Box 3.3

ASSESSMENT OF THE ALTERNATIVE MONETARY POLICY RULES USING THE JoSE MODEL

This Box uses the JoSE (Joint Spain-EuroArea[1]) model to study the quantitative implications of various monetary policy strategies for the frequency, duration and associated costs of ELB (Effective Lower Bound) episodes. JoSE is a dynamic general equilibrium model of a monetary union with two economies (Spain and the rest of the euro area) which incorporates the usual nominal, real and financial frictions in models used by central banks. The model is estimated through the use of Bayesian econometric techniques and macroeconomic series of both economies.

To assess effectiveness in terms of reduction of the prevalence and cost of the ELB of each of the monetary policy rules considered, the behaviour of the economy (over a large number of quarters) is simulated in the model under each of these rules.[2] Table 1 shows the results in terms of the percentage of quarters in which the common monetary authority is constrained by the ELB, the average duration of each episode, and the losses in terms of GDP and inflation (at Monetary Union level) associated with those episodes. Chart 1 shows the distribution of the inflation simulated for each monetary policy rule.

The reference point with respect to which the various alternatives are assessed is the standard inflation targeting (IT) rule included in the estimated version of the model, specifically a Taylor rule in which the nominal interest rate responds to deviations in the year-on-year inflation from its target of 2%. This rule approximately replicates the monetary policy regime in the euro area.[3] Model simulations indicate that under this rule the economy would be at the ELB 9% of the time, and the average duration of each ELB episode would be 4.2 quarters. This generates a cost in terms of lost GDP and inflation of -0.13% and -0.11%, respectively (average of the total of the quarters).[4]

Within the inflation targeting framework, a modification usually proposed to reduce the frequency of ELB episodes is to raise the inflation target. The simulations indicate that increasing this target to 3%, for example, would

Table 1
ELB FREQUENCY AND LENGTH FOR DIFFERENT MONETARY POLICY STRATEGIES

	Percentage of quarters in ELB	Average length of ELB episodes (quarters)	GDP loss associated with ELB (%)	Inflation loss associated with ELB (%)
Inflation targeting (2%) (a)	9.0	4.2	-0.13	-0.11
Price-level targeting	4.2	2.7	-0.03	0.00
Temporary price-level targeting	6.1	3.4	0.00	0.10
Inflation targeting on 4-year average inflation	6.4	3.3	-0.09	-0.04
Inflation targeting (3%) (a)	2.2	3.1	-0.03	-0.02
Inflation targeting (2%) with quantitative easing (a)	7.0	3.6	-0.04	-0.03
Inflation targeting (2%) with stronger quantitative easing (2x) (a)	6.1	3.3	0.01	0.01

SOURCE: Banco de España, based on JoSE model.

a Coefficients of inflation targeting rules: inertia, 0.85; inflation, 2.00; GDP growth, 0.10.

1 The JoSE model has been developed and estimated by G. Almeida, S. Hurtado and O. Rachedi (2019), *JoSE: the Joint Spain Euro-Area DSGE of the Banco de España,* Occasional Paper, Banco de España, forthcoming.

2 For more details on the exercise, see G. Almeida, S. Hurtado and O. Rachedi (2019), *Monetary Policy in the New Normal: Evidence on the Euro-Area from JoSE,* Occasional Paper, Banco de España, forthcoming.

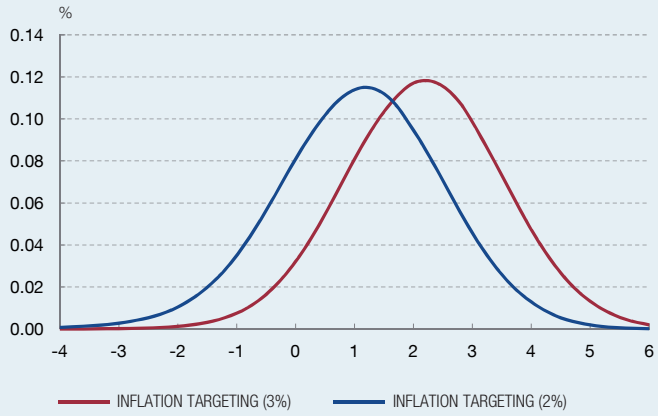
3 See S. Gerlach and G. Schnabel (2000), "The Taylor Rule and Interest Rates in the EMU Area", *Economic Letters,* 67, pp.165-171.

4 These simulations are based on the assumption of a long-term natural interest rate of 1%, which is higher than the current estimates of this rate in the euro area (see Chart 3.3 in the main text). The results should thus be taken as *lower* limits of the impact and average duration of binding ELB episodes.

