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Strategic deviations in optimal monetary policy

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Abstract

This paper investigates the circumstances under which a central bank is more or less likely to deviate from the optimal monetary policy rule. The research question is addressed in a simple New Keynesian dynamic stochastic general equilibrium (DSGE) model in which monetary policy deviations occur endogenously. The model solution suggests that higher future central bank credibility attenuates the current period policy trade-off between a stable inflation rate and a stable output gap. Together with the loss of credibility after a policy deviation, this provides the central bank with an incentive to implement past policy commitments. The result is valid even if the central bank may recover credibility with some probability after a policy deviation. My main finding is that the central bank is willing to implement past policy commitments if a sufficient fraction of agents is not aware of the exact end date of the policy commitment. The result challenges the time-inconsistency argument against monetary policy commitments and provides a potential explanation for the repeated implementation of monetary policy commitments in reality.

Keywords: Optimal monetary policy, Strategic deviations, Forward guidance

1 Introduction

Central banks have recently used more or less explicit policy commitments to manage public expectations. For example, the Swiss National Bank (SNB) promised to defend a EUR/CHF exchange rate floor with „utmost determination“ (September 6, 2011). Somewhat less explicit, the Federal Reserve Bank (Fed) “anticipate[d] (...) exceptionally low levels of the federal funds rate for some time“ (December 16, 2008). Similarly, the European Central Bank (ECB) “expecte[d] the key ECB interest rates to remain at present or lower levels for an extended period of time“ (Juli 4, 2013).

An open question is, however, under which circumstances a central bank is more or less likely to deviate from the announced policy path. Moreover, it is unclear how *future* central bank credibility interacts with the incentives to implement past policy commitments. The two research questions are as follows: first, how does future central bank credibility affect the optimal monetary policy rule? Second, under which circumstances is it optimal for the central bank to implement past policy commitments?

Answering the research questions sheds light on the importance of central bank credibility in monetary policy making. Central bank credibility has become increasingly relevant. For example, the effectiveness of forward guidance depends crucially on central bank credibility. The reason is that forward guidance works through agents' expectations (cf. (Angeletos and Lian 2018)). Likewise, new policy proposals like average inflation targeting draw their merits from the central bank's ability to make a credible policy commitment (cf. (Nessén and Vestin 2005)).

My paper connects to various strands of the literature, most notably to the literature on optimal monetary policy and the literature on limited commitment in monetary policy. The current literature on optimal monetary policy (e.g., Galí (2015); Woodford (2005); Clarida et al. (1999)) is mainly concerned with the central bank's policy trade-off in the presence of a cost-push shock: either the central bank stabilizes the inflation rate or it stabilizes the output gap. The optimal response to a cost-push shock is to

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smooth the response of the inflation rate and the output gap over time. Under full commitment, the central bank can deliver such an outcome, even though the optimal policy path may be time-inconsistent[1]. In contrast, under discretion a central bank lacks the credibility to effectively commit to a future policy path. Being constrained by that the central bank must (sub-optimally) react more forcefully when the cost-push shock hits the economy.

Problematically, both full commitment and discretion are implausible on theoretical and empirical grounds. Concerning full commitment, it is unclear how a central bank can prevent itself from a favorable policy deviation once time passes. Monetary policy decisions are usually taken by a committee in which individual members serve for some years only. Consequently, later cohorts can overturn commitments of earlier cohorts. Discretion, on the other hand, has become a less appealing concept in light of recent monetary policy conduct (e.g., forward guidance): it seems implausible to assume that a central bank issues a statement regarding its future policy conduct without *any* intention to deliver. Woodford (2012) argues that any form of forward guidance is in part interpreted as a policy commitment with some, but limited commitment.

As a consequence, researchers have recently started to study limited commitment in optimal monetary policy (e.g., Debortoli et al. (2014); Debortoli and Lakdawala (2016); Schaumburg and Tambalotti (2007)). In these models, the central bank is *exogenously* selected to deviate from past policy commitments with a time-invariant, state-independent probability. My work suggests that a time-invariant limited commitment scenario is not fully compatible with strategic policy decisions: In fact, central bank credibility is either time-varying or equal to one of the two extreme cases, i.e., full credibility or zero credibility[2]. In addition, a state-independent probability for a policy deviation may provoke outcomes which are inconsistent with basic economic logic, namely policy deviations when the implementation of past policy commitments would have delivered a higher welfare. Such outcomes are ruled out in my model.

In sum, my paper investigates the effects of future central bank credibility on the optimal monetary policy rule, as well as the circumstances under which a central bank is more or less likely to deviate from the announced policy path. It applies a simple New Keynesian dynamic stochastic general equilibrium (DSGE) model in which the central bank decides strategically whether or not to honor past policy commitments. Endogenous policy deviation come with a transitory loss of central bank credibility. After a policy deviation, the central bank may regain access to a commitment technology with a non-zero probability.

The results show that higher future expected central bank credibility attenuates the current period policy trade-off between a stable inflation rate and a stable output gap. This provides the central bank with an incentive to implement past policy commitments. Furthermore, I find that the central bank is willing to implement past policy commitments if a sufficient fraction of agents is not aware of the exact end date of the policy commitment.

The remaining of this paper is organized as follows. Section 2 discusses some additional literature. Section 3 derives the solution to the optimal monetary policy problem under limited credibility. Furthermore, it introduces the notion of strategic policy decisions. Section 4 presents the results of the analysis. Section 5 concludes.

2 Additional literature

In addition to the previously mentioned papers, my work connects to the literature on rules versus discretion and forward guidance. Kydland and Prescott (1977) and Barro and Gordon (1983a) were the first to analyze the relevance of rules versus discretion in monetary policy. In particular, their work studies the *permanent* temptation to deviate from a monetary policy rule that prescribes a state-independent, pre-announced inflation rate. Inflation surprises are beneficial because they reduce the natural unemployment rate towards the time-invariant efficient unemployment rate which is below the natural unemployment rate. Furthermore, they find that policy rules are, in general, not enforceable (i.e., time-inconsistent), unless a commitment technology is *assumed*. In an extension, Barro and Gordon (1983b) investigate enforceable policy rules when the central bank looses reputation from a policy deviation. They find that under such circumstances, policy rules may be enforceable if they are sufficiently close to the discretionary policy prescription.

The current debate on time-inconsistency of monetary policy rules is related to the central bank's optimal response to an exogenous inflation shock (e.g., Galí (2015); Woodford (2005); Clarida et al. (1999)). Such a cost-push shock drives a *temporary* wedge between the natural output level and the efficient output level.

The literature on forward guidance studies limited commitments in monetary policy. Bodenstein et al. (2012), for example, define forward guidance as the explicit commitment to implement policy in accordance with the optimal monetary policy rule under time-invariant limited credibility. In their paper, the timing of a policy deviation

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[1] Barro and Gordon (1983a) [599-600] argue that it is "deceptive" to term a policy rule "time-inconsistent" when "policymakers [have] incentives to deviate from the rule when agents expect it to be followed." They claim that "the incentives to deviate from the rule are irrelevant, since commitments are assumed to be binding. Thus, the time-inconsistency of the optimal solution is (...) irrelevant when commitments are feasible." Somewhat less restrictive, Clarida et al. (1999) define time-consistency as the absence of "incentives to change its plans in an unexpected way." I will use the latter definition of time-consistency.

[2] Central bank credibility is defined as the probability with which the central bank commitment is expected to be implemented in the future.

is exogenous. Such a setup provokes outcomes which are sub-optimal. In particular, it may be that the central bank is forced into a policy deviation when the continuation of the policy plan would have been optimal. In my model, policy deviations occur strategically, i.e., only if a policy deviations delivers a higher welfare than the implementation of the pre-announced policy path.

Haberis et al. (2014) model forward guidance as an imperfectly credible interest rate peg. They assume that the central bank's credibility increases with a (time-varying) fixed cost associated to a policy deviation. My model is more transparent about the nature of this cost: A policy deviation is costly because it is associated to higher future macroeconomics volatility. Furthermore, in their model, the actual decision of whether or not to implement past policy commitments is simply a coin-toss. It is hence subject to the critique that this may force the central bank to deviate even though it would have preferred to deliver.

