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# News Shocks and Optimal Simple Rules

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## Abstract

This paper evaluates the performance of optimal simple policy rules in the presence of news shocks. It is shown that the inclusion of forward-looking elements enhances the performance of simple optimized interest rate rules when agents learn about future disturbances in advance. We provide a rationale for this result by demonstrating that, if shocks are news shocks, the optimal unrestricted control rule under commitment contains as a basic principle a forward-looking element.

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# 1 Introduction

Since the real business cycle revolution, unanticipated random disturbances are considered as the main driving force in explaining business cycles. New Keynesians add nominal rigidities to the real business cycle framework to study the role of monetary policy in aggregate fluctuations but maintain the assumption of unpredictable random shocks. This is particularly true for the literature on the optimal design of monetary policy (see, among others, Clarida, Galí, and Gertler (1999), Svensson (1999), King, Khan, and Wolman (2003), or Woodford (2003)).

However recently, a number of macroeconometric studies emphasized the role of anticipated shocks as sources of macroeconomic fluctuations. Beaudry and Portier (2006) find that more than one-half of business cycle fluctuations are caused by news concerning future technological opportunities. Schmitt-Grohé and Uribe (2008) conduct a Bayesian estimation of a real-business cycle model and find that anticipated shocks are the most important source of aggregate fluctuations. In particular, they show that anticipated shocks explain two thirds of the volatility in consumption, output, investment, and employment.

In light of these findings, our contribution is to explore how monetary policy should be conducted in the presence of news shocks. In particular, we ask whether news shocks change the structure of optimal monetary policy rules.<sup>1</sup> In order to answer this question, we proceed as follows. First, we consider the unrestricted optimal monetary policy in a general rational expectations model as outlined by Söderlind (1999), but we allow disturbances to be anticipated in advance. We derive the optimal unrestricted policy under commitment and its implicit optimal interest rate rule. We show that in the presence of news shocks this optimal interest rate rule contains not only backward-looking state and costate variables, but also a forward-looking element. This forward-looking element does not appear in the case of unanticipated shocks.

It is well-known, however, that such an optimal unrestricted control rule can not be implemented as an explicit instrument rule for two reasons. First, it leads to an indeterminacy problem. Second, the rule is rather complicated since it depends on all endogenous model variables as well as on the exogenous shock processes. However, from

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<sup>1</sup>An assimilable question is whether optimal simple rules for open economies should include an exchange rate term (see, among others, Ball (1999) and Wollmershäuser (2006)).

the structure of the optimal control rule we can infer that an optimal simple monetary policy rule should also contain a forward-looking element. We demonstrate that this conjecture is indeed true by evaluating optimal simple rules for both the baseline New Keynesian model and its hybrid variant with internal habit formation in consumption preferences and Calvo price staggering with partial indexation.

The paper is organized as follows. Section 2 derives the optimal implicit instrument rule. In Section 3, we evaluate optimal simple rules within two simple model examples, the baseline New Keynesian model and the its hybrid variant. Section 4 provides concluding remarks.

## 2 Optimal unrestricted monetary policy under commitment

Consider the following rational expectations model with news shocks

$$A \begin{pmatrix} w_{t+1} \\ \mathbb{E}_t v_{t+1} \end{pmatrix} = B \begin{pmatrix} w_t \\ v_t \end{pmatrix} + C i_t + D \nu_{t+1-\tau}, \quad (1)$$

where  $w_t$  is an  $n_1 \times 1$  vector of predetermined variables, assuming  $w_0$  given,  $v_t$  an  $n_2 \times 1$  vector of non-predetermined variables,  $i_t$  an  $m \times 1$  vector of policy instruments, and  $\nu_{t+1-\tau}$  an  $r \times 1$  vector of i.i.d.-normal error terms with zero mean and constant variance. If  $\tau > 0$ , the shock is anticipated  $\tau$  periods in advance, thus we have a news shock. If  $\tau = 0$ , we have an unanticipated shock.  $\mathbb{E}_t$  is the expectations operator conditional on information up to date  $t$ . The matrices  $A$  and  $B$  are  $n \times n$  (where  $n = n_1 + n_2$ ), while the matrices  $C$  and  $D$  are  $n \times m$  and  $n \times r$  respectively. The vector  $w$ , composed of backward-looking variables, can include exogenous variables, following autoregressive processes. For notational convenience, we define the  $n \times 1$  vector  $k_t = (w_t', v_t')'$ . Assume that the policy maker's welfare loss at time  $t$  is given by

