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DOWNWARD NOMINAL WAGE RIGIDITY AND THE LONG-RUN PHILLIPS CURVE: SIMULATION-BASED EVIDENCE FOR THE EURO AREA

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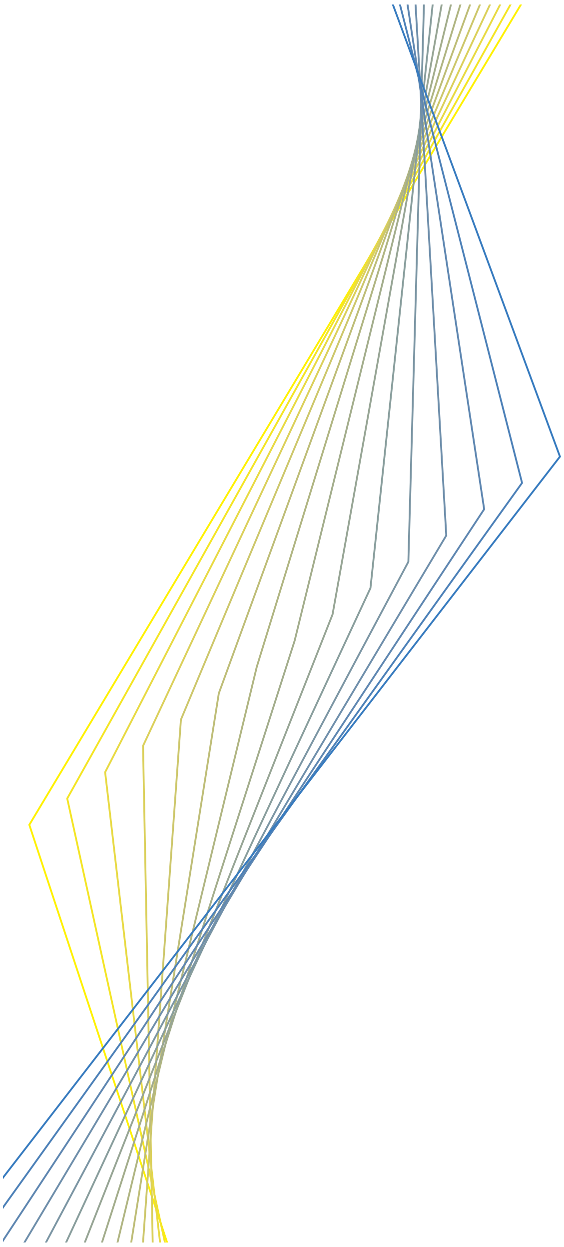

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GÜNTER COENEN[1, 2]

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1 Correspondence: Günter Coenen, Directorate General Research, European Central Bank, Kaiserstrasse 29, D-60311 Frankfurt am Main, Germany, phone: +49 69 1344-7887, e-mail: gunter.coenen@ecb.int.

2 The opinions expressed here are those of the author and do not necessarily reflect views of the European Central Bank. Helpful discussions with Ignazio Angeloni and Frank Smets are gratefully acknowledged. Any remaining errors are of course the sole responsibility of the author.

Address	**Kaiserstrasse 29**
	D-60311 Frankfurt am Main
	Germany
Postal address	**Postfach 16 03 19**
	D-60066 Frankfurt am Main
	Germany
Telephone	**+49 69 1344 0**
Internet	**http://www.ecb.int**
Fax	**+49 69 1344 6000**
Telex	**411 144 ecb d**

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Abstract

This paper summarises the results of a quantitative study of the possible impact of downward nominal wage rigidity on the determination of inflation and output in the euro area and the existence of a non-vertical long-run Phillips curve. The study was undertaken in the context of the review of the ECB's monetary policy strategy in Spring 2003 and complements an investigation of the consequences of the zero-interest-rate bound for monetary policy-making in the euro area, the results of which are summarised in Coenen (2003).