3 Model

This section is organized as follows. First, it presents the core of the New Keynesian model as in Galí (2015). Second, it derives the model solution under limited commitment as in Debortoli et al. (2014). Third, it introduces the notion of strategic deviations. Forth, it presents the driving process of the model and the model calibration. Fifth, it describe the finite period version of the model which is used to study strategic deviations in optimal monetary policy.

3.1 Model environment and optimal monetary policy

I analyze optimal monetary policy with strategic policy deviations and limited commitment in a simple New Keynesian dynamic stochastic general equilibrium (DSGE) model similar to Galí (2015). The model features a representative household which maximizes a utility function over consumption and leisure. In addition, there is a continuum of monopolistically competitive firms, producing differentiated intermediary output goods with a linear technology. There is no capital in the model. In each period, firms may re-optimize the price of their output goods with probability $1-\theta$, where $\theta \in (0,1)$, as in Calvo (1983). The log-linearized non-policy equilibrium of the model is given by the dynamic IS Eq. (1) and the New Keynesian Philipps curve (2)

$$x_t = \mathbb{E}_t x_{t+1} - \frac{1}{\sigma}\left(i_t - \mathbb{E}_t \pi_{t+1} - \rho\right) \tag{1}$$

$$\pi_t = \kappa x_t + \beta \mathbb{E}_t \pi_{t+1} + u_t \tag{2}$$

where x_t is the efficient output gap, π_t the inflation rate, i_t the nominal interest rate, u_t the cost-push shock, $\sigma \geq 0$ the constant relative risk aversion or, equivalently, the inverse intertemporal elasticity of substitution, ρ the steady state real interest rate, $\kappa \equiv \xi(\sigma + \varphi)$ with $\xi \equiv \frac{(1-\theta)(1-\beta\theta)}{\theta}$, and $\beta \in (0,1)$ the discount factor of the household. φ is the inverse of the Frisch labor supply elasticity[3].

The central bank is a benevolent planer who aims at maximizing the welfare of the representative household. Borrowing from Galí (2015) and Woodford (2005), the welfare loss function is approximated by

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \frac{1}{2}\left(\pi_t^2 + \vartheta x_t^2\right) \tag{3}$$

if the central bank operates under full commitment, i.e., if commitments are honored with probability 1. The weight of the output gap in the welfare loss function is given by $\vartheta \equiv \frac{\xi}{\epsilon}(\sigma + \varphi)$, where $\epsilon \in (1, \infty)$ is the elasticity of substitution between intermediary goods[4].

Naturally, the central bank can only control the household's expectations in as far as the household anticipates the central bank to honor its commitments. This is important because the allocations off the path on which commitments are honored are exogenous to the central bank problem.

3.2 Optimal monetary policy under limited commitment

Building on the work of Debortoli and Lakdawala (2016) and Debortoli et al. (2014), who derive the welfare loss function under limited commitment, I additionally introduce time-variation in central bank credibility[5].

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \prod_{i=0}^{t-1} \gamma_i \frac{1}{2}\left(\pi_t^2 + \vartheta x_t^2\right) \tag{4}$$

where γ_t denotes the central bank's credibility in period t and $\prod_{i=0}^{-1} \gamma_i = 1$. Note that γ_0 (rather than γ_1) is associated to (x_1, π_1) because the probability with which the household expects the period 0 commitment to be implemented in period 1 is governed by the central bank's credibility in period 0. The policy problem is subject to the New Keynesian Phillips curve

$$\pi_t = \kappa x_t + \beta \gamma_t \mathbb{E}_t \pi_{t+1} + \beta(1-\gamma_t)\mathbb{E}_t \pi_{t+1}^d + u_t \tag{5}$$

where $\mathbb{E}_t \pi_{t+1}$ is the inflation rate that is expected to prevail if commitments are honored in period $t+1$ and $\mathbb{E}_t \pi_{t+1}^d$ the inflation rate that is expected to prevail if the central bank deviates from the announced policy path in period $t+1$. Assume that the inflation rate which is expected to prevail if the central bank reneges on past policy commitment in $t+1$ is an arbitrary (linear) function of the state variable(s) in $t+1$. Formally, assume $\mathbb{E}_t \pi_{t+1}^d = \mathbb{E}_t f_{t+1}(u_{t+1})$ with the (time-varying) functional form of f_{t+1} unknown. Expressed as a Lagrangian, the central bank problem is

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[3] Details of the derivation are provided in the Online Appendix.

[4] Details of the derivation are provided in the Online Appendix.

[5] The derivation is provided in the Online Appendix.

$$\begin{aligned}\mathcal{L} =& \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \prod_{i=0}^{t-1} \gamma_i \Big\{ \frac{1}{2} \left(\pi_t^2 + \vartheta x_t^2\right) + \lambda_t \Big(\pi_t - \kappa x_t \\ &- \beta \gamma_t \pi_{t+1} + \beta (1-\gamma_t) f_{t+1}(u_{t+1}) - u_t \Big) \Big\}\end{aligned} \tag{6}$$

with λ_t being the Lagrange multiplier associated to the New Keynesian Phillips curve in period t[6]. Combining and iterating on the first order conditions with respect to π_t and x_t yields

$$x_t = -\frac{\kappa}{\vartheta} \left[\pi_t + \pi_{t-1} + \ldots + \pi_0 - \lambda_{-1}\right] \tag{7}$$

if $\gamma_i > 0 \ \forall i \in \{0, \ldots, t-1\}$[7]. By construction, deviations from the announced policy path in period s require $\lambda_{s-1} = 0$, as in Debortoli et al. (2014). Setting $\lambda_{s-1} = 0$ implies $x_s = -\frac{\kappa}{\vartheta} \pi_s$ which is the optimality condition for the period in which the policy plan is first implemented (cf. Galí (2015) 130, 135). In other words, setting the non-physical $\lambda_{s-1} = 0$ is akin to a policy deviation in period s[8]. Consequently, with $t = 0$ being the initial period of the policy plan

$$x_t = -\frac{\kappa}{\vartheta} \hat{p}_t \tag{8}$$

where $\hat{p}_t \equiv \pi_t + \hat{p}_{t-1}$ and $\hat{p}_{-1} = 0$[9]. For $t > 0$, the optimal output gap depends not only on the current inflation rate but also on lagged inflation rates. That is, there is a history dependence in the optimal output gap. This finding previews the result that under (limited) credibility it is both possible and optimal to commit to future policy responses when facing a current period cost-push shock. The reason is that such a commitment affects the household's expectations which in turn affect current period variables (in particular, the inflation rate). Consequently, less of a current period variability in the output gap is necessary to achieve the optimal inflation rate. This is beneficial because the welfare loss function is strictly convex in the inflation rate and the output gap. To solve the model, re-express the New Keynesian Phillips curve in terms of $\hat{p}_t$.

$$\hat{p}_t = \mu_t \left[\hat{p}_{t-1} + \beta \gamma_t \mathbb{E}_t \hat{p}_{t+1} + \beta (1-\gamma_t) \mathbb{E}_t \pi_{t+1}^d + u_t\right] \tag{9}$$

with $\mu_t \equiv \frac{\vartheta}{\vartheta(1+\beta\gamma_t)+\kappa^2}$. Suppose $u_t \sim AR(1)$ with $\mathbb{E}(\varepsilon_t^u) = 0$ and $V(\varepsilon_t^u) = \sigma^2_{\varepsilon_t^u}$ and guess the time-varying solution for $\hat{p}_t$ to be a linear function of $\hat{p}_{t-1}$ and u_t.

$$u_t = \rho_u u_{t-1} + \varepsilon_t^u \tag{10}$$

$$\hat{p}_t = a_t \hat{p}_{t-1} + c_t u_t \tag{11}$$

Further guess the time-varying (linear) solution $\pi_t^d = \hat{h}_t u_t$ with $\hat{h}_t$ unknown. Finally, assume that the central bank implements the discretionary solution with certainty in $T + i \ \forall i \geq 1$. Analyzing a finite period model ($T < \infty$) is useful because it allows to solve the model by backward iteration without any meaningful loss of economic substance. In particular, as of period T, the only optimal monetary policy rule consistent with rational expectations and perfect information is the discretionary optimal monetary policy rule. This is because the unique set of central bank credibility consistent with rational expectations and perfect information is $\gamma_{T+i} = 0 \ \ \forall i \geq 0$[10].

