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Eurosystem

Economic Letter

Monetary policy regimes and the lower bound on interest rates

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Vol. 2018, No. 6

Monetary policy regimes and the lower bound on interest rates

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This Letter analyses different monetary policy regimes from the New Keynesian perspective. In the presence of a lower bound on policy rates, adjusting the inflation target with past realisations of inflation strengthens monetary stimuli during recessions. However, amplified short-term fluctuations in inflation and output make such history-dependent regimes unappealing. Therefore, this Letter discusses a hybrid regime that incorporates their advantages without suffering from their drawbacks.

Introduction

In the aftermath of the global financial crisis, major economies have displayed a sluggish return of inflation to target. And if long-run real interest rates remain at the current low levels, monetary policy will have even less room to cut short-term rates in the future. While a number of other useful non-standard measures can be implemented, the toolbox currently in use at central banks might not prove sufficient to deal with another severe recession. Therefore, it is important to understand whether revising it can reinforce monetary stimuli.

This Letter investigates this issue in the light of the existing literature on New Keynesian (NK) macroeconomics, the mainstream approach to monetary policy analysis (Clarida et al. 1999, Eggertsson and Woodford 2003, and Woodford 2003). Different monetary policy regimes are compared according to how strongly they stimulate the economy during recessions, when policy rates can be constrained by the zero lower bound (ZLB).[2]

Generating the expectation of future inflation is central to accelerate the recovery at the ZLB. A fixed, forward-looking inflation target can be less effective in this respect than regimes whose target adjusts with realised inflation.

However, such history-dependent regimes have important drawbacks that make them unappealing. In particular, they could amplify short-term fluctuations in inflation and output. This Letter discusses such limits and outlines the solution of a hybrid regime that incorporates the main advantages of a history-dependent regime without suffering from its main drawbacks.

Monetary policy regimes and the zero lower bound

The theoretical framework. The NK framework combines the rigorous micro-foundation of the Real Business Cycle theory with Keynesian ingredients like monopolistic competition and nominal

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[2]The literature often refers to the "effective lower bound" on interest rates, given that some central banks implemented modestly negative policy rates. While the arguments discussed in this Letter require that a lower bound exists, they do not depend on whether the bound is at zero or below (see footnote 6 below for more details).

rigidities.[3] Production follows the Dixit-Stiglitz monopolistic competition, i.e., each firm maximises profits by setting price and taking into account the demand for the good produced. Nominal rigidities emerge from a constrained frequency with which firms can adjust prices, so-called Calvo pricing.[4]

The dynamics of the economy are described by the following log-linear approximate equilibrium conditions: a forward-looking "IS relation,"

$$x_t = E_t x_{t+1} - \sigma \left(i_t - E_t \pi_{t+1} - r_t^n \right), \tag{1}$$

and a forward-looking "AS relation" (or NK Phillips curve),

$$\pi_t = \kappa x_t + \beta E_t \pi_{t+1} + u_t. \tag{2}$$

Here $\pi_t \equiv \log(P_t/P_{t-1})$ is the inflation rate, x_t is the output gap (defined as the difference between current output and the equilibrium level that would prevail in the absence of nominal frictions), u_t is a cost-push shock, and i_t is the continuously compounded nominal interest rate – corresponding to $\log(1 + i_t^A)$, where i_t^A is the annual nominal interest rate.[5]

Suppose that the central bank follows a strict, forward-looking, inflation targeting (IT) rule,

$$\pi_t = \pi^*. \tag{3}$$

Given the conditions (1) and (2) above, the inflation target can be achieved only if the central bank follows the rule:

$$i_t = r_t^n + \pi^*. \tag{4}$$

Absent a constraint on nominal rates, monetary policy can successfully offset shocks hitting the economy (captured in the model by unexpected variations in the natural rate of interest, r_t^n) simply following the rule (4). This is because a sufficient reduction in the nominal rate will lower the real rate to the extent necessary to close the output gap and stabilise the economy. However, the ZLB on nominal rates implies that the monetary authority cannot follow the rule (4) if the negative shock is so large that $r_t^n \leq -\pi^*$.[6]

The following numerical examples (Eggertsson and Woodford 2003) analyse the equilibrium dynamics of inflation and output gap under different monetary policy regimes.[7] In these examples, the economy is hit by a shock that reduces the natural rate of interest from a steady-state level of 4% to -2%.