$$J_t = \frac{1}{2} \mathbb{E}_t \sum_{j=0}^{\infty} \lambda^j \{ k_{t+j}' \tilde{W} k_{t+j} + 2k_{t+j}' P i_{t+j} + i_{t+j}' R i_{t+j} \}, \quad (2)$$

where  $\tilde{W}$  and  $R$  are symmetric and non-negative definite and  $P$  is  $n \times m$ .

We are now going to develop the policy maker's optimal policy rule at time  $t = 0$ . It

is assumed that the policy maker is able to commit to such a rule. From the Lagrangian

$$\mathcal{L}_0 = \frac{1}{2} E_0 \sum_{t=0}^{\infty} \lambda^t \{k_t' \tilde{W} k_t + 2k_t' P i_t + i_t' R i_t + 2\rho_{t+1}' [B k_t + C i_t + D \nu_{t+1-\tau} - A k_{t+1}]\} \quad (3)$$

with the  $n \times 1$  multiplier  $\rho_{t+1}$ , we get the first-order conditions with respect to  $\rho_{t+1}$ ,  $k_t$ , and  $u_t$ :

$$\begin{pmatrix} A & 0_{n \times m} & 0_{n \times n} \\ 0_{n \times n} & 0_{n \times m} & \lambda B' \\ 0_{m \times n} & 0_{m \times m} & -C' \end{pmatrix} \begin{pmatrix} k_{t+1} \\ i_{t+1} \\ \rho_{t+1} \end{pmatrix} = \begin{pmatrix} B & C & 0_{n \times n} \\ -\lambda \tilde{W} & -\lambda P & A' \\ P' & R & 0_{m \times n} \end{pmatrix} \begin{pmatrix} k_t \\ i_t \\ \rho_t \end{pmatrix} + \begin{pmatrix} D \\ 0_{n \times r} \\ 0_{m \times r} \end{pmatrix} \nu_{t+1-\tau} . \quad (4)$$

To solve the system of equations in (4), expand the state and costate vector  $k_t$  and  $\rho_t$  as  $(w_t', v_t)'$  and  $(\rho_{wt}', \rho_{vt}')'$  respectively and rearrange the rows of the  $(2n + m) \times 1$  vector  $(k_t', i_t', \rho_t)'$  by placing the predetermined vector  $\rho_{vt}$  after  $w_t$ . Since  $v_t$  is forward-looking with an arbitrarily chosen initial value  $v_0$ , the corresponding Lagrange multiplier  $\rho_{vt}$  is predetermined with an initial value  $\rho_{v0} = 0$ . Rearrange the columns of the  $(2n + m) \times (2n + m)$  matrices in (4) according to the re-ordering of  $(k_t', i_t', \rho_t)'$  and write the result as

$$F \begin{pmatrix} \tilde{w}_{t+1} \\ \tilde{v}_{t+1} \end{pmatrix} = G \begin{pmatrix} \tilde{w}_t \\ \tilde{v}_t \end{pmatrix} + \begin{pmatrix} D \\ 0_{n \times r} \\ 0_{m \times r} \end{pmatrix} \nu_{t+1-\tau} , \quad (5)$$

where  $\tilde{w}_t = (w_t', \rho_{vt}')'$  and  $\tilde{v}_t = (v_t', i_t', \rho_{wt}')'$ . The  $n \times 1$  vector  $\tilde{w}_t$  contains the 'backward-looking' variables of (4) while the  $(n + m) \times 1$  vector  $\tilde{v}_t$  contains the 'forward-looking' variables.