Plug the guess for $\hat{p}_t$ (Eq. 11) and the guess for π_t^d into the re-expressed Phillips curve (Eq. 9) and solve recursively for $a_t \in (0, 1)$.

$$\hat{p}_t = \frac{\mu_t}{1 - \mu_t \beta \gamma_t a_{t+1}} \left[\hat{p}_{t-1} + (1 + \beta \gamma_t c_{t+1} \rho_u + \beta (1-\gamma_t) \hat{h}_{t+1} \rho_u) u_t\right] \tag{12}$$

$$a_t = \frac{\mu_t}{1 - \mu_t \beta \gamma_t a_{t+1}} \ \ \forall \ t \tag{13}$$

Realize that a deviation from the announced policy path in t requires $\hat{p}_{t-1} = 0$ (cf. Eq. 8). From the guess for $\hat{p}_t$ (Eq. 11), we know that $\hat{p}_t^d = c_t u_t$. Furthermore, by definition, $\hat{p}_t^d = \pi_t^d$. Because I assume $\pi_t^d = \hat{h}_t u_t$, it must be that $\hat{h}_t = c_t \ \forall t$. Solve recursively for $c_t \ \forall t \in \{0, \ldots, T\}$, using $\{a_t\}_{t=0}^{T+1}$ from above.

$$c_t = \frac{\mu_t (1 + \beta c_{t+1} \rho_u)}{1 - \mu_t \beta \gamma_t a_{t+1}} \quad \forall t \in \{0, \ldots, T\} \tag{14}$$

with $c_{T+i} = \frac{\vartheta}{\kappa^2 + \vartheta(1-\beta\rho_u)} \ \ \forall i \geq 1$ as in (Galí (2015), 130). The optimality condition (Eq. 8), together with the guess for $\hat{p}_t$ (Eq. 11) and the solution for the coefficients (in particular, $c_t = \hat{h}_t$) yields the time-varying model solution for $\gamma_t \in (0, 1)$

$$x_t = a_t x_{t-1} - \frac{\hat{h}_t \kappa}{\vartheta} u_t \tag{15}$$

where $\mu_t \equiv \frac{\vartheta}{\vartheta(1+\beta\gamma_t)+\kappa^2} \ \forall t$, $a_t = \frac{\mu_t}{1-\mu_t\beta\gamma_t a_{t+1}} \ \forall t$, $\hat{h}_t = \frac{\mu_t(1+\beta\hat{h}_{t+1}\rho_u)}{1-\mu_t\beta\gamma_t a_{t+1}} \ \forall t \in \{0, \ldots, T\}$, and $\hat{h}_{T+i} = \frac{\vartheta}{\kappa^2+\vartheta(1-\beta\rho_u)} \ \ \forall i \geq 1$.

The output gap x_t depends on the *entire* sequence of current and future central bank credibilities $\{\gamma_j\}_{j=t}^T$. More specifically, $\{\gamma_j\}_{j=t}^T$ determines the optimal persistence in the output gap as well as the severity of the policy trade-off.

As a result of the classic policy trade-off, the central bank optimally commits to a conditional (future)

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[6] The derivation of the model solution is provided in the Online Appendix.

[7] With $\gamma_0 = 0$, the central bank's first order condition is $x_t = -\frac{\kappa}{\vartheta} \pi_t$.

[8] For more details, see Eqs. 143 and 145 in the Online Appendix.

[9] In the period of the policy implementation ($t = 0$), the *ratio* between the inflation rate and the output gap is independent of central bank credibilities. However, the *level* of the inflation rate and the output gap changes with $\{\gamma_t\}_{t=0}^T$ (cf. Eq. 15).

[10] So far, γ_t is not *constrained* to be consistent with rational expectations and perfect information. In other words, $\gamma_T > 0$ is, in principle, possible even though the central bank implements the discretionary solution in period $T + 1$ with certainty.

deflation in response to a positive cost-push shock. Crucially, to decrease $\mathbb{E}_t\pi_{t+1}$ sufficiently, the central bank must announce a more pronounced deflation, the shorter the horizon over which the central bank is expected to implement the policy commitment. In other words, the central bank must implement a more persistent (negative) output gap, the sooner the central bank is expected to return to a discretionary mode. Formally, the lower T and/or the lower the values in $\{\gamma_j\}_{j=t}^{T}$, the higher a_t.

The degree to which the household's expectations adjust to policy commitments determines the severity of the policy trade-off between the output gap and the inflation rate in period t. More specifically, if the (representative) household expect the policy commitment to be implemented over a shorter horizon, the policy trade-off becomes more severe ($\hat{h}_t$ rises).

To illustrate, assume that the central bank's optimal policy is a commitment to a (conditional) future deflation. Since the inflation rate can be expressed as a (positive) function of discounted future expected output gaps, $\mathbb{E}_t\pi_{t+1}$ is *ceteris paribus* higher, the lower T and/or the lower the values in $\{\gamma_j\}_{j=t}^{T}$. From above, we know that this off-equilibrium increase in $\mathbb{E}_t\pi_{t+1}$ induces the central bank to commit to a higher persistence in the output gap. However, households discount future expected inflation rates and incur convex losses from x_t and π_t. For this reason, the (off-equilibrium) rise in $\mathbb{E}_t\pi_{t+1}$ cannot be offset completely by the central bank's optimal commitment to a higher persistence in the output gap. It is for that reason that the current period policy trade-off accentuates. Formally, the lower T and/or the lower the values in $\{\gamma_j\}_{j=t}^{T}$, the higher the impact coefficient ($\hat{h}_t$).

3.3 Strategic deviations in optimal monetary policy

In contrast to previous work on limited commitment in optimal monetary policy, I allow the central bank to take *strategic* policy decisions. More specifically, the central bank can either honor past policy commitments or deviate. It delivers on past policy commitments if and only if the value of doing is strictly greater than the value associated to a policy deviation.

Introducing strategic policy deviations is important for two reasons. First, it shows under which circumstances a central bank is *more or less* likely to deviate from the announced policy path. Debortoli et al. (2014) were the first who adressed this question: They report the potential welfare gains of a policy deviation over the horizon of the impulse response function to a cost-push shock. My work complements their analysis by showing that the temptation to deviate is not only time-dependent, but also state-dependent.

Second, the introduction of strategic policy deviations provides an endogenous criterion based on which we can assess *whether or not* the central bank would deviate from past policy commitments. This debate seemed to be resolved because the static perspective suggests that it is always weakly preferable to implement the discretionary solution. My work shows that there are dynamic considerations which induce the central bank to implement past policy commitments.

The strategic policy problem is a recursive representation of the central bank optimization problem (Eq. 4) that takes into account that the continuation values differ depending on the central bank's policy choice. Importantly, it is assumed that the central bank looses its credibility for some time after deviating from the announced policy path. In each period after a policy deviation, including the period of the policy deviation, the central bank may regain access to a commitment technology with a non-zero probability. The central bank can take a strategic policy decision in period $t+1$ after it deviated in period t only if it regains access to a commitment technology in period t. By contrast, if the central bank honors past policy commitments in t, it can take a strategic policy decision in $t+1$ with certainty. Formally,

$$V_t^d(u_t) = \max_{\{x_{t+s},\pi_{t+s}\}_{s=0}^{\infty}} U_t^d + \beta\left[p_r\mathbb{E}_t V_t(x_{t-1},\gamma_{t-1},u_t) + (1-p_r)\mathbb{E}_t V_{t+1}^d(u_{t+1})\right] \tag{16}$$

$$V_t^h(x_{t-1},\gamma_{t-1},u_t) = \max_{\{x_{t+s},\pi_{t+s}\}_{s=0}^{\infty}} U_t^h + \beta\mathbb{E}_t V_{t+1}(x_t,\gamma_t,u_{t+1}) \tag{17}$$