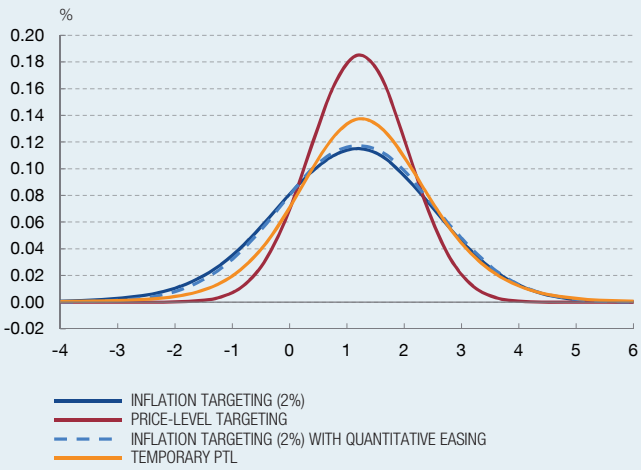
Chart 1
INFLATION RATE DISTRIBUTION ACCORDING TO MONETARY POLICY RULE

Raising the inflation target by 1 pp appreciably reduces the probability of low inflation, but the probability of inflation above 4% increases fourfold. Alternatively, a price-level targeting (PLT) rule gives a more more constrained distribution, since it reduces the probability of low inflation without raising the probability of high inflation. Quantitative easing reduces the probability of strongly negative inflation.

1 EFFECT OF INCREASING THE INFLATION TARGETING ON INFLATION DISTRIBUTION IN THE EURO AREA



2 EFFECT OF ALTERNATIVE MONETARY POLICY STRATEGIES ON INFLATION DISTRIBUTION IN THE EURO AREA

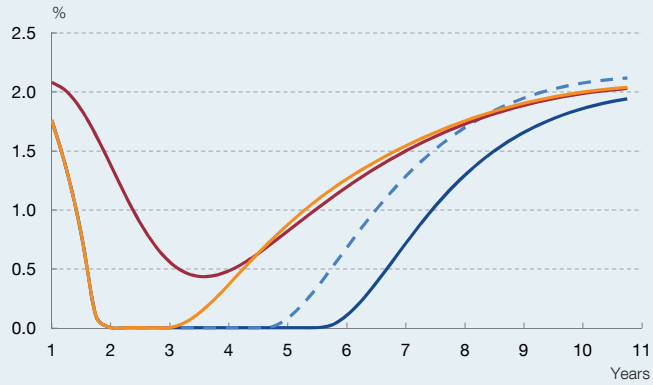


SOURCE: Banco de España, based on JoSE model.

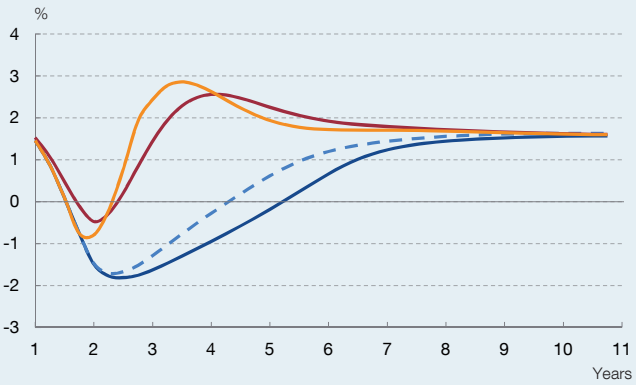
Chart 2
RESPONSE TO A FALL IN DEMAND FOR DIFFERENT MONETARY POLICY STRATEGIES

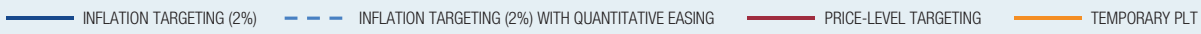
The implementation of QE along with a 2% target rule is only effective in reducing deflationary pressure when the cumulative size of the purchase programme is high. By contrast, a price-level targeting rule directly avoids the ELB through the promise of higher future inflation.

1 NOMINAL INTEREST RATE



2 INFLATION





SOURCE: Banco de España, based on JoSE model.

substantially reduce the frequency with which the ELB is reached from 9% to 2%. However, as shown by Chart 1.1, the reduction of the probability of very low inflation (typically associated with ELB episodes) is achieved at the cost of a significant increase in the probability of very high inflation.

An alternative to the inflation targeting regime would be a price-level targeting (PLT)[5] rule, in which the interest rate responds to price-level deviations from a target path, instead of responding to inflation deviations. The simulations of the model show that this rule is effective in reducing the percentage of quarters in which the economy reaches the ELB, in mitigating almost completely the associated costs in terms of GDP falls and inflation, and in substantially decreasing the variance of inflation. The mechanism through which this rule operates is that expectations of high future inflation (and thus lower real interest rates) are generated in ELB episodes in which the price level falls below its target trend due to excessively low inflation.