JEL Classification System: E31, E52, E58, E61

Keywords: Downward nominal wage rigidity, price stability, long-run Phillips curve, euro area

Non-technical summary

This paper summarises the results of a quantitative study of the possible impact of downward nominal wage rigidity on the determination of inflation and output in the euro area and the existence of a non-vertical long-run Phillips curve. The study was undertaken in the context of the review of the ECB's monetary policy strategy in Spring 2003 and complements an investigation of the consequences of the zero-interest-rate bound for monetary policy-making in the euro area, the results of which are summarised in Coenen (2003).

Employing stochastic simulations of a small estimated model of the euro area with staggered wage contracts which accounts for downward nominal wage rigidity by restricting the change in nominal contract wages to be non-negative, the following results have emerged:

- With an annual trend rate of productivity growth equal to 1.5 percent, the impact of downward nominal wage rigidity on the determination of inflation and output is noticeable but economically not significant for inflation targets set at 1 percent or higher.

- The magnitude of the induced distortions is increasing in the degree of inflation persistence, but the adverse consequences of downward nominal wage rigidity remain limited with an inflation target of 1 percent even if the degree of inflation persistence is high.

- The asymmetry of wage adjustments arising from downward nominal wage rigidity generates a non-vertical long-run Phillips curve, with output falling increasingly short of potential with lower inflation targets. However, even with an inflation target equal to zero, the output loss is in the order of one-eighths to one-fourths of a percentage point, depending on the degree of inflation persistence.

1. Introduction and summary

In the case of the euro area, the IMF (2002) and the OECD (2002) have identified the existence of downward nominal wage rigidity as an important argument for maintaining a small positive inflation rate. This argument reflects the widely-held view that a small positive inflation rate may facilitate wage adjustments in an economy in which workers show resistance to nominal wage cuts and, thereby, improve the economy's overall macroeconomic performance.[1]

Central to this argument is the assumption that, in an environment of very low inflation, downward rigidity in nominal wages is likely to be an important feature of wage-setting behaviour. The binding effect of downward nominal wage rigidity will raise the average level of real wages and, thus, impact adversely on aggregate supply. Moreover, firms facing a rise in wage costs will, at least in part, pass on these increased costs to higher prices, which, at the aggregate level, will induce an upward bias in inflation. To the extent that the monetary policy-makers try to keep inflation close to target and counteract the resulting upward bias in the inflation rate, this will lead to a rise in nominal as well as real interest rates and, thereby, to a reduction in aggregate demand. Hence, under the assumption that workers do not learn and change their behaviour over time, the sustainable level of aggregate demand itself depends on the targeted level of inflation.

This paper revisits the importance of the above argument employing stochastic simulations of a small estimated model of the euro area with staggered wage contracts which accounts for downward nominal wage rigidity by restricting the change in nominal contract wages to be non-negative. The following results have emerged from the stochastic simulation exercise:

- With an annual trend rate of productivity growth equal to 1.5 percent, the impact of downward nominal wage rigidity on the determination of inflation and output is noticeable but economically not significant for inflation targets set at 1 percent or higher.

- The magnitude of the induced distortions is increasing in the degree of inflation persistence, but the adverse consequences of downward nominal wage rigidity remain limited with an inflation target of 1 percent even if the degree of inflation persistence is high.

- The asymmetry of wage adjustments arising from downward nominal wage rigidity generates a non-vertical long-run Phillips curve, with output falling increasingly short of potential with lower inflation targets. However, even with an inflation target equal to zero, the output loss is in the order of one-eighths to one-fourths of a percentage point, depending on the degree of inflation persistence.

[1] For an influential study of the consequences of downward nominal wage rigidity see Akerlof, Dickens and Perry (1996), who present empirical and simulation-based evidence for the U.S. economy. More recently, using data from Switzerland, Fehr and Götte (2000) have shown that downward rigidity of nominal wages may hamper real wage adjustments even in a low-growth environment where workers' resistance to wage cuts is typically considered to be lower.