Equation (4) implies that the  $(2n + m) \times (2n + m)$  matrix  $F$  is singular. To solve equation (5) we apply the generalized Schur decomposition method (Söderlind (1999), Klein (2000)). The decomposition of the square matrices  $F$  and  $G$  is given by  $F = \bar{Q}' S \bar{Z}'$ ,  $G = \bar{Q}' T \bar{Z}'$  or equivalently  $Q F Z = S$ ,  $Q G Z = T$ , where  $Q, Z, S$ , and  $T$  are square matrices of complex numbers,  $S$  and  $T$  are upper triangular and  $Q$  and  $Z$  are unitary, i.e.  $Q \cdot \bar{Q}' = \bar{Q}' \cdot Q = I_{(2n+m) \times (2n+m)} = Z \cdot \bar{Z}' = \bar{Z}' \cdot Z$ , where the non-singular matrix  $\bar{Q}'$  is

the transpose of  $\bar{Q}$ , which denotes the complex conjugate of  $Q$ .  $\bar{Z}'$  is the transpose of the complex conjugate of  $Z$ . The matrices  $S$  and  $T$  can be arranged in such a way that the block with the stable generalized eigenvalues (the  $i$ th diagonal element of  $T$  divided by the  $i$ th diagonal element of  $S$ ) comes first. Premultiply both sides of equation (5) with  $Q$  and define auxiliary variables  $\tilde{z}_t$  and  $\tilde{x}_t$  so that

$$\begin{pmatrix} \tilde{z}_t \\ \tilde{x}_t \end{pmatrix} = \bar{Z}' \begin{pmatrix} \tilde{w}_t \\ \tilde{v}_t \end{pmatrix}. \quad (6)$$

Partitioning the triangular matrices  $S$  and  $T$  in order to conform with  $\tilde{z}$  and  $\tilde{x}$ . Then set

$$Q \begin{pmatrix} D \\ 0_{n \times r} \\ 0_{m \times r} \end{pmatrix} = \begin{pmatrix} Q_1 \\ Q_2 \end{pmatrix}, \quad (7)$$

where  $Q_1$  is  $n \times r$  and  $Q_2$  is  $(n+m) \times r$ . We then obtain the equivalent system

$$\begin{pmatrix} S_{11} & S_{12} \\ 0_{(n+m) \times n} & S_{22} \end{pmatrix} \begin{pmatrix} \tilde{z}_{t+1} \\ \tilde{x}_{t+1} \end{pmatrix} = \begin{pmatrix} T_{11} & T_{12} \\ 0_{(n+m) \times n} & T_{22} \end{pmatrix} \begin{pmatrix} \tilde{z}_t \\ \tilde{x}_t \end{pmatrix} + \begin{pmatrix} Q_1 \\ Q_2 \end{pmatrix} \nu_{t+1-\tau}, \quad (8)$$

where the  $n \times n$  matrix  $S_{11}$  and the  $(n+m) \times (n+m)$  matrix  $T_{22}$  are invertible while  $S_{22}$  is singular. The square matrix  $T_{11}$  may also be singular. The lower block of equation (8) contains the unstable generalized eigenvalues and must be solved forward. Since

$$\tilde{x}_{t+s} = M_2 \tilde{x}_{t+s+1} - T_{22}^{-1} Q_2 \nu_{t+s+1} \quad (s = 0, 1, 2, \dots), \quad (9)$$

where  $M_2 = T_{22}^{-1} S_{22}$ , the unique stable solution for  $\tilde{x}_t$  is given by

$$\tilde{x}_t = - \sum_{s=0}^{\tau-1} M_2^s T_{22}^{-1} Q_2 \nu_{t+s+1-\tau}. \quad (10)$$

Note that  $\tilde{x}_t = 0$  for  $t \geq \tau$ . Thus, we have  $\tilde{x}_t = 0$  for all  $t$  if the shock is unanticipated, i.e.  $\tau = 0$ .

The upper block of (8) contains the stable generalized eigenvalues and can be solved

backward. Since

$$\tilde{z}_{t+1} = M_1 \tilde{z}_t + S_{11}^{-1}(T_{12} \tilde{x}_t - S_{12} \tilde{x}_{t+1}) + S_{11}^{-1} Q_1 \nu_{t+1-\tau}, \quad (11)$$

where  $M_1 = S_{11}^{-1} T_{11}$  (which in general is not invertible), the general solution is given by

$$\tilde{z}_t = M_1^t K + \sum_{s=0}^{t-1} M_1^{t-s-1} S_{11}^{-1} (T_{12} \tilde{x}_s - S_{12} \mathbf{E}_s \tilde{x}_{s+1} + Q_1 \mathbf{E}_s \nu_{s+1-\tau}), \quad (12)$$

where  $K \in \mathbb{R}$  is a constant and  $\tilde{x}_s$  is defined in (10).