As noted in the main text, the PLT strategy may be difficult to apply in practice due to a possible lack of credibility of the monetary authority's commitment to offset high inflation with low inflation (and a consequent contraction in economic activity and employment) in the future.[6] In response to this criticism, Ben Bernanke[7] proposed a *temporary* PLT regime which only applies when inflation is too low as a result of a binding ELB episode (the rest of the time an IT regime prevails). According to the model used in this box, under a rule of this type the reduction in the percentage of quarters at the ELB is not as large as under the previous alternatives, but the almost total elimination of costs in terms of GDP and inflation is maintained.[8]

Another alternative somewhere between IT and PLT would be a Taylor rule responsive to inflation deviations but in terms of a relatively long moving average of, for example, four years.[9] This rule yields a reduction in the percentage of quarters at the ELB similar to that with PLT, but is less effective in eliminating the costs derived from persistent falls in GDP and from inflation when the economy hits the ELB.

Lastly, the role played by non-standard policies within the current IT framework is considered. Specifically the model combines the 2% inflation target rule with the implementation of asset purchase programmes (quantitative easing, QE), when conventional interest rate policy is constrained by the ELB. For this purpose, two different asset purchase rules are considered: one which replicates the size and duration observed in the ECB asset purchase programme (APP), and another in which the volume of asset purchases is doubled. The simulations show that these measures scarcely reduce the number of ELB episodes, but do substantially reduce their duration and, above all, the associated GDP and inflation costs: with the calibration which replicates the size of the APP, these costs are reduced to levels similar to those which would be achieved by raising the inflation target to 3%. Although this rule does not substantially reduce the probability of moderate negative inflation, it does prove effective in preventing highly negative inflation (see Chart 1.2). The most aggressive rule (which doubles the rate of purchases compared with the observed value) could potentially totally eliminate the GDP and inflation costs associated with the ELB.

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5 See L. Svensson (1999), "Price-Level Targeting versus Inflation Targeting: A Free Lunch?", *Journal of Money, Credit and Banking,* 31, pp. 277-295, and V. Gaspar, F. Smets and D. Vestin (2007), *Is Time Ripe for Price Level Path Stability?,* ECB Working Papers, 818.

6 Another view on the advisability of adopting PLT can be found in R. Barnett and R. Engineer (2000), "When is price-level targeting a good idea?", in *Price Stability and the Long-run Target for Monetary Policy,* Bank of Canada, Proceedings of a conference held at the Bank of Canada, June, pp. 101-136. The authors argue that the advantages of this regime are smaller when the inflation expectations of economic agents are aligned with recently observed inflation (backward-looking expectations).

7 B. Bernanke (2017), *Monetary Policy for a New Era,* Peterson Institute for International Economics, Washington.

8 The fact that this rule produces a negative GDP and inflation cost is made possible by the asymmetry of this policy: it responds differently to strongly negative and strongly positive shocks, which, as shown in Chart 1.2, is reflected in a reduction of the density of the left-hand tail which scarcely affects the right-hand tail of the distribution.

9 M. Nessén and D. Vestin (2005), "Average Inflation Targeting", *Journal of Money, Credit and Banking,* 37, pp. 837-863, refer to this strategy as «average inflation targeting». At the limit, a rule which responded to an infinitely long moving average of inflation would be equivalent to a PLT rule.

Box 3.3

ASSESSMENT OF THE ALTERNATIVE MONETARY POLICY RULES USING THE JoSE MODEL (cont'd)

To help explain more clearly the functioning of the various monetary rules, Chart 2 shows the response of the nominal interest rate and inflation to a combination of negative demand shocks which, under the 2% inflation target rule, push the economy to the ELB for four years. The introduction of QE of a size similar to that of the APP reduces the duration of the ELB and the deflationary pressures, but its effectiveness is initially small and only increases as the size of the central bank balance sheet grows. The PLT rule, through a promise of higher future inflation and the consequent lower ex ante real interest rates, manages to keep the economy from hitting the ELB. Lastly, the temporary PLT regime does not prevent the ELB constraint from being reached, but it does allow a rapid exit.

In summary, the aforementioned simulations suggest that rules specifically designed to address ELB episodes, such as permanent or temporary PLT, or the implementation of asset purchase programmes have an effectiveness in reducing the impact and costs of such episodes which is similar to that of other potentially more inefficient strategies such as raising the inflation target.