Example 1: Advantages of a higher inflation target. Figure 1 compares different IT regimes whose inflation target is either 0, 1%, or 2%.

If $\pi^* = 0$ (dashed line), the low leverage of monetary policy at a zero interest rate, coupled with the unfeasibility of additional rate cuts, results in a severe recession. The probability that the natural rate remains negative for the next quarter generates expectations of future deflation. This keeps the real rate of return positive in spite of a zero nominal rate, leading to a highly negative output gap.

[3] See, e.g., Clarida et al. (1999), Eggertsson and Woodford (2003), and Woodford (2003).

[4] Prices remain unchanged for a fraction $0 < \alpha < 1$ of firms each period (Calvo 1983).

[5] See Woodford (2003) for a detailed derivation of the IS and the AS relationships.

[6] If one assumes instead that the effective lower bound on the nominal rate is $-\alpha < 0$, the same argument applies, but for a greater value of the negative shock, so that $r_t^n \leq -\pi^* - \alpha$.

[7] See Eggertsson and Woodford (2003), p. 170, for the choice of coefficient values for σ, κ and β.

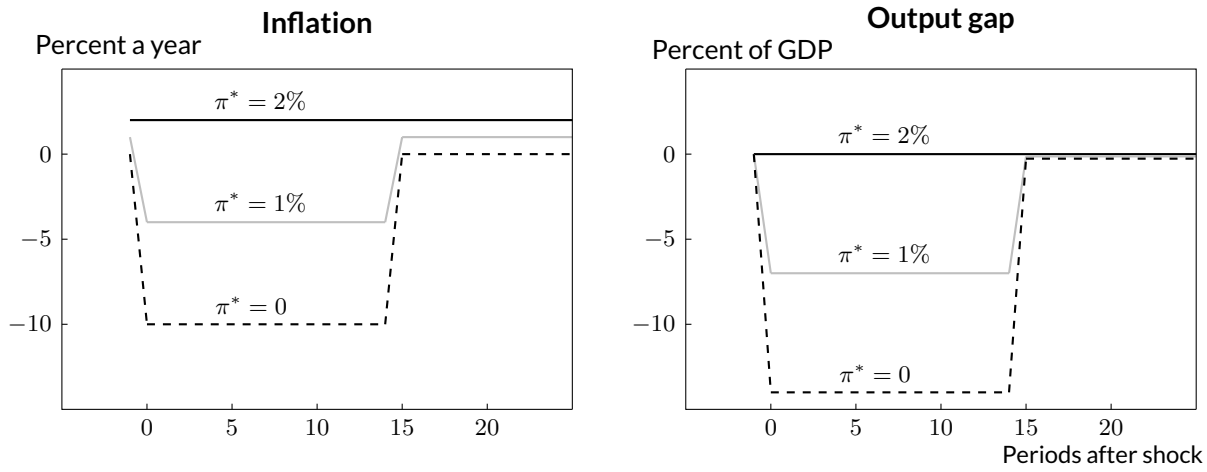

Figure 1: Inflation and output gap under IT

The natural rate can revert to its steady-state level with probability 0.1 each period, but the shock is assumed to last fifteen periods (ex-ante unknown). Source: Eggertsson and Woodford (2003).

With $\pi^* = 1\%$ (shaded line), the nominal rate reduction still does not offset the negative shock. But agents expect inflation prevailing once the economy will be out of the recession. This implies a lower real rate of return, so that the economy will suffer less from deflation and a negative output gap. Nevertheless, given the severity of the shock, an inflation target of at least 2% (solid line) is needed to allow monetary policy to successfully deal with the recession. The expectation of future inflation allows the real rate of return to reach the negative territory so as to sufficiently stimulate the economy and close the negative output gap.

These different performances are due to inflation expectations. Specifically, the lower the inflation target, the lower expected inflation, and thus the weaker the monetary stimulus at the ZLB. Moreover, if the reduction in the natural rate of interest is structural and π^* does not adjust upward, inflation can systematically fall short of the target because of a higher frequency and duration of ZLB episodes, accompanied by a persistent negative output gap (Kiley and Roberts 2017).

For these reasons, raising the inflation target is currently discussed as a policy option by economists and policymakers (see Blanchard et al. 2010, and Ball et al. 2016) – an option that, however, finds its drawback in the distortions produced by a higher inflation.[8] Example 2 shows that there is instead a regime bringing about the same advantages of a higher inflation target, without incurring in the distortion produced by high inflation.

