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**NO. 350 / APRIL 2004**

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POLICY AND THE  
ZERO BOUND ON  
NOMINAL INTEREST  
RATES**

by Günter Coenen  
and Volker Wieland





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by Günter Coenen<sup>2</sup>  
and Volker Wieland<sup>3</sup>

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## Abstract

In this paper, we study the effectiveness of monetary policy in a severe recession and deflation when nominal interest rates are bounded at zero. We compare two alternative proposals for ameliorating the effect of the zero bound: an exchange-rate peg and price-level targeting. We conduct this quantitative comparison in an empirical macroeconomic model of Japan, the United States and the euro area. Furthermore, we use a stylized micro-founded two-country model to check our qualitative findings. We find that both proposals succeed in generating inflationary expectations and work almost equally well under full credibility of monetary policy. However, price-level targeting may be less effective under imperfect credibility, because the announced price-level target path is not directly observable.

*JEL Classification System:* E31, E52, E58, E61

*Keywords:* monetary policy rules, zero-interest-rate bound, liquidity trap, nominal rigidities, exchange rates.

## Non-technical summary

Researchers, practitioners and policymakers alike have made proposals for avoiding and if necessary escaping deflation. In this paper, we focus on two proposals that have dominated the debate most recently: an exchange-rate peg and price-level targeting. Svensson (2001, 2003), in particular, has emphasized that the central bank may create expectations of inflation by devaluing and pegging the exchange rate for some time. Alternatively, the central bank can try to manage expectations regarding future interest-rate policy by announcing a target path for the price level and thus induce inflationary expectations. The latter proposal has been pushed most recently by Eggertsson and Woodford (2003).

Our objective is to compare the effectiveness of an exchange-rate peg and price-level targeting in stimulating the Japanese economy in a severe recession and deflation scenario when nominal interest rates are bounded at zero. We conduct a quantitative evaluation in the estimated macroeconomic model with rational expectations and nominal rigidities of Coenen and Wieland (2002) that covers the three largest economies, the United States, the euro area and Japan. We recognize the zero-interest-rate bound explicitly in the analysis and use numerical methods for solving nonlinear rational expectations models. Since this model is not fully developed from microeconomic foundations we also cross-check our findings using a stylized two-country model with imperfect competition that is derived from optimizing behavior of households and firms given Calvo-type price contracts. This model is taken from Benigno and Benigno (2001). The qualitative findings regarding the impact of the zero bound and the two alternative proposals are quite similar in the two models. Not surprisingly, the dynamics observed in the optimizing model are highly stylized and lack the persistence observed in the data, but they provide some additional support for our conclusions from a theoretical perspective.

Our quantitative findings in the estimated three-country model indicate an economically significant impact of the zero bound. Furthermore, we show that exchange-rate-based and price-level-target-based proposals are equally effective in inducing inflationary expectations and stimulating the economy. This result depends on the assumptions of rational expectations and full credibility of monetary policy. Price-level targeting may be less effective under imperfect credibility, because the announced price-level target path is not directly observable. In particular, we show that if a significant percentage of market participants doubts that the central bank has truly adopted a price-level target, the central bank's announcement is not anymore as effective in mitigating the impact of the zero bound. The exchange-rate peg at least offers the advantage that the public can observe every period whether the central bank maintains the exchange-rate peg.

## I. Introduction

Due to the recent experience in Japan the threat of deflation and a liquidity trap has taken center stage in the debate on the proper formulation of monetary policy. Deflationary episodes present a particular problem for monetary policy because the effectiveness of its main instrument, the short-term nominal interest rate, may be limited by the zero lower bound.<sup>1</sup> With interest rates near zero, the central bank will not be able to offset recessionary shocks by lowering nominal and thereby real interest rates. Furthermore, deflationary shocks may raise real interest rates and worsen such a recession.

Researchers, practitioners and policymakers alike have made proposals for avoiding and if necessary escaping deflation. In this paper, we focus on two proposals that have dominated the debate most recently: an exchange-rate peg and price-level targeting. Svensson (2001, 2003), in particular, has emphasized that the central bank may create expectations of inflation by devaluing and pegging the exchange rate for some time.<sup>2</sup> Alternatively, the central bank can try to manage expectations regarding future interest-rate policy by announcing a target path for the price level and thus induce inflationary expectations. The latter proposal has been pushed most recently by Eggertson and Woodford (2003).

