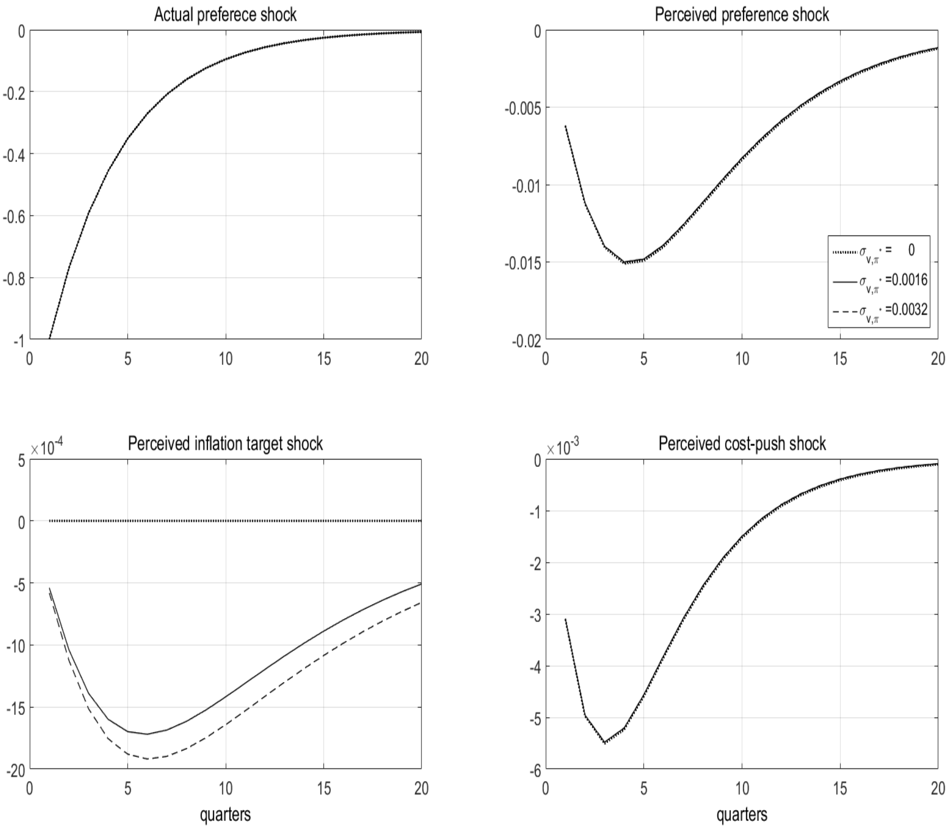
Notes: the figure shows the responses to a negative unit cost-push shock for different degrees of measurement precision of the inflation target.

Figure 2. Impulse responses to a favorable cost-push shock
(*percentage deviations*)



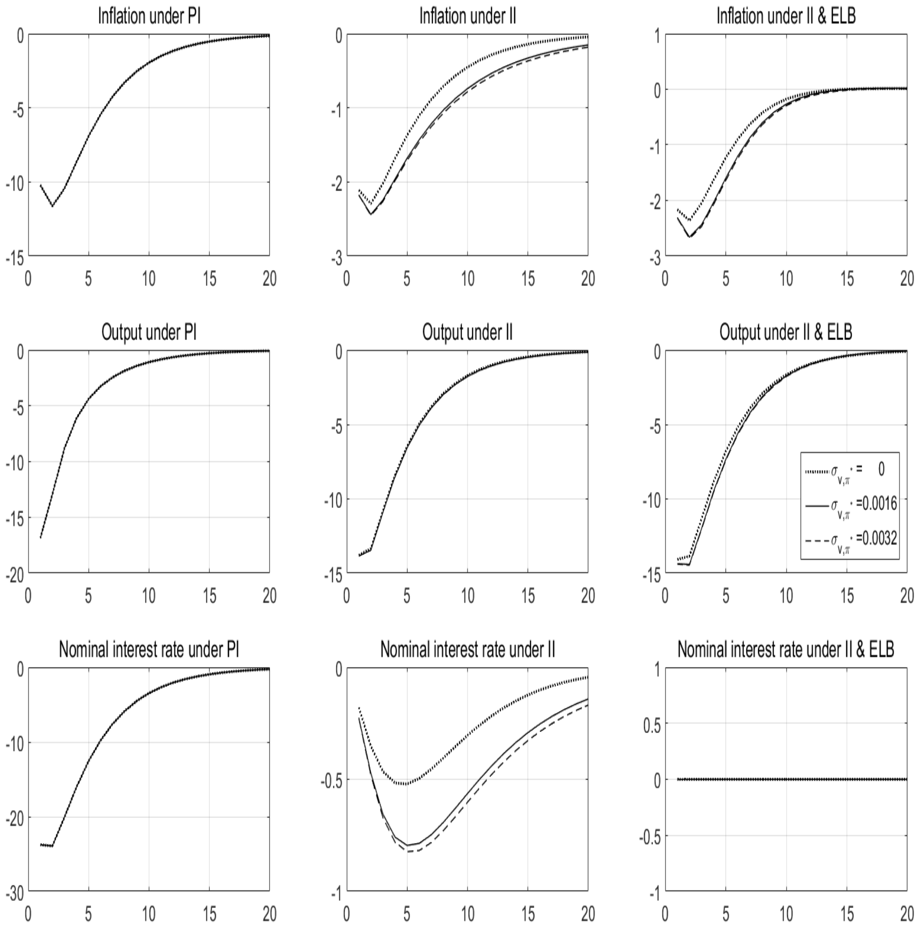
Notes: the charts in the left column show the responses under perfect information (PI). The charts in the middle column show the responses under imperfect information (II) and for different degrees of measurement precision of the inflation target. The charts in the right column show the responses under II and for different degrees of measurement precision of the inflation target when the interest rate is at its effective lower bound (ELB).