Although the study provides a number of useful insights into the functioning of the euro area economy in the presence of downward nominal wage rigidity, there are several caveats which seem worth mentioning. First, the study utilises a relatively stylised model of aggregate demand and aggregate supply. As a result, the model does not incorporate an explicit labour market, the existence of which would allow analysing more deeply the effects of nominal wage rigidity on the supply side via its impact on the formation of real wages and the level of employment. Second, the study does not distinguish between alternative features of wage compensation schemes such as bonuses and overtime which may provide additional flexibility regarding wage settlements between workers and firms. Similarly, it disregards the possibility of wage reductions which in principle can be achieved as individual workers change their jobs or re-enter the labour market after earlier displacement. Third, increases in productivity, which generally help to maintain the level of nominal wages of workers, while at the same time providing flexibility to adjust real labour costs, are assumed to be exogenous. Fourth, the study assumes throughout that monetary policy-makers follow a standard Taylor rule which very likely is not optimal, especially when the degree of downward nominal wage rigidity is high. Finally, the study does not address the particular challenges which may arise from the existence of downward nominal wage rigidity in a possibly heterogeneous monetary union.[2]

Taken together, these caveats underline the need to conduct further studies, employing alternative models and methods, to obtain a deeper understanding of the relevance of downward nominal wage rigidity for monetary policy-making in the euro area.

The remainder of the paper is organised as follows. Section 2 briefly describes how downward nominal wage rigidity is incorporated in an otherwise linear macroeconomic model of the euro area satisfying monetary super-neutrality. Utilising this augmented model, Section 3 investigates the impact of downward nominal wage rigidity on the determination of inflation and output by employing stochastic dynamic simulations. In this context, the existence of a non-vertical long-run Phillips curve is shown.

2. Downward nominal rigidity in wage-setting behaviour: A macroeconomic perspective

In the paper, the possible consequences of downward nominal wage rigidity are assessed from a purely macroeconomic perspective. Specifically, the study utilises two variants of the estimated small structural model of the euro area developed by Coenen and Wieland (2000) which feature different types of staggered wage contracts:[3] the nominal wage contracting specification due to Taylor (1980) and the relative real wage contracting specification by Fuhrer and Moore (1995).

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[2] Regarding the euro area, for instance, both the IMF (2002) and the OECD (2002) have stressed that downward nominal wage rigidity may seriously hamper relative wage adjustments among Member States in response to cross-country differences in economic activity. In the same vein, it has been argued that downward nominal wage rigidity may render it more difficult for Member States to bring about improvements in their relative competitiveness.

[3] A short description of the two alternative contracting specifications, allowing for productivity growth, is given in the appendix For more details on the model used and the employed estimation methodology see Coenen and Wieland (2000) who refer to the two contracting specifications as the NW and the RWS specification respectively. Within the model, monetary policy-makers are assumed to follow an interest rate rule that relates the short-term nominal interest rate to developments in inflation and deviations of actual output from potential. Changes in the short-term nominal interest rate affect aggregate demand through their impact on the ex-ante long-term real interest rate.

As explained in more detail in the companion paper of Coenen (2003), the two contracting specifications differ with respect to the degree of inflation persistence that they induce, with Fuhrer-Moore-type contracts giving more weight to past inflation developments compared to Taylor-type contracts. To the extent that there are different set-ups of labour market institutions in EMU Member States which translate into different degrees of inflation persistence, the use of the two alternative contracting specifications may possibly shed some light on the particular dimension of the existence of downward nominal wage rigidities in the context of a monetary union.

The non-negativity constraint on nominal wage adjustments is enforced ex post by restricting the change in the nominal contract wage, Δx, to be equal to zero whenever the relevant wage contracting specification prescribes a cut in the wage level, x. In this context, the wage contract prescribed by the contracting specification may be seen as the *notional* contract wage, while the actually *signed* contract reflects workers' resistance to wage cuts.[4] It is important to note that due to the staggering of wage contracts, only a subset of nominal wages is adjustable at a given point in time. This may help reconcile the macroeconomic perspective of this study with the empirical observation that only a fraction of workers is eventually exposed to the threat of wage cuts at a given point in time.