By premultiplying equation (6) with  $Z$  and by partitioning the matrix  $Z$  to conform with the dimension of  $\tilde{z}$  and  $\tilde{x}$ , we obtain

$$\begin{pmatrix} \tilde{w}_t \\ \tilde{v}_t \end{pmatrix} = \begin{pmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{pmatrix} \begin{pmatrix} \tilde{z}_t \\ \tilde{x}_t \end{pmatrix}. \quad (13)$$

If  $Z_{11}$  is invertible, equation (13) implies

$$\tilde{v}_t = Z_{21} \tilde{z}_t + Z_{22} \tilde{x}_t = Z_{21} (Z_{11}^{-1} \tilde{w}_t - Z_{11}^{-1} Z_{12} \tilde{x}_t) + Z_{22} \tilde{x}_t = N \tilde{w}_t + \hat{Z} \tilde{x}_t, \quad (14)$$

where  $N = Z_{21} Z_{11}^{-1}$  and  $\hat{Z} = Z_{22} - Z_{21} Z_{11}^{-1} Z_{12}$ . Write equation (14) as

$$\begin{pmatrix} v_t \\ i_t \\ \rho_{wt} \end{pmatrix} = \begin{pmatrix} N_{11} & N_{12} \\ N_{21} & N_{22} \\ N_{31} & N_{32} \end{pmatrix} \begin{pmatrix} w_t \\ \rho_{vt} \end{pmatrix} + \begin{pmatrix} \hat{Z}_1 \\ \hat{Z}_2 \\ \hat{Z}_3 \end{pmatrix} \tilde{x}_t \quad (15)$$

and assume the  $n_2 \times n_2$  matrix  $N_{12}$  is invertible. The optimal control rule under commitment or implicit instrument rule can then be written as

$$i_t = N_{21} w_t + N_{22} \rho_{v,t} + \hat{Z}_2 \tilde{x}_t = \Gamma_v v_t + \Gamma_w w_t + \Gamma_{\tilde{x}} \sum_{s=0}^{\tau-1} M_2^s T_{22}^{-1} Q_2 \mathbf{E}_t \nu_{t+s+1-\tau}, \quad (16)$$

where  $\Gamma_v = N_{22} N_{12}^{-1}$ ,  $\Gamma_w = N_{21} - N_{22} N_{12}^{-1} N_{11}$ , and  $\Gamma_{\tilde{x}} = -\hat{Z}_2 + N_{22} N_{12}^{-1} \hat{Z}_1$ . For  $t < \tau$ , the vector of policy instruments,  $i_t$ , depends on the forward-looking state variable  $\tilde{x}_t$  of the Schur-transformed system (8). For  $t \geq \tau$  the sum in equation (16) is equal to zero which

implies that for  $t \geq \tau$ ,  $i_t$  is only a linear function of the original state variables  $v_t$  and  $w_t$ .

Note that the optimal control rule (16) can not be implemented as an instrument rule for two reasons. First, it leads to an indeterminacy problem with respect to the original system (1) since the number of unstable eigenvalues would be smaller than the number of forward-looking state variables. Second, the rule is too complicated because it depends on all predetermined and non-predetermined state variables inclusive of the exogenous shock processes. Therefore, we focus attention to optimized simple monetary rules which guarantee saddle path stability. Since the optimal control rule is not only a function of the current state vector but also contains the auxiliary forward-looking variable  $\tilde{x}_t$ , we conjecture that an optimal simple rule should also include forward-looking elements when the policy maker is faced with news shocks.