Figure 3. Impulse responses to a negative preference shock



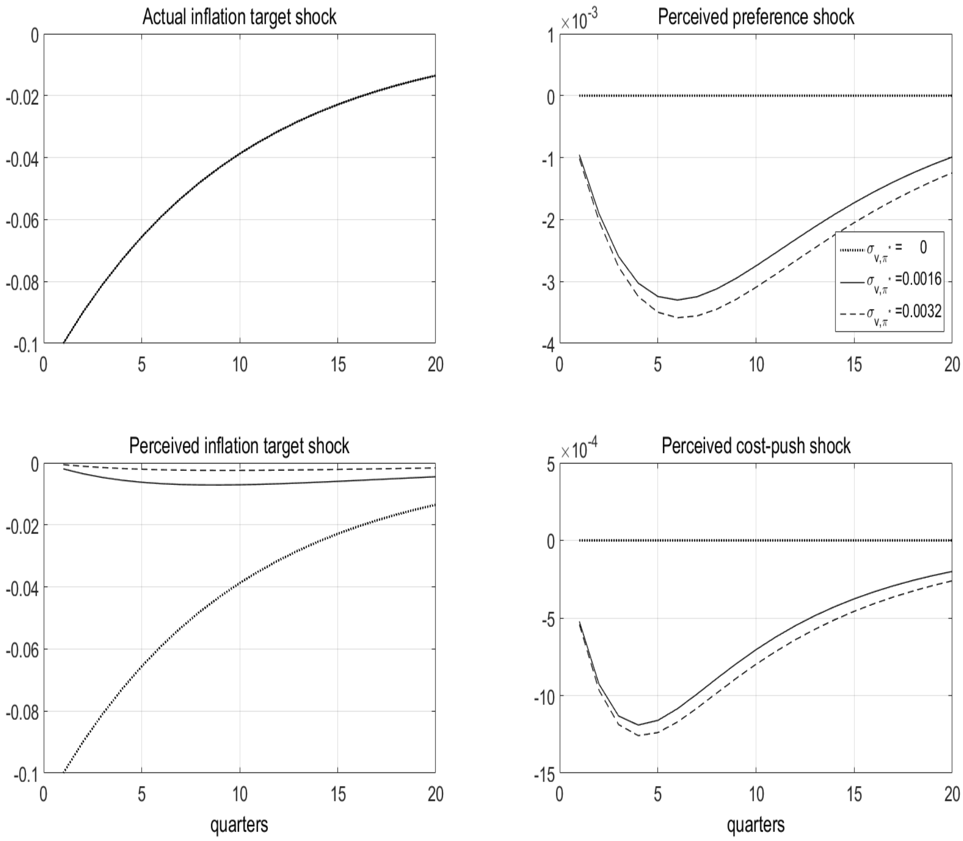
Notes: the figure shows the responses to a negative unit preference shock for different degrees of measurement precision of the inflation target.