Our objective is to compare the effectiveness of an exchange-rate-peg and price-level targeting in stimulating the Japanese economy in a severe recession and deflation scenario when nominal interest rates are bounded at zero. We conduct a quantitative evaluation in the estimated macroeconomic model of Coenen and Wieland (2002) that comprises the United States, the euro area and Japan. We recognize the zero-interest-rate bound explicitly in the analysis and use numerical methods for solving nonlinear rational expectations

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<sup>1</sup>Nominal interest rates on deposits cannot fall substantially below zero, as long as interest-free currency constitutes an alternative store of value (McCallum, 2000).

<sup>2</sup>Related proposals for depreciating the exchange rate have been made by Orphanides and Wieland (2000) and McCallum (2002) and have been compared with Svensson's proposal by Coenen and Wieland (2003).

models. Since this model is not fully developed from microeconomic foundations we check whether similar results obtain in the stylized two-country model of Benigno and Benigno (2001) that is derived under optimizing behavior of households and firms with imperfect competition and Calvo-type price contracts.

## II. Recession, Deflation and the Zero-Interest-Rate Bound

In the model of Coenen and Wieland (2002) monetary policy is neutral in the long-run, because expectations in financial markets, goods markets and labor markets are formed in a rational, model-consistent manner. However, short-run real effects arise due to the presence of nominal rigidities in the form of staggered contracts. Model parameters are estimated using quarterly data from 1974 to 1999 and the model fits empirical inflation and output dynamics in the United States, the euro area and Japan surprisingly well.

As a benchmark we assume that monetary policy follows Taylor's rule. Thus, the nominal short-term interest rate,  $i_t$ , responds to deviations of the annual inflation rate,  $\pi_t$ , from the target,  $\pi^*$ , and deviations of output from potential,  $q_t$ , as follows:

$$i_t = r^* + \pi_t + 0.5(\pi_t - \pi^*) + 0.5q_t, \quad (1)$$

where  $r^*$  refers to the equilibrium real interest rate. Under normal circumstances, when the short-term nominal interest rate is well above zero, the central bank may ease monetary policy by expanding the supply of the monetary base and bringing down the short-term rate of interest. Since prices of goods and services adjust more slowly than those on financial instruments, such a money injection reduces real interest rates and provides a stimulus to the economy. Whenever monetary policy is expressed in form of an interest rate rule, it is implicitly assumed that the central bank injects liquidity so as to achieve the rate that is prescribed by the interest rate rule. However, at the zero bound further injections of



liquidity have no additional effect on the nominal interest rate, and a negative interest rate prescribed by the interest rate rule cannot be implemented.

To illustrate the potentially dramatic consequences of the zero-interest-rate bound and deflation we simulate an extended period of recessionary and deflationary shocks in the Japan block of our three-country model. Initial conditions are set to steady state with an inflation target of 1%, a real equilibrium rate of 1.5%, and thus an equilibrium nominal interest rate of 2.5%. Then, the economy is hit by a sequence of negative demand and contract price shocks for a total period of 5 years. The magnitude of the demand and contract price shocks is set equal to -1.5 and -1 percentage points respectively.

The output and inflation performance of the Japanese economy if monetary policy were to stick to Taylor's rule is shown by the solid lines in **Figure 1**. The left panel reports the output gap while the right panel displays the annual rate of inflation. As a result of the sequence of shocks the Japanese economy plunges into a double-digit recession (with an output gap of up to -14%) while experiencing a massive decline in the price level (with a rate of inflation close to -11%).