### 3 Optimal simple rules

In the following, we will check correctness of the conjecture that simple rules which include forward-looking elements perform better when the economy is hit by news shock. In order to do so, we consider a set of possible simple interest rate rules and minimize the policy maker's loss function with respect to the coefficients of the respective rule. The rules considered are variants of the interest rate rule proposed by Taylor (1993) which describes the nominal interest rate as a linear function,  $f$ , of current inflation,  $\pi_t$ , and the current output gap,  $x_t$ . We employ the following forward-looking variants of the Taylor rule: i)  $i_t = f(\pi_t, x_t, E_t \pi_{t+1})$ , ii)  $i_t = f(\pi_t, x_t, E_t x_{t+1})$ , iii)  $i_t = f(\pi_t, x_t, E_t \pi_{t+1}, E_t x_{t+1})$ , iv)  $i_t = f(x_t, E_t \pi_{t+1})$ , iv)  $i_t = f(\pi_t, E_t x_{t+1})$ , and v)  $i_t = f(E_t \pi_{t+1}, E_t x_{t+1})$ . We consider three different values for the length of the anticipation period,  $\tau$ :  $\tau = 0$ ,  $\tau = 3$ , and  $\tau = 8$ .  $\tau = 0$  implies an unanticipated shock,  $\tau = 3$  and  $\tau = 8$  imply that agents learn about the exogenous disturbance three and eight quarters in advance, respectively.

Note that a rule which is found to be optimal in the case of an unanticipated shock will not be optimal in the case of, for instance,  $\tau = 3$ . Therefore, we reoptimize the coefficients of a given rule when  $\tau$  changes. This approach is necessary for a reasonable comparison of different optimal simple rules given a specific timing of the exogenous disturbance.



### 3.1 The baseline New Keynesian model

The building blocks of the baseline New Keynesian model are the New Keynesian Phillips curve (NKPC), the IS curve and a description of monetary policy. The NKPC reads as

$$\pi_t = \beta \mathbb{E}_t \pi_{t+1} + \kappa x_t + u_t, \quad (17)$$

where  $\beta$  is the discount factor and  $\kappa > 0$ .  $u_t$  is a cost-push shock described by the stochastic process:

$$u_t = \rho u_{t-1} + \varepsilon_{t-\tau}, \quad (18)$$

where  $0 \leq \rho < 1$  is the autocorrelation parameter.  $\varepsilon_t$  is an i.i.d.-normal error term with zero mean and unit variance. If  $\tau > 0$ , an innovation to  $u_t$  is anticipated  $\tau$  periods in advance. If  $\tau = 0$ , we have an unanticipated shock to  $u_t$ . The IS curve is given by

$$x_t = \mathbb{E}_t x_{t+1} - \frac{1}{\sigma} (i_t - \mathbb{E}_t \pi_{t+1}), \quad (19)$$

where  $\sigma > 0$  is the inverse of the elasticity of substitution in consumption. The social loss function is given by a weighted average of the variance of inflation and the output gap:<sup>2</sup>

$$Loss = \text{Var}(\pi_t) + \alpha_x \text{Var}(x_t). \quad (20)$$

Our numerical results are based on the following parametrization:  $\beta = 0.99$ ,  $\sigma = 2$ ,  $\kappa = 0.2575$ ,  $\rho = 0.5$ ,  $\alpha_x = 0.5$ .

Table 1 displays the social loss under the unrestricted optimal policy and under various optimal simple rules for  $\tau = 0$ ,  $\tau = 3$ , and  $\tau = 8$ .

It is shown that the inclusion of forward-looking elements has no effect at all when considering the (standard) case of an unanticipated disturbance. If, however, the occurrence of the shock is anticipated in advance, forward-looking elements are able to enhance the performance of simple Taylor-type monetary policy rules. Take, for instance, the rule

<sup>2</sup>This specific loss function can be obtained from the general loss function (2) by setting  $\lambda = 1$ ,  $P = \mathbf{0}$ ,  $R = \mathbf{0}$ , and by scaling the intertemporal loss function (2) by the factor  $1 - \lambda$  (Rudebusch and Svensson (1999)).

Rule	Loss		
	$\tau = 0$	$\tau = 3$	$\tau = 8$
Unrestricted optimal policy	2.1973	3.5623	3.7308
$i_t = f(\pi_t, x_t)$	3.4396	5.8401	6.2386
$i_t = f(\pi_t, x_t, E_t \pi_{t+1})$	3.4396	5.5499	5.8317
$i_t = f(\pi_t, x_t, E_t x_{t+1})$	3.4396	5.6287	5.8295
$i_t = f(\pi_t, x_t, E_t \pi_{t+1}, E_t x_{t+1})$	3.4396	5.5499	5.8310
$i_t = f(x_t, E_t \pi_{t+1})$	3.4396	8.2423	8.6311
$i_t = f(\pi_t, E_t x_{t+1})$	3.4396	5.6376	5.8312
$i_t = f(E_t \pi_{t+1}, E_t x_{t+1})$	3.4396	7.8539	8.1091