In the steady state of the model, the rate of change in the nominal contract wage, Δx, is determined by the monetary policy-makers' inflation target, π^*, and the trend rate of productivity growth, $\Delta\lambda$. Of course, the higher the inflation target and/or the trend rate of productivity growth, the smaller should be the likelihood that the non-negativity constraint on nominal wage adjustments is binding. As a baseline assumption, the annual trend rate of productivity growth is set equal to 1.5 percent throughout the study, while the consequences of downward nominal wage rigidity is explored for alternative levels of the inflation target.[5]

3. The impact of downward wage rigidity on the stationary distributions of inflation and output

This section evaluates the quantitative impact of the imposed non-negativity constraint on nominal wage growth on the stationary distributions of inflation and output by employing stochastic dynamic simulations for alternative inflation targets that fall in a range between 0 and 4 percent.[6] To this end, the structural model is subjected repeatedly to a sequence of shocks which are drawn from a normal distribution with the covariance matrix of the shocks estimated using historical data. Throughout these

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[4] The two contracting specifications were estimated by Coenen and Wieland (2000) without incorporating downward nominal wage rigidity explicitly. To account for the possible consequences of downward rigidity on the wage-setting behaviour at the empirical level, a model with more explicit microfoundations that distinguishes between alternative features of wage compensation schemes will be helpful. For example, flexibility regarding bonuses and overtime may become increasingly important if the likelihood of the non-negativity constraint becoming binding is high.

[5] Since productivity is assumed to follow a deterministic log-linear trend, productivity growth is constant. It would be interesting to allow for endogenous determination of productivity. This, however, is beyond the scope of this study.

[6] For further details on the preparations for the simulations the reader is referred to the companion paper of Coenen (2003). Again, the simulations have been conducted using an efficient solution algorithm implemented in the PcTroll software package which can cope with the non-linearity arising from the non-negativity constraint on nominal wage adjustments.

counter-factual simulations, monetary policy is assumed to follow the rule proposed by Taylor (1993) which relates the nominal interest rate to deviations of annual inflation from the inflation target and deviations of output from its potential, with the response coefficients set equal to 1.5 and 0.5, respectively.

a) The frequency of bind of the non-negativity constraint on nominal wage adjustments

To evaluate whether the non-negativity constraint on nominal wage adjustments has quantitatively significant effects, the study starts by assessing the likelihood that downward wage adjustments would be constrained by workers' resistance to wage cuts if the economy were subjected to shocks similar in magnitude to those observed historically. Summarising the results of a large number of counterfactual stochastic simulations with alternative inflation targets, **Figure 1** shows the frequency with which the non-negativity constraint would hamper downward wage adjustments. The solid line with squares refers to the model with Taylor-type wage contracts while the solid line with diamonds refers to the model with Fuhrer-Moore-type contracts.

As is evident in the figure, under Taylor-type wage contracts the non-negativity constraint on wage adjustments does not represent a quantitatively very important factor for inflation targets set at 1 percent or higher. With an inflation target of 1 percent the constraint becomes binding with about 9 percent frequency, while the frequency of bind falls to less than 3 percent with a target of 2 percent. Although the increase in the frequency of bind is accelerating as the inflation target approaches zero, the frequency of bind remains well below 25 percent. Under Fuhrer-Moore-type contracts the frequency of bind is uniformly higher than under Taylor-type contracts. With an inflation target of 2 percent, for example, the constraint on downward wage adjustments becomes binding with about 12 percent frequency, while the frequency of bind amounts to 18 percent with an inflation target equal to 1 percent.

b) The distortion of the stationary distributions of inflation and output

Having provided a quantitative assessment of the likelihood that the non-negativity constraint on wage adjustments becomes binding, the following analysis focuses on the extent to which the behaviour of the annual inflation rate and output are distorted with increased frequency of bind. Quantitative information on the size of the distortion is obtained from the stationary distributions of the variables of interest. These distributions are constructed from the outcomes of the stochastic dynamic simulations with the non-negativity constraint on nominal wage adjustments being imposed.