Figure 4. Impulse responses to a negative preference shock
(*percentage deviations*)



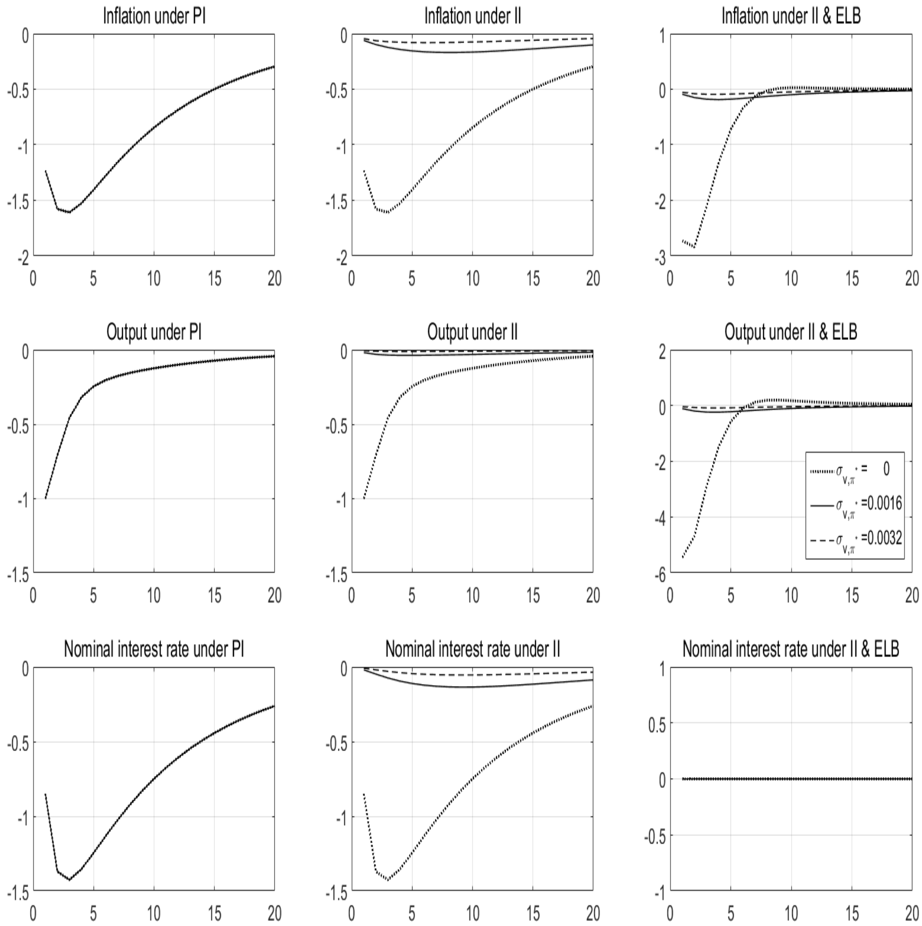
Notes: the charts in the left column show the responses under perfect information (PI). The charts in the middle column show the responses under imperfect information (II) and for different degrees of measurement precision of the inflation target. The charts in the right column show the responses under II and for different degrees of measurement precision of the inflation target when the interest rate is at its effective lower bound (ELB).

Figure 5. Impulse responses to a negative inflation target shock



Notes: the figure shows the responses to a 0.1 shock to the inflation target for different degrees of measurement precision of the inflation target.