**Table 1:** Optimal simple rules with news shocks

$i_t = f(\pi_t, x_t, E_t \pi_{t+1}, E_t x_{t+1})$ , where the interest rate reacts not solely to current inflation and output gap, but also to the expected future values  $\pi_{t+1}$  and  $x_{t+1}$ . This rule performs better than the original Taylor rule for both  $\tau = 3$  and  $\tau = 8$ . Note, however, that purely forward-looking rules that react not at all on current economic conditions such as  $i_t = f(E_t \pi_{t+1}, E_t x_{t+1})$  perform remarkably worse than an optimized standard Taylor rule. But this is completely in line with the conclusion drawn from the inspection of the optimal control rule (16) which contains current state variables *and* forward-looking elements if the policy maker is faced with news shocks.

### 3.2 A hybrid New Keynesian model

To check the robustness of our result, we now consider a standard New Keynesian model for a closed and cashless economy with the additional features of internal habit formation in consumption preferences and a variant of the Calvo (1983) mechanism with partial indexation of non-optimized prices to past inflation.<sup>3</sup>

After log-linearization, the model consists of hybrid IS and Phillips curves. The hybrid IS curve is given by

$$x_t = \kappa_1 x_{t-1} + \kappa_2 E_t x_{t+1} - \kappa_3 E_t x_{t+2} - \kappa_4 (i_t - E_t \pi_{t+1}), \quad (21)$$

where  $\kappa_1 = \frac{h}{1+h+\beta h^2}$ ,  $\kappa_2 = \frac{1+\beta h+\beta h^2}{1+h+\beta h^2}$ ,  $\kappa_3 = \frac{\beta h}{1+h+\beta h^2}$ , and  $\kappa_4 = \frac{(1-h)(1-\beta h)}{\sigma(1+h+\beta h^2)}$ .  $h$  measures the degree of habit formation in consumption preferences. Note that for  $h = 0$ , we obtain the purely forward-looking New Keynesian IS curve.

<sup>3</sup>Similar models are used by Smets and Wouters (2003), Giannoni and Woodford (2004), or Casares (2006).

The hybrid Phillips curve reads as

$$\pi_t = \omega_1 \mathbb{E}_t \pi_{t+1} + \omega_2 \pi_{t-1} + \omega_3 x_t - \omega_4 x_{t-1} - \beta \omega_4 \mathbb{E}_t x_{t+1} + u_t, \quad (22)$$

where  $\omega_1 = \frac{\beta}{1+\beta\gamma}$ ,  $\omega_2 = \frac{\gamma}{1+\beta\gamma}$ ,  $\omega_3 = \Theta(\eta + \delta_1)$ ,  $\omega_4 = \Theta\delta_2$ ,  $\delta_1 = \frac{\sigma(1+\beta h^2)}{(1-h)(1-\beta h)}$ ,  $\delta_2 = \frac{h\sigma}{(1-h)(1-\beta h)}$ , and  $\Theta = \frac{(1-\beta\theta)(1-\theta)}{\theta(1+\beta\gamma)}$ .  $\gamma$  is the degree of price indexation,  $\eta$  is the inverse of the Frisch elasticity of labor supply,  $\theta$  is the usual Calvo parameter.  $u_t$  is again a cost-push shock which is described by a stochastic process (18). Note that for  $\gamma = 0$ , equation (22) collapses into the purely forward-looking New Keynesian Phillips curve.

Following Woodford (2003, Ch. 6), the welfare-theoretic loss function is of the form

$$Loss = \text{Var}(\pi_t - \gamma\pi_{t-1}) + \alpha_x \text{Var}(x_t - \delta x_{t-1}), \quad (23)$$

where  $\alpha_x = \frac{\Theta h \sigma}{\chi \delta (1-\beta h)(1-h)}$ ,  $\chi$  denotes the elasticity of substitution between differentiated goods, and  $\delta$  is the smaller root of the quadratic equation  $\frac{h\sigma}{(1-\beta h)(1-h)}(1 + \beta\delta^2) = \left(\eta + \frac{\sigma}{(1-\beta h)(1-h)}(1 + \beta h^2)\right)\delta$ .