$$V_t(x_{t-1},\gamma_{t-1},u_t) = \max\left\{V_t^d(u_t), V_t^h(x_{t-1},\gamma_{t-1},u_t)\right\} \tag{18}$$

$$U_t^i = -\frac{1}{2}\left(\pi_{t,i}^2 + \vartheta x_{t,i}^2\right) \tag{19}$$

where V_t^d denotes the value associated to a policy deviation in period t, V_t^h the value associated to honored commitments in period t, p_r the probability of regaining access to a commitment technology after a policy deviation, and U_t^i the period objective function of the central bank evaluated at the optimal $x_{t,i}$ and $\pi_{t,i}$, i.e., evaluated at the $x_{t,i}$ and $\pi_{t,i}$ which satisfy the optimal monetary policy rule under limited credibility (Eq. 15). If the probability of regaining access to a commitment technology after a policy deviation is zero ($p_r = 0$), policy deviations come with a permanent and complete loss of central bank credibility. By contrast, if $p_r = 1$, the central bank is not punished in terms of credibility for deviating from the announced policy plan. $x_{t,i}$ and $\pi_{t,i}$ depend on the central bank's policy choice $i \in \{d,h\}$ where d stands for a policy deviation and h stands for the implementation of past policy commitments.

3.4 The driving process and model calibration

The driving force is a cost-push shock u_t^j which evolves according to a 2-state Markov process where the (discrete) magnitude of u_t^j is indexed by $j \in \{L, H\}$. Formally,

$$\begin{bmatrix} u_t^H \\ u_t^L \end{bmatrix} = \begin{bmatrix} p_{H,H} & 1 - p_{L,L} \\ 1 - p_{H,H} & p_{L,L} \end{bmatrix} \begin{bmatrix} u_{t-1}^H \\ u_{t-1}^L \end{bmatrix} \tag{20}$$

where $1 - p_{L,L}$ denotes the probability of transitioning from the low state L to the high state H (which is associated to u_t^H). Let $u_t^H = -u_t^L$ with $u_t^H > u_t^L$ and assume, for simplicity, that $p_{H,H} = p_{L,L} = 0.5$.

The model is calibrated to quarterly data as suggested in (Galí (2015) 67). In particular, $\beta = 0.99$ (implying a annualized steady state real interest rate of approximately 4%), $\epsilon = 9$ (implying a steady state mark-up of 12.5%), $\alpha = 0$ (reflecting a simplifying constant returns to scale assumption), $\sigma = 1$ (log-utility), $\psi = 5$ (implying a Frisch elasticity of the labor supply equal to 0.2), $\theta = 0.75$ (implying an average duration of a price equal to four quarters), $\rho_u = 0$ (where not stated otherwise), and $u_t^H = 0.005$. Finally, I allow the central bank to regain access to a commitment technology with a quarterly probability of $p_r = 0.10$. The calibration was selected so as to ensure that the central bank has a greater than 95 percent probability of regaining access to a commitment technology 8 years after the policy deviation. With $p_r = 0.1$, the probability of having access to a commitment technology 8 years after the policy deviation is 96.6%.

3.5 A simple model with strategic policy deviations

Suppose $t = \{0, 1, 2, 3\}$, with $T = 2$, and assume $x_{-1} = 0$. The central bank decides strategically whether or not to deviate from the optimal monetary policy rule in $t = \{1, 2\}$. In period $T + 1$, the central bank implements the discretionary solution with certainty.

Consistency with rational expectations requires that the agents' beliefs about the number of states in which a policy deviation occurs coincide with the actual number of states in which a policy deviation occurs. For example, $\gamma_t = 1$ is consistent with rational expectations and perfect information if and only if the central bank implements past policy commitments in period $t + 1$ independent of the realization of u_{t+1}. $\gamma_t = 0.5$ is consistent if and only if past policy commitments are implemented in exactly one state in period $t + 1$ (provided that u_{t+1} can only take on two values), and $\gamma_t = 0$ is consistent if the central bank reneges on past policy commitments in period $t + 1$ independent of the realization of u_{t+1}.

Future central bank credibility affects the optimal allocation in period t via two channels: Directly via the optimal future allocation (i.e., via $\mathbb{E}_t \pi_{t+1}$) and indirectly via today's solution coefficients (a_t and h_t). For this reason, we must assess the consistency of each γ_i conditional on an entire *sequence* of $\{\gamma_t\}_{t=i}^{T}$ rather than conditional on γ_i only. A consistent sequence of $\{\gamma_t\}_{t=0}^{T}$ is a sequence in which every individual γ_t is consistent.

4 Results

In response to a positive cost-push shock, the central bank cannot simultaneously stabilize the inflation rate and the output gap. Because the central bank objective function is convex in π_t and x_t, it is moreover suboptimal to *either* stabilize the inflation rate *or* the output gap. Consequently, the optimal response to a positive cost-push shock consists of a positive inflation rate and a negative output gap. The implementation of a negative output gap exerts negative pressure on the inflation rate and partly offsets the (off-equilibrium) rise in the inflation rate caused by the positive cost-push shock. Furthermore, the optimal policy path involves a commitment to a prolonged (conditional) recession which is accompanied by a negative inflation rate.

4.1 Future central bank credibility and current period allocation

The optimal monetary policy rule with strategic policy deviations shows that the persistence in the output gap (a_t) as well as the severity of the policy trade-off ($\hat{h}_t$) depend on current and future central bank credibilities ($\gamma_{t+i}\ \forall i \geq 0$). These central bank credibilities may be time-varying. My model is hence flexible enough to study the effect of future (time-varying) central bank credibilities on the current optimal monetary policy rule. By that, it advances on the research of Galí (2015); Woodford (2005) and Debortoli et al. (2014) who implicitly assume a time-invariant optimal monetary policy rule.

To illustrate the dependence of the optimal monetary policy rule on future central bank credibilities, consider two simulations (indexed by *j*) with a deterministic sequence of central bank credibilities $\left\{\gamma_t^j\right\}_{t=0}^{T+1}$ (where $T = 2$) and a deterministic sequence of cost-push shocks $\{u_t\}_{t=0}^{T+1} = \{H, 0, 0, 0\}$. In simulation a, the central bank credibilities are $\left\{\gamma_t^a\right\}_{t=0}^{T+1} = \{1, 1, 1, 0\}$ and in simulation b they are $\left\{\gamma_t^b\right\}_{t=0}^{T+1} = \{1, 1, 0, 0\}$. Policy commitments are assumed to be honored in $t \in \{0, 1, 2\}$ but not in $t = 3$[11].

How does future central bank credibility affect the optimal monetary policy rule? Let us first investigate how the optimal persistence in the output gap is affected by future central bank credibilities. Suppose, for the sake of the argument, that the impact coefficient of the cost-

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[11] $\gamma_t = 0$ does not *per se* imply a policy deviation in period t. It only reflects the central bank's inability to credibly commit to a future policy path. In other words, $\gamma_t = 0$ does not, *per se*, refrain the central bank from implementing past policy commitments. Similarly, $\gamma_{t-1} = 1$ does not *per se* imply honored commitments in period t because γ_{t-1} solely reflects the probability with which the agents expect future central bank commitments to be implemented.