Example 2: Advantages of a history-dependent regime. Under IT, the central bank commits to a forward-looking target that does not vary with the current level of inflation. Therefore, a temporary inflation shock leads to a permanent shift in the time path of the price level, so-called "price-level drift". History-dependent regimes take instead into account whether, and by how much, current inflation is off target. Under price-level targeting (PT), for example, monetary policy targets a known price-level path. This implies that the central bank commits to achieve a higher inflation rate after periods of negative inflation shocks.[9]

[8] In the NK model, distortions produced by inflation are easily explained. When prices rise, some firms are not able to adjust their price due to the Calvo friction. But then relative prices, and thus the allocation of resources, will be distorted and sub-optimal. And the higher the inflation, the more severe the distortion in relative prices.

[9] A different, related policy, not analysed in this article but widely discussed in the literature, consists in targeting nominal GDP: see, e.g. Bernanke and Mishkin (1997), Woodford (2012) and Billi (2013).

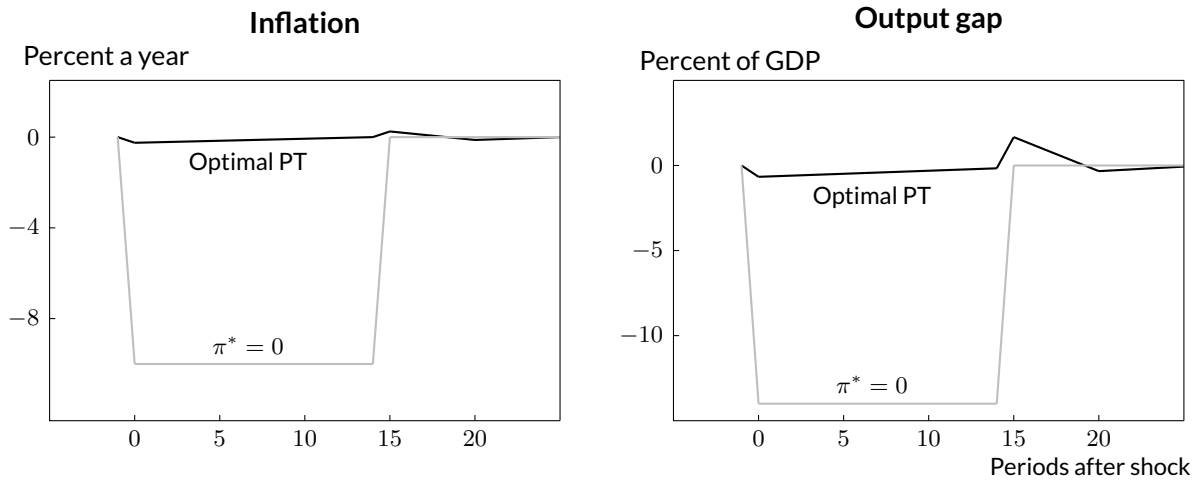

Figure 2: Inflation and output gap under optimal PT and under IT

The natural rate can revert to its steady-state level with probability 0.1 each period, but the shock is assumed to last fifteen periods (ex-ante unknown). Source: Eggertsson and Woodford (2003).

Eggertsson and Woodford (2003) characterise optimal monetary policy under commitment over the set of all possible state-contingent paths for inflation and output. They find that the optimal monetary policy rule must take into account past realisations of inflation.[10] In other words, the optimal PT regime leads to a welfare-superior outcome compared to the one obtainable under an IT regime.

The intuition for this result is as follows. If the economy is hit by a sufficiently large deflationary shock, a zero interest rate will not suffice to close the output gap. Given expectations of deflation or too low inflation under IT, the real rate of return will not be sufficiently reduced to stabilise the economy. On the other hand, under PT, monetary policy commits to achieving a higher inflation rate after periods of negative inflation shocks; this can sufficiently lower the real interest rate, in spite of the nominal rate being constrained by the ZLB. Without undermining the capacity of combating inflation in the medium term, a credible commitment to such a rule provides the significant advantage of a strong monetary stimulus exactly when needed, and to the extent necessary.[11]

In Figure 2, an IT regime with target $\pi^* = 0$ is compared to the optimal PT regime implying an equivalent (zero) steady-state inflation. While an IT rule requires a rate hike as soon as the deflationary shock reverts, PT implies a zero interest rate for five more periods. As the private sector anticipates this conduct, both the severe deflation (-10%) and contraction of real activity (-14%) that occur under IT are almost totally avoided under PT. Moreover, thanks to this immediate, strong response of the economy to the negative shock, substantial adjustments will be unnecessary in the future, and the creation of inflation will be almost negligible.