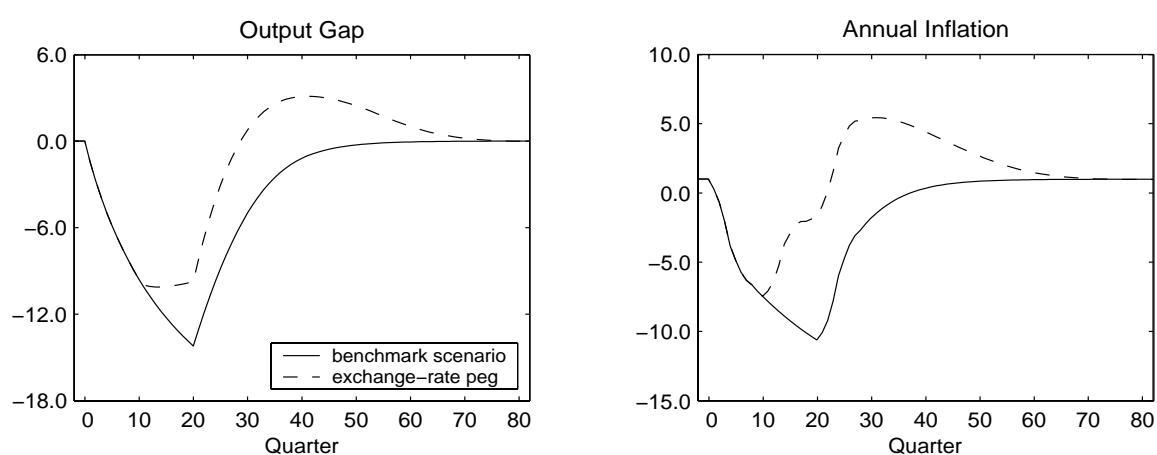


FIGURE 1. OUTPUT GAP AND INFLATION IN A SEVERE RECESSION AND DEFLATION

To a large extent the depth of this recession is due to the reduced effectiveness of monetary policy in a liquidity trap. As shown by the solid line in the left panel of **Figure 2** nominal interest rates are constrained at zero for almost a decade. Thus, deflation leads to an increase in the long-term real interest rate up to 3% and the Yen temporarily appreciates in real terms. Consequently, the recession and deflation are much more pronounced than they would be in the absence of the zero bound.

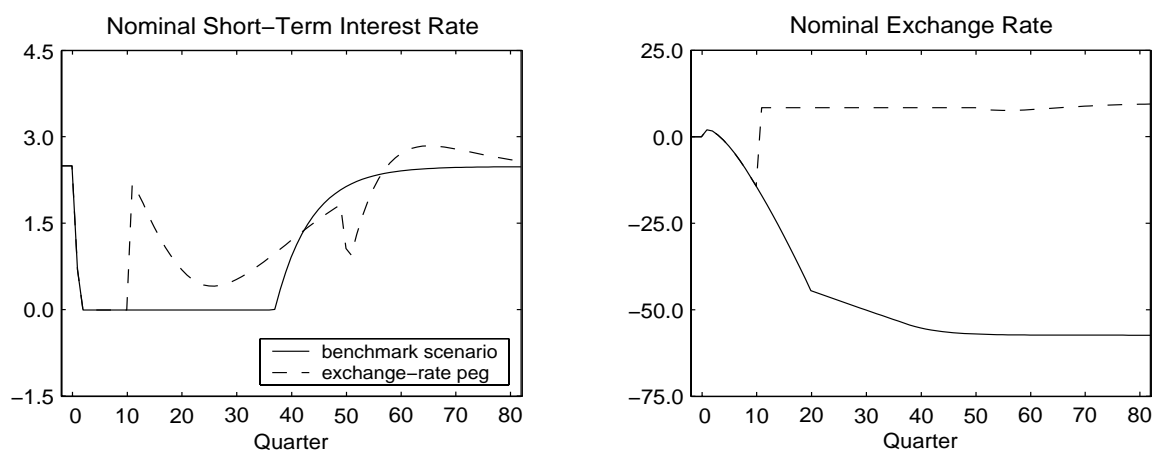


FIGURE 2. INTEREST RATE AND EXCHANGE RATE IN A SEVERE RECESSION AND  
DEFLATION

A counterfactual simulation (not shown in this figure), in which the zero bound is not imposed, indicates that the central bank would like to respond to the onset of recession and disinflation by drastically lowering nominal interest rates. If this were possible the long-term real interest rate would decline by about 4% and the central bank would be able to contain the output gap and deflation around -9% and -7% respectively. The reduction in nominal interest rates would be accompanied by an 11% real depreciation in trade-weighted terms.