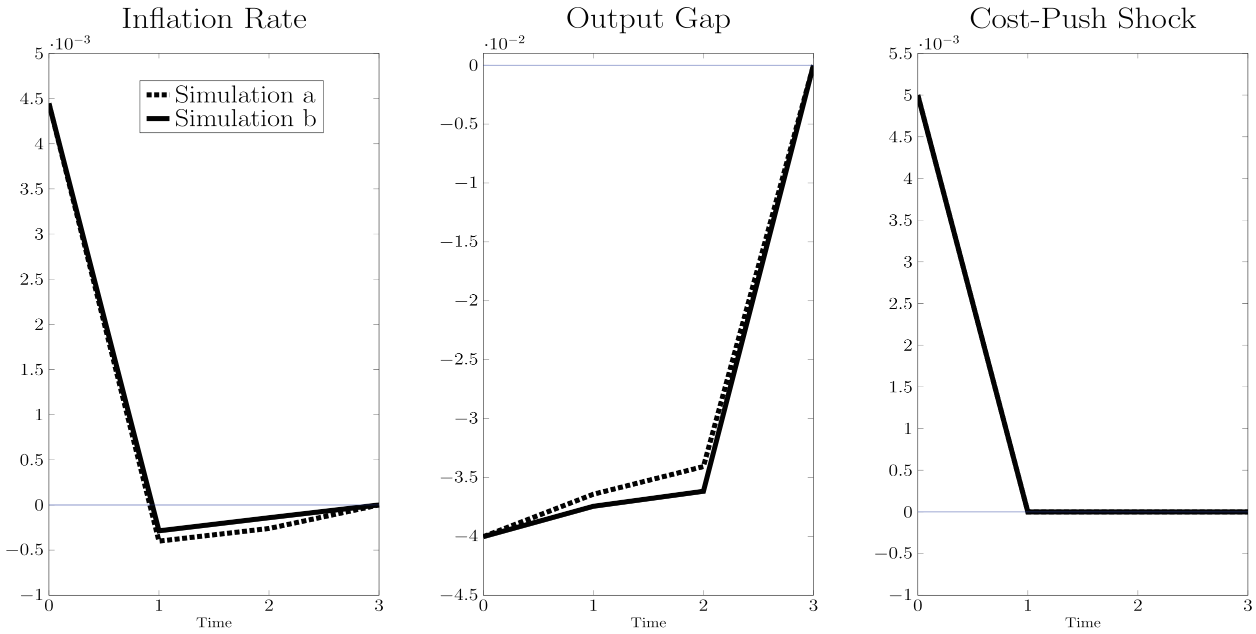

Fig. 1 The optimal persistence in the policy rule. The inflation rate, the output gap, and the cost-push shock under two policy simulations. Simulation *a* (dashed lines) assumes central bank credibilities $\left\{\gamma_t^a\right\}_{t=0}^{T+1} = \{1,1,1,0\}$ and simulation *b* (solid lines) assumes central bank credibilities $\{\gamma_t^b\}_{t=0}^{T+1} = \{1,1,0,0\}$. In both simulations, the sequence of cost-push shocks is $\{u_t\}_{t=0}^{T+1} = \{H,0,0,0\}$ and $\rho_u = 0$. To highlight the difference in the optimal persistence in the policy rule, the impact coefficients of the cost-push shock on the output gap $(\hat{h}_t^j)$ are equalized across simulations $j = \{a,b\}$

push shock $(\hat{h}_t)$ is equal in both simulations. Under this assumption, the allocation in period t depends on future central bank credibilities only because future central bank credibilites affect the optimal persistence in the output gap.

Monetary policy commitments affect the agents' expectations about future output gaps. By that, they exert (positive or negative) pressure on the current inflation rate. To see this, re-express the Phillips curve as follows:

$$\pi_0^a = \kappa \mathbb{E}_0 \sum_{i=0}^{3} \beta^i x_i^a + u_t \tag{21}$$

$$\pi_0^b = \kappa \mathbb{E}_0 \sum_{i=0}^{2} \beta^i x_i^b + u_t \tag{22}$$

In simulation a $(\gamma_2 = 1)$, agents expect the central bank to honor policy commitments in period 3 while in simulation b $(\gamma_2 = 0)$, agents expect a return to the feasible $(x_t, \pi_t) = (0,0)$ allocation in period 3. Facing a positive cost-push shock in $t = 0$, a naïve central banker may consider the same policy commitment independent of future central bank credibilities. Is this optimal, knowing that $\mathbb{E}_0 x_3^a < 0$ and $\mathbb{E}_0 x_3^b = 0$? More formally, is $x_0^a = x_0^{b,G}$, $x_1^a = x_1^{b,G}$, and $x_2^a = x_2^{b,G}$ (where G denotes a guess) an optimal monetary policy response, even though $\mathbb{E}_0 x_3^a < 0$ and $\mathbb{E}_0 x_3^b = 0$?

The answer is no, because optimality would require the allocation $\left(x_0^a, \pi_0^a\right)$ to deliver the same welfare as $\left(x_0^{b,G}, \pi_0^{b,G}\right)$. Strict convexity in the central bank objective function suggests, however, that the two allocations do not deliver the same welfare. This is because the output gap is the same in both allocations $\left(x_0^a = x_0^{b,G}\right)$ while the corresponding inflation rate is not $\left(\pi_0^a < \pi_0^{b,G}\right)$. The (off-equilibrium) difference $\pi_0^a < \pi_0^{b,G}$ is *partly* offset by a commitment to a more severe recession in simulation b.

Figure 1 displays the optimal monetary policy responses for both simulations under the assumption $\hat{h}_t^a = \hat{h}_t^b \;\; \forall t$[12]. The output gap and the inflation rate are the same in period 0 because $x_{-1} = 0$ and because $\hat{h}_0$ is independent γ_2 by assumption. As of period 1, however, simulation b features a more negative optimal output gap than simulation a. This is because in simulation b, the central bank must optimally implement a more pronounced recession to partly offset the shorter horizon for which it can provide a credible policy commitment. The persistence parameter in the optimal monetary policy rule is hence higher in simulation b $\left(a_t^b > a_t^a \;\; \forall t \leq T\right)$.

Let us now analyze how future central bank credibilities affect the severity of the policy trade-off between the

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[12] To see any meaningful difference between simulation a and b, Figs. 1 and 2 assume an unrealistically high degree of price stickiness $(\theta = 0.9792)$. The qualitative result is, however, *not* affected by the degree of price stickiness.

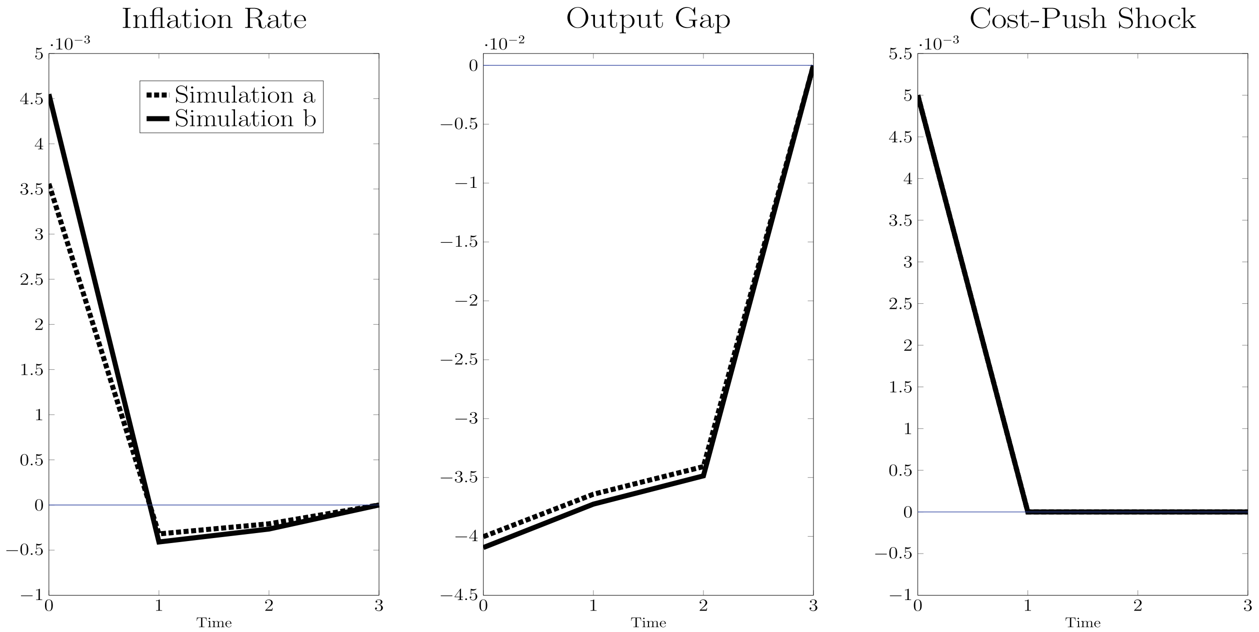

Fig. 2 The optimal impact coefficient in the policy rule. The inflation rate, the output gap, and the cost-push shock under two policy simulations. Simulation *a* (dashed lines) assumes central bank credibilities $\{\gamma_t^a\}_{t=0}^{T+1} = \{1, 1, 1, 0\}$ and simulation *b* (solid lines) assumes central bank credibilities $\{\gamma_t^b\}_{t=0}^{T+1} = \{1, 1, 0, 0\}$. In both simulations, the sequence of cost-push shocks is $\{u_t\}_{t=0}^{T+1} = \{H, 0, 0, 0\}$ and $\rho_u = 0$. To highlight the difference in the impact coefficient of the cost-push shock on the output gap in the policy rule, the persistence parameters $\left(a_t^j\right)$ are equalized across simulations $j = \{a, b\}$

output gap and the inflation rate (which is formally captured by $\hat{h}_t$). To isolate this channel, suppose that a_t is left unaffected by the sequence of current and future central bank credibilities.