As discussed above, PT performs better than IT at the ZLB thanks to the expectation of a higher future inflation. Expectations crucially depend, in turn, on the credibility of monetary policy. Would expectations remain anchored if, due to the persistence of the deflationary shock, the private sector observes many consecutive target shortfalls and the policy rate constrained at the ZLB? Honkapohja and Mitra (2018) address the issue of credibility of PT under imperfect knowledge and learning,

[10] Eggertsson and Woodford (2003), p. 174 ff. Although the optimal state-contingent interest rate path is characterised numerically, the optimal policy rule can be implemented easily and does not even require estimating the long-term natural interest rate (which is needed under IT).

[11] Adam and Billi (2006) find a very similar result in a richer, fully stochastic framework where the economy can fall in a liquidity trap.

showing that although a newly established policy regime could well have low initial credibility, this may not be a problem as credibility can improve over time and lead to convergence toward the target equilibrium.[12]

The drawbacks of PT and the solution of hybrid targeting

The previous section focuses on the stimulus that different monetary regimes provide at the ZLB, but there is a burgeoning literature on the wider gains and shortcomings of PT (see Ambler 2007 for a literature review). For instance, PT makes the price of future goods more easily predictable, and in this way facilitates long-term contracting. By contrast, eliminating any price-level drift can exacerbate price distortions and reduce welfare if firms, as in the models of inflation persistence by Fuhrer and Moore (1995) and Galì and Gertler (1999), set their price based on past inflation.

To solve this problem, it is sufficient to maintain some drifts in the price level. Specifically, the central bank could target a moving average of current and past inflation rates ('average-inflation targeting'), with the length of the moving average period adjusted to the fraction of backward-looking price setting firms (Steinsson 2003, and Nessén and Vestin 2005).

Other arguments in favor of keeping some price-level drifts include the ability of unexpected inflation to enable erosion of real wages when nominal wages are downward rigid (Blanchard and Galì 2010, Abbritti and Fahr 2013).

However, the limitation discouraging the adoption of a PT regime is the likely increase in the variability of inflation and output in the short run. This would be a result of central banks being no longer able to 'look through' supply shocks temporarily pushing inflation away from the target path. Under a full commitment to a PT rule, for instance, policy rates would need to respond to any oil price shock.

A hybrid regime like the one outlined below, on the other hand, can incorporate the main advantage of PT – namely, a faster recovery from a recession – without suffering from amplified short-term fluctuations of inflation and output.

The solution of a hybrid regime. [13]

Consider a hybrid regime with a forward-looking target π^*, augmented with an average-inflation targeting mechanism that only intervenes in the following circumstance: inflation has been below target each period, for a defined number x of consecutive periods, by more than a certain level ϵ. If this happens, the central bank raises the target such that the average inflation will equal π^*. The average inflation is computed over the period starting from τ, time in which the first deviation by more than ϵ occurred, to present. This strategy continues until the average inflation reaches π^*.[14]

Suppose, for instance, that $\pi^* = 2\%, x = 4$ months, and $\epsilon = 1\%$. In normal times, the central bank would aim at delivering an inflation rate of 2% over the medium-term ahead – in the continu-

[12] See also Busetti et al. (2017), who analyse the effects of a series of deflationary shocks on the de-anchoring of inflation expectations in a NK model with adaptive learning.

[13] Bernanke (2017) has recently proposed a similar regime, with a temporary switch to PT as the policy rate hits the ZLB. Williams (2017) has also expressed support for flexible PT. Kiley and Roberts (2017) consider policies of a similar nature, according to which the central bank commits to holding rates low for a time after the ZLB no longer binds.

[14] See the Appendix for a formal definition of this monetary policy rule.

ity of the current general practice. However, when the economy is hit by a large deflationary shock, monetary policy incorporates features of PT, namely, the commitment to overshoot the target in the future. Such a commitment, if credible, will bring about a faster convergence towards the desired inflation rate.