### III. Exchange-Rate Peg versus Price-Level Targeting

Svensson (2001) offers what he calls a foolproof way of escaping from a liquidity trap. With interest rates constrained at zero and ongoing deflation he recommends that the central bank stimulates the economy and raises inflationary expectations by switching to an exchange-rate peg at a substantially devalued exchange rate. The exchange-rate peg is intended to be temporary and should be abandoned in favor of price-level or inflation targeting once the price-level reaches a pre-announced target path. His concrete proposal is as follows:

- Announce a devaluation and subsequent peg of the nominal exchange rate at a given target,

$$s_t = \bar{s}, \quad t \geq t_0; \quad (2)$$

- announce that the peg will be abandoned once the price level again coincides with an upward-sloping target path,

$$p_t^* = p_{t_0}^* + 0.25 \pi^* (t - t_0), \quad t \geq t_0 \quad (3)$$

with  $p_{t_0}^* > p_{t_0}$  and  $\pi^* > 0$ . From then on, a policy of price-level or inflation targeting may be followed.<sup>3</sup>

Svensson emphasizes that the central bank should be able to enforce the peg at a devalued rate by standing ready to buy up foreign currency at this rate to an unlimited extent if necessary. This situation differs from the defense of an overvalued exchange rate, which requires selling foreign currency and poses the risk of running out of foreign exchange reserves.

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<sup>3</sup>If the target inflation that is implicit in the price-level target path differs from the foreign target inflation rate then a crawling exchange-rate peg may be more appropriate than a fixed peg.

We investigate the consequences of Svensson's proposal if it is adopted after the central bank has observed 9 quarters of zero nominal interest rates. The outcome is shown by the dashed lines in **Figure 1** and **Figure 2**. In our simulation the peg is implemented with respect to the U.S. Dollar and  $s_t$  denotes the bilateral nominal Yen/U.S. Dollar exchange rate. Important choice variables in Svensson's proposal are the initial price level of the implied target path, the extent of the devaluation and the length of the peg.

The exchange-rate peg delivers the intended results. As shown in **Figure 1** (dashed line) inflationary expectations are jump-started and rise very quickly. As a result, the real interest rate declines very rapidly, the real exchange rate depreciates, and the economy recovers more quickly from the recession. The implied nominal devaluation is shown in the right panel of **Figure 2** (dashed line). It induces a 15% real depreciation in the trade-weighted exchange rate.

Uncovered interest parity and exchange-rate expectations play a key role. Once the central bank announces the peg the expected exchange-rate change is zero and the nominal interest rate rises to the level of the foreign rate absent any risk premium. The left panel of **Figure 2** (dashed line) confirms that the nominal interest rate jumps to a positive level immediately upon the start of the peg.

The preceding analysis of Svensson's proposed exchange-rate peg emphasizes that escaping from the liquidity trap requires generating expectations of inflation. However, the exchange-rate peg is not a necessary ingredient. Inflationary expectations may simply be achieved by promising future policy easing. Using a small micro-founded closed-economy model Eggertson and Woodford (2003) show that it is optimal for the central bank to commit to keeping nominal interest rates lower in the future in order to affect expectations of inflation while the zero bound is still binding. They also show that the optimal policy



can be implemented through commitment to a history-dependent rule using a price-level target that evolves over time. Furthermore, they find that a simpler rule with a fixed target achieves most of the benefits of the optimal policy. Inspired by their findings we investigate whether switching to a price-level target alone would be sufficient to stimulate inflationary expectations in our estimated model. More precisely, we consider the performance of the following policy proposal:

- Announce an upward-sloping price-level target path as defined by equation (3) and replace the inflation target in Taylor's rule (equation (1)) with this price-level target, thereby committing to lower interest rates in the future until the price gap is completely closed.

**Figure 3** compares the performance of the Japanese economy in our model when the central bank switches to the price-level target (dashed-dotted line) after 9 quarters of zero interest rates with the performance under a switch to an exchange-rate peg (dashed line).