The severity of the policy trade-off is greater, the less flexible public expectations adjust to monetary policy commitments. As before, agents expect the policy commitment to be implemented for two (three) periods in simulation *a* (*b*). Applying the same logic as in the argument above, this implies that the optimal x_0^b must lie below x_0^a to partly offset the shorter horizon over which the public expects the central bank to implement the policy commitments in simulation *b*. Importantly, the optimal x_0^b is *not* so low as to have $\pi_t^b = \pi_t^a$. The policy trade-off is hence more pronounced in simulation *b*.

Figure 2 illustrates the optimal monetary policy responses for both simulations under the assumption $a_t^a = a_t^b \ \forall t$. In $t = \{0, 1, 2\}$, the inflation gap and the output gap are both further off steady state than in simulation *b*.

Figure 3 summarizes the evolution of the optimal persistence and the optimal impact coefficient over time for both simulations. Independent of *t*, both coefficients are more favorable (that is: lower) in simulation *a*, compared to simulation *b*. Also, both coefficients become less favorable (that is: rise) over time because the horizon over which the central bank can provide a credible policy commitment becomes shorter, the more time has passed.

4.2 Policy deviations vs. honored commitments

When is it optimal for the central bank to implement past policy commitments? Proposition 1 shows that if each agent forms a correct belief about the central bank's credibility in period T (which is $\gamma_T = 0$ because the central bank implements the discretionary solution in period $T+1$ with certainty) full credibility in $t < T$ is inconsistent with strategic policy decisions.

Proposition 1 *Time-invariant full credibility ($\gamma_t = 1 \ \forall t < T$) is inconsistent with strategic policy deviations.*

Proof. See Online Appendix.

Proposition 1 can be proven directly: Time-invariant full credibility is inconsistent with strategic policy deviations if the value function under a policy deviation is weakly greater than the value function under honored commitments in at least one period[13]. $V_2^h\left(u_2^k\right) > V_2^d\left(u_2^k\right)$ is satisfied if and only if

$$(1 - a_2)^2 + \frac{\kappa^2}{\vartheta} a_2^2 < 0 \tag{23}$$

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[13] Formally, if $\exists \ \ t$ such that $V_t^d\left(u_t^k\right) \geq V_t^h\left(u_t^k\right)$ for some k, time-invariant full credibility ($\gamma_t = 1 \ \ \forall t < T$) is inconsistent with strategic policy deviations.

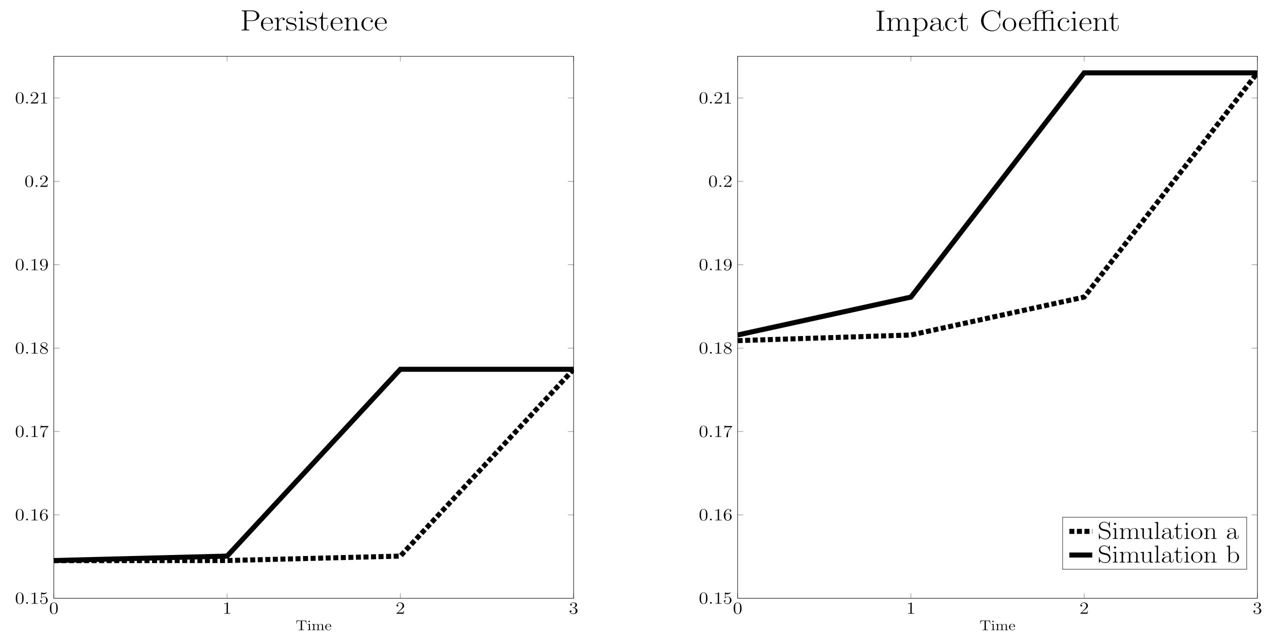

Fig. 3 The optimal monetary policy rule. The optimal persistence parameter $\hat{a}_t^j$ (left panel) and the optimal impact coefficient $\hat{h}_t^j$ in the policy rules for both simulation $j = \{a, b\}$ with $\rho_u = 0.95$. Simulation *a* (dashed lines) assumes central bank credibilities $\{\gamma_t^a\}_{t=0}^{T+1} = \{1, 1, 1, 0\}$ and simulation *b* (solid lines) assumes central bank credibilities $\{\gamma_t^b\}_{t=0}^{T+1} = \{1, 1, 0, 0\}$

where ϑ is strictly positive. Full credibility in period $t < T$ is inconsistent with strategic policy deviations because condition 23 cannot hold with $\gamma_T = 0$.

Proposition 2 establishes the pair result that zero credibility is consistent with strategic policy deviations if each agent forms a correct belief about the central bank's credibility in period T.

Proposition 2 *Time-invariant zero credibility ($\gamma_t = 0\ \forall t \leq T$) is consistent with strategic policy deviations.*

Proof. See Online Appendix.

If the central bank cannot affect the agents' expectations in period T (because all of them hold the correct belief $\gamma_T = 0$), it cannot do better than the discretionary solution. As a consequence, agents assign a zero credibility to any central bank commitment made in period $T - 1$ ($\gamma_{T-1} = 0$). This, in turn, makes it optimal for the central bank to implement the discretionary solution in $T-1$, such that $\gamma_{T-2} = 0$, and so on.

Taken together, proposition 1 and 2 confirm the long established result of Kydland and Prescott (1977) and Barro and Gordon (1983a). Their work shows that the central bank is always tempted to deviate from past policy commitments. This time-inconsistency problem precludes any *credible* policy commitment in a model with rational and perfectly informed agents.

As a side result, proposition 3 shows that time-invariant *limited* credibility is inconsistent with strategic policy deviations.

Proposition 3 *Time-invariant limited credibility ($\gamma_t = 0.5\ \forall t < T$) is inconsistent with strategic policy deviations.*

Proof. See Online Appendix.