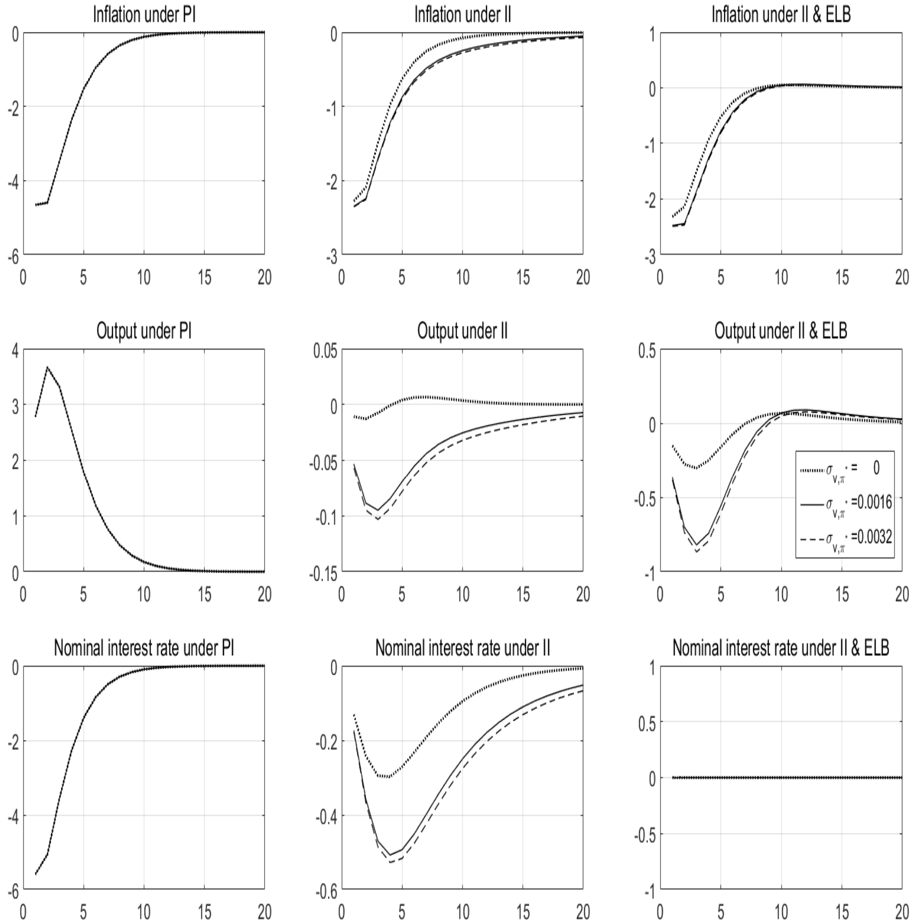
Figure 6. Impulse responses to a negative inflation target shock
(*percentage deviations*)



Notes: the charts in the left column show the responses under perfect information (PI). The charts in the middle column show the responses under imperfect information (II) and for different degrees of measurement precision of the inflation target. The charts in the right column show the responses under II and for different degrees of measurement precision of the inflation target when the interest rate is at its effective lower bound (ELB).

Figure 7. Impulse responses to a favorable cost-push shock: larger degree of habit in consumption

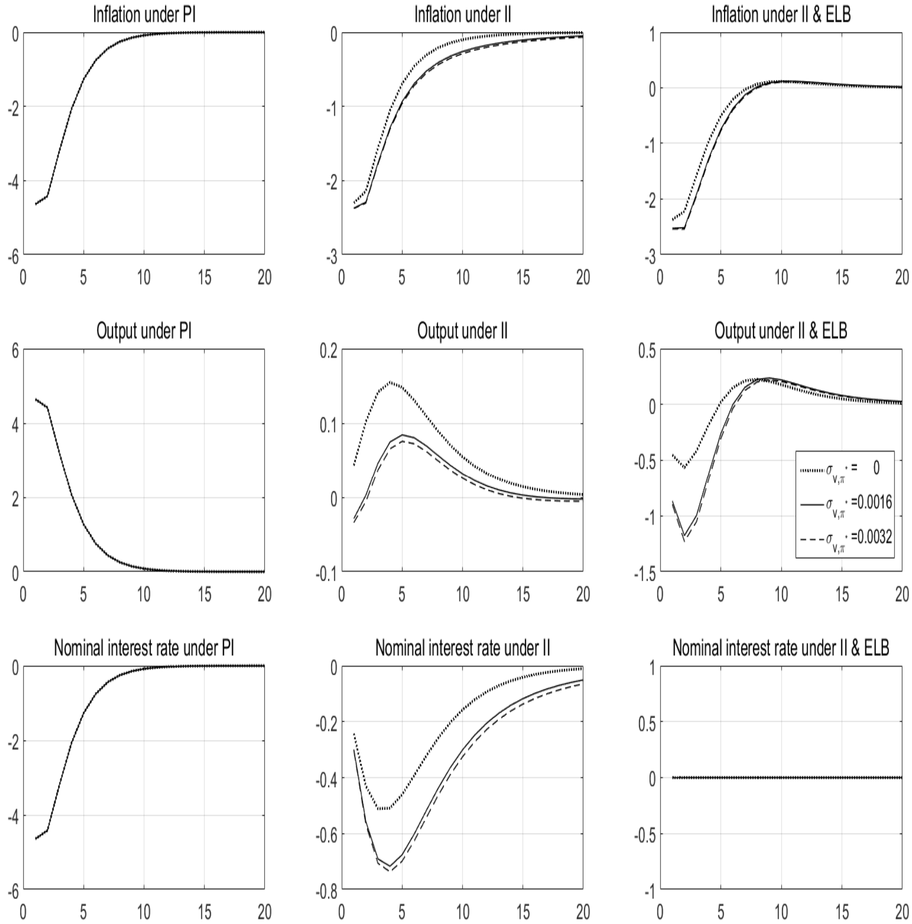
(*percentage deviations*)