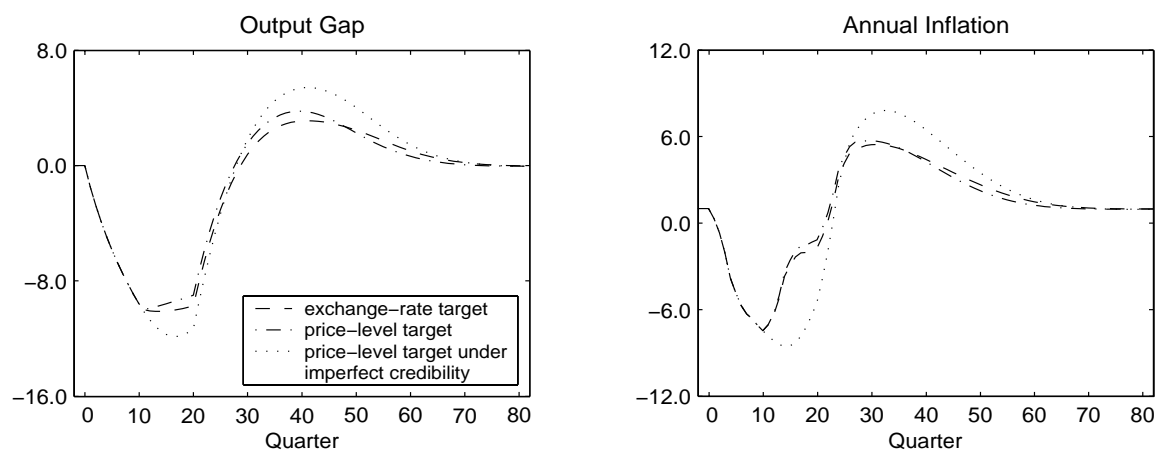


FIGURE 3. EXCHANGE-RATE PEG VERSUS PRICE-LEVEL TARGETING

Surprisingly, switching to the price-level target alone is just as effective in generating inflationary expectations as the exchange-rate peg. Output and inflation return even a bit more quickly to steady-state, the reason being that the nominal interest rate remains at zero much longer and that consequently the long-term real rate falls lower and the real depreciation is a bit larger than under the exchange-rate peg.

#### IV. Implications of Imperfect Credibility

So far, exchange-rate-based and price-level-target-based approaches appear equally effective in inducing inflationary expectations in a liquidity trap. From a practical perspective, however, there is an important difference. While the exchange-rate peg can be verified every day it is maintained by the central bank, the price-level target path and resulting price gap are not directly observable. Thus, the success of price-level targeting may depend very much on the credibility of the announced target path.

To gauge the validity of our findings we consider an alternative scenario, in which a share  $\lambda$  of market participants trust the central bank's commitment to the price-level target ( $0 \leq \lambda \leq 1$ ) while the others remain sceptical regarding the policy switch ( $1 - \lambda$ ). Sceptical market participants still believe that the central bank will pursue an inflation target rather than a price-level target. In other words, they do not believe that the central bank intends to induce sufficient inflation in the future to fully make up the price-level gap. We assume that the share  $\lambda$  converges to one at an exponential rate and report output and inflation outcomes for an initial value of 0.2 in **Figure 3** (dotted lines). We find that the benefits of a switch to price-level targeting are reduced substantially if a large share of market participants does not immediately buy the central bank's announcement.

## V. Conclusions

The strength of the estimated three-country model lies in its ability to match the observed degree of persistence of output and inflation in Japan, the United States and the euro area. However, the model differs from a standard New-Keynesian micro-founded model in several ways, most importantly because lags of the output gap are included in the behavioral demand equations. To investigate the validity of our results from a theoretical perspective we have simulated a similar recession and deflation scenario in the micro-founded two-country model of Benigno and Benigno (2001).<sup>4</sup> We have obtained qualitatively similar results as far as the effect of the zero bound on output, inflation and interest rates is concerned. However, not surprisingly, the effect of the zero bound is rather small and the dynamics are highly stylized due to the lack of intrinsic persistence in the micro-founded model.

Based on our quantitative findings in the estimated model we conclude that the zero bound on nominal interest rates has an economically significant impact on the macroeconomic performance of the Japanese economy in a recession and deflation scenario. We also find that the central bank may improve performance substantially by devaluing the exchange rate and switching to an exchange-rate peg or by committing to a price-level target path and an interest-rate rule that will close the price gap in the future. From a practical perspective, however, the lack of immediate verifiability may render a price-level-targeting-based proposal for escaping from a liquidity trap less credible and consequently less effective.

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<sup>4</sup>For a more detailed presentation of these results see Coenen and Wieland (2004).

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