The logic of the proof is similar to the proof of proposition 1 but with $\gamma_t = 0.5\ \forall t < T$ instead of $\gamma_t = 1\ \forall t < T$. $V_2^h\left(u_2^k\right) > V_2^d\left(u_2^k\right)$ requires

$$(1 - a_2)^2 + \frac{\kappa^2}{\vartheta} a_2^2 < 0 \tag{24}$$

which cannot hold with $\gamma_T = 0$. Time-invariant limited credibility is hence inconsistent with strategic policy deviations if each agent holds a correct belief about the central bank's credibility in period T. This result suggests that the time-invariant limited commitment case assumed in Debortoli et al. (2014); Debortoli and Lakdawala (2016) and Schaumburg and Tambalotti (2007) is not fully relevant under strategic policy deviations.

Are there any circumstances under which the central bank is *willing* to honor past policy commitments? The answer is yes. Proposition 4 proves that there is a threshold $\bar{\gamma}$ for which $\gamma_T \geq \bar{\gamma} \in [0, 1]$ induces the central bank to honor past policy commitments in period T.

Proposition 4 *There exists a* $\bar{\gamma} \in [0,1]$ *such that time-invariant full credibility is consistent with strategic policy deviations if* $\gamma_T \geq \bar{\gamma}$.

Proof. See Online Appendix.

Proposition 4 is true if the value of honoring past policy commitments in $t \leq T$ is strictly greater than the value of a policy deviation for each potential shock sequence, given that $\gamma_T \geq \bar{\gamma} \in [0,1]$[14]. In period 2, the central bank is willing to honor past policy commitment if and only if $V_2^h\left(u_2^k\right) > V_2^d\left(u_2^k\right)$. With $\{u_t\}_{t=0}^{T} = \{H,H,H\}$, $V_2^h(u_2^k) > V_2^d(u_2^k)$ requires

$$\frac{\vartheta + \kappa^2}{\vartheta}\left(\Sigma^2 + 2\Sigma + (1-p_r)\right)a_2^2 - 2\Sigma(1+\Sigma)a_2 + \left(\Sigma^2 - (1-p_r)\right) < 0 \tag{25}$$

where $\Sigma \equiv a_1(1-a_0)$ is affected by a_T (and hence γ_T). In order to find $\bar{\gamma}$, guess γ_T^G and compute $\bar{a}^1$ such that Eq. 25 holds with equality. Then, re-arrange $\bar{a}^1$ such that

$$\bar{\gamma}^1 = \frac{\left(\vartheta + \kappa^2\right)\left(\vartheta - \left(\vartheta + \kappa^2\right)\bar{a}^1\right)}{\vartheta\beta\kappa^2\bar{a}^1} \tag{26}$$

The coefficients associated to a_2 in Eq. 25 (in particular: Σ) depend on the initial guess γ_T^G. γ_T^G is hence not necessarily equal to $\bar{\gamma}^1$ (which is found to satisfy Eq. 25 with equality if Σ is formed with γ_T^G). Thus, we have to solve for the fixed point of $\bar{\gamma}$ in Eq. 25 by continued iterations[15].

Policy deviations are less costly if the probability of regaining access to a commitment technology is high. That is, the central bank is more inclined to deviate from the announced policy path if p_r is high. Therefore, the threshold on $\bar{\gamma}$ rises in p_r. Put differently, Proposition 4 is particularly true if p_r is sufficiently low. If the probability of regaining access to a commitment technology is low, the central bank is sufficiently punished for deviating from past policy commitments, making it optimal to honor past policy commitments. By contrast, if p_r is too high, $\bar{\gamma}$ becomes greater than 1, making it suboptimal for the central bank to honor past policy commitments.

For reasonable parameterization, there is a $\gamma_T \geq \bar{\gamma} \in [0,1]$ such that $V_2^h(\tilde{u}) > V_2^d(\tilde{u})$ for each potential shock sequence $\tilde{u}$. Honoring past policy commitment in period 2 is hence compatible with strategic policy deviations if a sufficient fraction of agents (inconsistently) believes that the central bank implements past policy commitments in period $T+1$.

Somewhat less rigorously, if there is uncertainty about the exact end date of the announced policy path, the central bank may find it beneficial to implement past policy commitments period T. The uncertainty may be interpreted as limited information on the part of the representative household about the effective horizon of the policy commitment. In particular, it may be that the household attaches a non-zero probability to seeing the central bank implement the history dependent commitment solution beyond the true end date of the announced policy path, possibly due to misinterpretations of central bank communication. Though the lens of my model, proposition 4 explains (at least in parts) why monetary policy commitments were often implemented in reality.

4.3 Sufficient central bank credibility

What central bank credibility ($\bar{\gamma}$) is sufficient to ensure honored commitments in period T? Understanding the determinants of $\bar{\gamma}$ requires the understanding of two mechanisms: First, the higher γ_T, the higher the relative cost of a policy deviation in period T (the reason is that the central bank benefits from a less severe policy trade-off, the higher its credibility). Second, the central bank is more willing to deviate, the greater the (potentially: counterfactual) inflation gap that is supposed to be implemented if past policy commitments are honored.

Taken together, these two forces suggest that a higher inflation gap under honored commitments (which increases the temptation to deviate) requires a higher $\bar{\gamma}$ (which decreases the temptation to deviate).

Figure 4 presents the difference $V_2^d(\tilde{u}) - V_2^h(\tilde{u})$, conditional on γ_2 and the realized shock sequence $\tilde{u}$. A positive difference means that the central bank prefers to deviate from past policy commitments. More specifically, blueish colors indicate values of γ_2 which support the implementation of past policy commitments in period 2. In contrast, yellowish colors indicates values of γ_2 which are too low to incentivize the implementation of past policy commitments in period 2. The black solid line is the threshold $\bar{\gamma}$ which ensures honored commitments in period T.

To illustrate, for the shock sequence $\{H,H,H\}$ and $p_r = 0.1$, $\gamma_2 \geq 0.53$ suffices to ensure the implementation of past policy commitments in period T. In contrast, for the shock sequence $\{H,H,L\}$, $\gamma_2 \geq 0.82$ is necessary to avoid a policy deviation in period 2. The threshold for $\bar{\gamma}$ hence carries information about the central bank's temptation to deviate from the announced policy path.

Why is it that $\bar{\gamma}$ has to be higher for $\{H,H,L\}$ than for $\{H,H,H\}$? The reason is that the central bank commits to a conditional future deflation (inflation) in the presence of a (sequence of) positive (negative) cost-push shocks. The conditional future deflation is amplified if the cost-push shock changes its sign between the current and the future period. More specifically, after two

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[14] Formally, if $\exists\ \gamma_T \geq \bar{\gamma} \in [0,1]$ such that $V_1^h(\tilde{u}) > V_1^d(\tilde{u})$ and $V_2^h(\tilde{u}) > V_2^d(\tilde{u})$ for each potential shock sequence $\tilde{u}$, $\gamma_t = 1\ \ \forall t < T$ is consistent with strategic policy deviations.

[15] Proceed as follows: first, compute the difference between γ_T^G and $\bar{\gamma}^I$ (where $\bar{\gamma}^I$ denotes $\bar{\gamma}$ after I iterations). Second, if the difference between γ_T^G and $\bar{\gamma}^I$ is above some critical value, repeat the computation of $\bar{a}^I$ (and the corresponding $\bar{\gamma}^I$) with γ^{I-1} as an input. Repeat until γ^I is sufficiently close to $\bar{\gamma}^I$ and report $\bar{\gamma} = \bar{\gamma}^I$.