Notes: the parameter measuring the degree of habit in consumption, γ, is set to 0.5, twice the value in Table 1. The charts in the left column show the responses under perfect information (PI). The charts in the middle column show the responses under imperfect information (II) and for different degrees of measurement precision of the inflation target. The charts in the right column show the responses under II and for different degrees of measurement precision of the inflation target when the interest rate is at its effective lower bound (ELB).

Figure 8. Impulse responses to a favorable cost-push shock: no habit in consumption

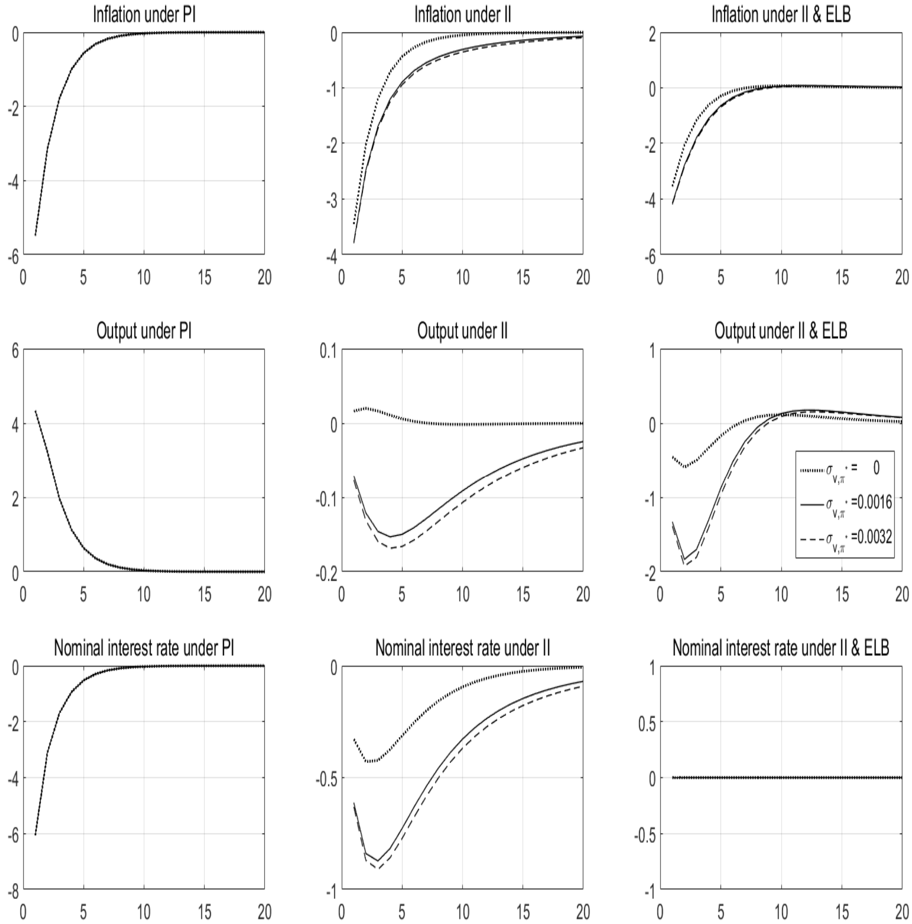
(*percentage deviations*)



Notes: the parameter measuring the degree of habit in consumption, γ, is set to 0. The charts in the left column show the responses under perfect information (PI). The charts in the middle column show the responses under imperfect information (II) and for different degrees of measurement precision of the inflation target. The charts in the right column show the responses under II and for different degrees of measurement precision of the inflation target when the interest rate is at its effective lower bound (ELB).

Figure 9. Impulse responses to a favorable cost-push shock:
no indexation of prices to past inflation

(*percentage deviations*)



Notes: the parameter measuring the degree of indexation of prices to past inflation, α, is set to 0. The charts in the left column show the responses under perfect information (PI). The charts in the middle column show the responses under imperfect information (II) and for different degrees of measurement precision of the inflation target. The charts in the right column show the responses under II and for different degrees of measurement precision of the inflation target when the interest rate is at its effective lower bound (ELB).

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