We complete the description of the model by presenting the calibration. The time unit is one quarter. The discount rate is equal to  $\beta = 0.99$ , implying a quarterly steady-state real interest rate of approximately one percent. The intertemporal elasticity of substitution is assumed to be  $\sigma = 2$ . We follow Casares (2006) and set the habit formation parameter to  $h = 0.85$ . The Frisch elasticity of labor supply is set 1.  $\chi$  is set to 8 which implies a steady-state mark-up in the goods market of approximately 14 percent. The Calvo parameter  $\theta$  is set to 0.75 implying an average duration of price contracts of one year. The price indexation parameter  $\gamma$  is set to 0.45 which is roughly equal to the value reported by Smets and Wouters (2003).

The results of our numerical simulations are shown in Table 2. We again observe that an augmented interest rate rule performs identical to the standard Taylor rule when shocks occur unexpectedly. In the case of anticipated shocks, this is again not true. As in the baseline model, the rule  $i_t = f(\pi_t, x_t, \mathbb{E}_t \pi_{t+1}, \mathbb{E}_t x_{t+1})$  performs best within the set of simple rules considered. This holds when agents learn about the exogenous disturbance 3

Rule	Loss		
	$\tau = 0$	$\tau = 3$	$\tau = 8$
Unrestricted optimal policy	0.0899	0.1829	0.2155
$i_t = f(\pi_t, x_t)$	0.0900	0.1843	0.8148
$i_t = f(\pi_t, x_t, E_t \pi_{t+1})$	0.0900	0.3058	0.5679
$i_t = f(\pi_t, x_t, E_t x_{t+1})$	0.0900	0.3044	0.2164
$i_t = f(\pi_t, x_t, E_t \pi_{t+1}, E_t x_{t+1})$	0.0900	0.1839	0.2162
$i_t = f(x_t, E_t \pi_{t+1})$	0.1065	1.4032	1.5427
$i_t = f(\pi_t, E_t x_{t+1})$	0.0900	0.4823	0.2166
$i_t = f(E_t \pi_{t+1}, E_t x_{t+1})$	0.1000	1.3844	1.5244

**Table 2:** Optimal simple rules in a hybrid model with news shocks

as well as 8 quarters in advance.<sup>4</sup>

Finally, we relate our findings to the recent literature that analyzes the impacts of news shocks on macroeconomic volatility. Fève, Matheron and Sahuc (2009) and Winkler and Wohltmann (2009) demonstrate that news shocks potentially amplify the volatility of key macroeconomic variables. Our results strongly support this finding by showing that the anticipation of future cost disturbances hikes the social loss which is assumed to be a weighted average of variances. Importantly, our results show that this is true irrespective of the way monetary policy is conducted and irrespective of the model considered.

## 4 Conclusion

This paper offered a novel insight about the optimal conduct of monetary policy by demonstrating that news shocks provide a rationale for the inclusion of forward-looking elements in optimal monetary policy rules. We demonstrated that the optimal implicit instrument rule derived from the solution of an optimal control problem comprises a forward-looking element when disturbances are anticipated in advance. In the standard case of unanticipated shocks, this rule is only a linear function of backward-looking state variables. We infer from this general result that optimal simple (monetary) policy rules should also contain a forward-looking element. We show that this conjecture is indeed true by evaluating a set of optimal simple rules within two simple models, namely the baseline New Keynesian framework and its hybrid variant. For news shocks, we find that partly forward-looking

<sup>4</sup>Our results suggest that the optimized simple rules  $i_t = f(\pi_t, x_t, E_t \pi_{t+1})$  and  $i_t = f(\pi_t, x_t, E_t x_{t+1})$  perform worse than the optimized standard Taylor rule  $i_t = f(\pi_t, x_t)$  for  $\tau = 3$ . However, this result is caused by problems of Dynare's `osr` program since these rules comprise the standard Taylor rule as a limiting case and hence they can not be inferior to it.

simple rules are welfare-enhancing when compared to a standard optimized Taylor rule. However, consistent with our theoretical result, the inclusion of forward-looking elements does not enhance the performance of optimal simple rules if shocks occur unexpectedly.

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