Compared to PT, a spatial and a temporal tolerance bands with a purely forward-looking target (average-targeting only intervenes after 4 consecutive months of inflation below 1%), allows monetary policy to 'look through' temporary shocks and shocks of small magnitude. This will contain short-run variability of inflation and output. Moreover, by keeping some, or most of the price-level drifts, this regime reduces the risk of distortion in relative prices when agents are backward-looking.

Compared to IT, this hybrid regime performs better in deflationary periods. First, switching to a higher inflation target after four months of inflation below 1% generates the expectation of a higher inflation in the future, which reduces the likelihood of hitting the ZLB. This constitutes an advantage of this regime also in comparison with those where PT only intervenes as the policy rate hits the ZLB (as in Bernanke 2017 and in Kiley and Roberts 2017). Second, even if the ZLB is hit eventually, a credible commitment of overshooting 2% inflation in the future implies a lower real rate of return. This will more effectively stimulate the economy and help closing the output gap.

As IT has proven to be effective to combat inflation, the hybrid regime above discussed involves an average-targeting mechanism that intervenes only if inflation remains (sufficiently largely and extensively) *below* target. However, a two-sided rule could be also considered, with average-targeting also intervening after substantial deviations of inflation *above* target.

A two-sided rule would allow for a faster return of inflation to target during economic expansions, as it implies more aggressive policy tightening than IT. This would bring about the advantage of a lower average inflation in the medium term. Moreover, maintaining the price path within a symmetric band would make it easier to predict future prices and facilitate long-term contracting. On the other hand, a one-sided rule has the considerable advantage of making it sure that a large and long-lived supply shock does not lead to an excessively contractionary policy response.

Conclusion

With the recent financial crisis, major central banks had to deal with the unavailability of policy rate reductions and started implementing non-standard measures like asset purchase programmes. Although most often considered effective, such programs are not believed to constitute a perfect substitute for interest rate reductions. Therefore, it is important to understand how a policy regime can provide more powerful (standard) monetary stimuli at the ZLB, as well as reduce the persistence at the constraint and the likelihood of hitting it again in the future.

This Letter reviews different policy regimes in the light of the standard NK framework. The analysis argues that strict inflation targeting can be less effective than other policy rules, due to a weaker stimulus at the ZLB and a higher risk of persistence at the constraint. For these reasons, this Letter discusses a policy rule that incorporates the main theoretical advantage of price targeting (a faster recovery from a large and persistent deflationary shock), without suffering from its main drawbacks (amplified short-term volatility in inflation and output).

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Appendix. A formal definition of the hybrid regime

Given a forward-looking inflation target π^*, a number of periods x, and a maximum tolerated deviation from target ϵ, a formal definition of the state-contingent inflation target at time t is as follows:

$$\pi_t^* = \begin{cases} (x+1)\pi^* - \sum_{i=t-x}^{t-1} \pi_i & \text{if } \pi_{t-1}^* = \pi^* \text{ and} \\ & \forall i \in \{t-x,\ t-1\}:\ \pi_i < \pi^* - \epsilon, \\ (t-\tau+1)\pi^* - \sum_{i=\tau}^{t-1} \pi_i & \text{if } \pi_{t-1}^* \neq \pi^*, \\ \pi^* & \text{otherwise.} \end{cases} \tag{5}$$

The first line of equation (5) states the condition for the average-inflation targeting mechanism to apply, namely that inflation has been off the tolerance band for x consecutive periods. The average target is computed over the inflation rates realised since the first period in which the excessive deviation occurred, τ, until the current period. The second line checks whether the average target has been met. Outside these circumstances, the regime coincides with a standard IT, with the central bank committing to the forward-looking target π^*.

If the price stability mandate defines instead, more realistically, a target to be met in the medium term – i.e., y periods ahead – the average-inflation mechanism includes inflation forecasts π^e (conditional on the current degree of the monetary policy stance) over a horizon up to $y-1$ periods ahead. In this case, conditional on inflation having been below the tolerance band for x consecutive periods, or the average targeting mechanism being already in place without the commitment being fulfilled yet, monetary policy commits to the following inflation path:

$$\frac{\sum_{i=\tau}^{t-1} \pi_i + \sum_{j=t}^{t+y-1} \pi_j^e}{t+y-\tau} = \pi^*. \tag{6}$$

Similarly as before, the regime switches to a forward-looking target as the commitment expressed in equation (6) has been fulfilled.

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