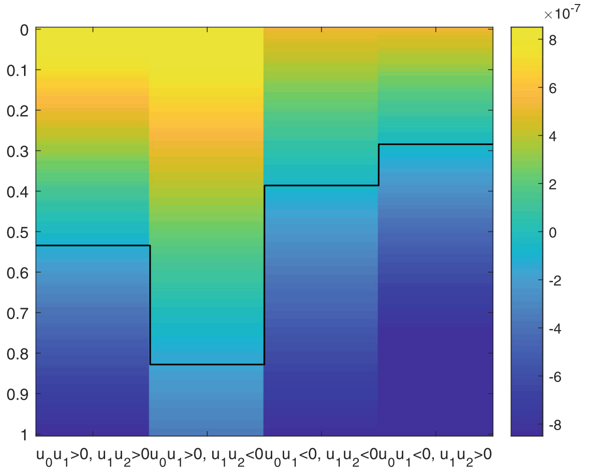

Fig. 4 Heatmap: Threshold on γ_2 to ensure honored commitments in period *T*. The graph shows the threshold on γ_2 (y-axis) for each potential sequence of shock realizations (x-axis) in black, conditional on $p_r = 0.10$. Yellowish (blueish) colors indicate values of γ_2, conditional on a potential shock sequence, for which a policy deviation is favorable (not favorable) in terms of welfare. If $\gamma_2 > \bar{\gamma}$, policy deviations do not occur in period 2

consecutive positive cost-push shocks, the expected inflation rate for period 2 under honored commitments is negative. A negative cost-push shock in period 2 amplifies the (conditional) commitment to a deflation, i.e., the change in the sign of the cost-push shock between period 1 and 2 makes the inflation gap under honored commitments greater (compared to a shock sequence in which three consecutive positive cost-push shocks materialize). The central bank is thus more inclined to deviate from past policy commitments if the shock sequence $\{H, H, L\}$ materializes. Because the central bank is more tempted to deviate under $\{H, H, L\}$ than under $\{H, H, H\}$ (at some constant γ_2), $\bar{\gamma}$ must be higher under $\{H, H, L\}$.

Figure 5 displays the welfare under honored commitments for the shock sequence $\{H, H, L\}$ and the shock sequence $\{H, H, H\}$. As discussed above, the central bank prefers $\{H, H, H\}$ over $\{H, H, L\}$ if it honors past policy commitments. This suggests that the central bank faces a state dependent *temptation* to deviate from past policy commitments[16]. Put differently, my model suggests that the central bank may face more or less (political) pressure to renege on past promises depending on the state of the economy.

Of course, for $\gamma_0 = \gamma_1 = 1$ to be consistent with rational expectations, I assume that the central bank implements past policy commitments in period 1 with probability 1. Moreover, γ_2 must be such that the central bank is known to be willing to implement policy commitments in period 2 with certainty, i.e., even if the realized u_2 is such that the temptation to renege in period 2 is maximized. The central bank is willing to honor past policy commitments under any realization of the shock sequence if $\gamma_2 \geq 0.82$[17].

5 Concluding remarks

The empirical motivation for this paper is the observation that central banks have recently used more or less explicit policy commitments to manage public expectations. Woodford (2012) and Andrade et al. (2019) argue that these commitments are subject to potential revisions. Current and future credibility therefore plays a crucial role in determining the effectiveness of monetary policy commitments. In particular, if the central bank's credibility is high, agents are more willing to adjust their expectations. The responsiveness of the agents' expectations feeds back into the optimal behavior of the central bank, i.e., affects the optimal monetary policy rule.

Most papers in the recent literature on limited commitment in monetary policy, e.g., Debortoli et al. (2014) and Bodenstein et al. (2012), make two critical assumption: First, central bank credibility is time-invariant and exogenous. Second, policy deviations occur randomly. My paper allows for time-variation in the central bank's credibility and endogenous monetary policy decision. It asks two questions: first, how does future central bank credibility affect the optimal monetary policy rule? Second, under which circumstances is it optimal for the central bank to implement past policy commitments?

To address this question, I use a simple New Keynesian dynamic stochastic general equilibrium (DSGE) model in which the central bank decides strategically if it wants to honor past policy commitments. Policy deviation come with a transitory loss of central bank credibility. After a policy deviation, the central bank may regain access to a commitment technology with a non-zero probability. The central bank decides to renege on past policy commitments if and only if a deviation delivers a higher welfare than the implementation of past policy commitments.

The results show that higher future expected central bank credibility attenuates the current period policy trade-off between a stable inflation rate and a stable output gap. Moreover, it decreases the optimal persistence

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[16] This does not contradict proposition 3 which says that a time-invariant limited credibility is inconsistent with strategic policy deviations. The reason is that past policy commitments are *never* (*always*) honored if $\gamma_T < \bar{\gamma}$ ($\gamma_T > \bar{\gamma}$).

[17] Because the agents know the first two realizations of the shock sequence in $t = 1$, the consistent γ_1 may depend on the state of the economy. In particular, after two consecutive, equally signed cost-push shocks, $\gamma_1 = 0.5$ is consistent with honored commitments in period 1 in some range of γ_T, while $\gamma_1 = 1$ is consistent in the *same* range of γ_T if the sign of the cost-push shock differs between period 0 and 1 (this is true for $\gamma_T \in (0.53, 0.82)$). Central bank credibility in period 1 may be 0.5 because the inflation rate in period 2 under honored commitments, and with it the temptation to deviate, differs with the first two realizations of the cost-push shock. I constrain the attention to cases in which $\gamma_2 \geq \bar{\gamma}$ implies $\gamma_1 = 1$ for each potential shock sequence to avoid dealing with path dependent sequences of central bank credibilities. $\bar{\gamma} = 0.72$ is hence the most conservative measure of the threshold $\bar{\gamma}$ that is necessary to defer policy deviations in $t \leq T$.

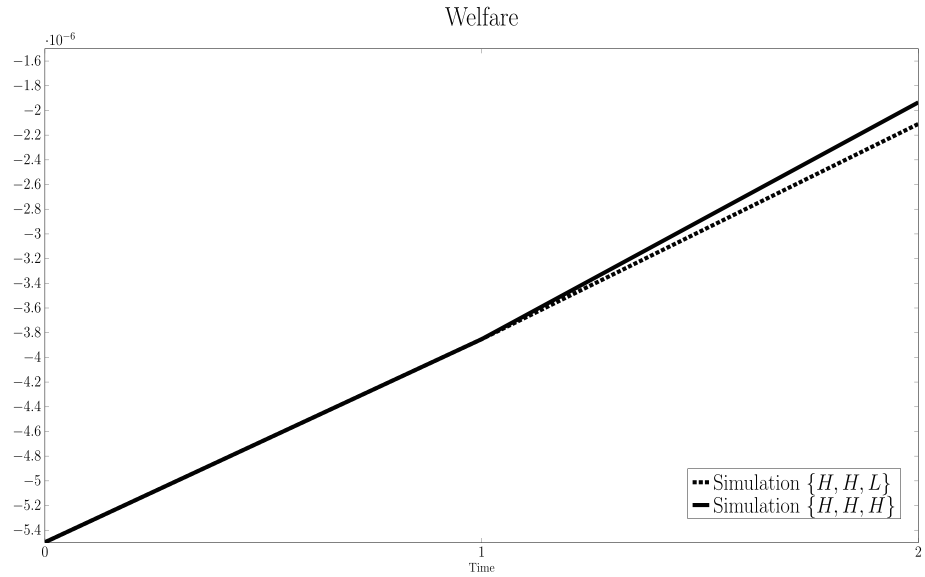

Fig. 5 Welfare under honored commitments. The dashed line presents the welfare under honored commitments if the cost-push sequence is $\{H, H, L\}$. The solid line presents the welfare under honored commitments if the cost-push sequence is $\{H, H, H\}$

in the output gap. Both is because agents are more willing to adjust their expectations if policy commitment are expected to be honored with a higher probability and/or over a longer horizon. The higher the future expected central bank credibility, the lower the cost of implementing policy commitments today.

The less costly implementation of the optimal monetary policy rule under high credibility, together with the transitory loss of credibility after a policy deviation, provides the central bank with a incentive to implement past policy commitments. My main result shows that the central bank is willing to implement past policy commitments if a sufficient fraction of agents is not aware of the exact end date of the policy commitment. This finding challenges the time-inconsistency argument against monetary policy commitments and provides a potential explanation for the repeated implementation of monetary policy commitments in reality.

Abbreviations

CHF: Swiss Franc; DSGE: Dynamic stochastic general equilibrium model; ECB: European Central Bank; IS (equation): Investment-savings' (equation); SNB: Swiss National Bank

Supplementary Information

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Additional file 1: The Online Appendix to this paper is available on www.fabiocanetg.ch/research.

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