Figure 2 provides summary information regarding the distortion of the mean and the variability of the variables of interest when the non-negativity constraint on wage growth is imposed. The two panels in the left column of the figure show the induced bias in the means of these variables and the two panels on the right the induced bias in their standard deviations. The benchmarks for comparison are the statistics of the stationary distributions in the absence of the non-negativity constraint on wage adjustments.

Starting with the results for the model incorporating Taylor-type contracts (solid line with squares), it can be seen in the upper left panel of **Figure 2** that the non-negativity constraint introduces a noticeable upward bias in the mean of the inflation rate for inflation targets near zero. This upward bias comes about as the result of the assumed mark-up policies of firms which pass on to higher prices the increased wage costs due to the occasionally binding non-negativity constraint on wage changes. At the same time, as indicated in the lower left panel, the mean of output is biased downwards, the reason being that the monetary policy-makers try to keep inflation close to target and counteract the resulting upward bias in the inflation rate by raising the nominal interest rate. This will lead to a rise in the real interest rate and, thereby, to a fall in aggregate demand below potential. The quantitative effects, however, are fairly small for inflation targets set at 1 percent or higher. For example, with an inflation target equal to 1 percent, average inflation exceeds the target by 0.04 percentage points, while average output falls short of potential by 0.03 percentage points. With the inflation target approaching zero, the upward bias in average inflation rises to 0.13 percentage points, while the shortfall in average output amounts to 0.10 percentage points. The non-negativity constraint on nominal wage adjustments also introduces a noticeable downward bias in the standard deviation of inflation, while the emerging upward bias in the standard deviation of output appears negligibly small.

Turning to the results obtained under Fuhrer-Moore-type contracts (solid line with diamonds), the two panels in the left column of **Figure 2** reveal that a more significant bias materialises with respect to the means of both inflation and output if the degree of inflation persistence is high. Under Fuhrer-Moore-type contracts and with an inflation target equal to 1 percent, for example, average inflation exceeds the inflation target by about 0.10 percentage points, while average output falls short of potential by 0.09 percentage points. Similarly, the magnitude of the bias in the standard deviations of inflation and output turns out to be larger by a factor of 2 to 3 if the degree of inflation persistence is high.

Finally, the solid and dash-dotted lines in **Figure 3** depict the probability density functions of the inflation gap and the output gap with inflation targets of 0 and 2 percent, respectively. As shown by the two panels in the left column of the figure, with an inflation target equal to zero, the probability mass from the left tail of the inflation distribution is noticeably shifted towards its centre, with the distortion under Fuhrer-Moore-type contracts being significantly larger than under Taylor-type contracts. In fact, under the contracting specification by Fuhrer and Moore the probability mass is markedly piled up in the negative region of the inflation distribution. This is consistent with the finding of a more substantial upward bias in the mean rate of inflation, together with a strong downward bias in its standard deviation, as documented in **Figure 2**. Apparently, the occurrence of larger distortions under Fuhrer-Moore-type contracts reflects that the higher degree of inflation persistence induced by this type of contracts also translates into a larger unconditional variance of inflation. By contrast, as indicated by the two panels in the right column of **Figure 3**, the distortion of the output distribution is rather small under either of the two contracting specifications, although the distortion under Fuhrer-Moore-type contracts is yet again perceptibly larger than under Taylor-type contracts.

c) The existence of a non-vertical long-run Phillips curve

The presence of downward nominal wage rigidity invalidates the long-run super-neutrality of monetary policy that obtains in the linear version of the wage contracting models. The relationship between the average level of inflation and the average level of output that is due to the non-negativity constraint on nominal wage adjustments implies the existence of a non-vertical long-run Phillips curve in these models. This is shown in **Figure 4** which plots the upward sloping relationship between average inflation and the average output gap, with output falling increasingly short of potential with lower inflation targets. However, the slope of the long-run Phillips curve induced by downward nominal wage rigidity is only noticeable at average inflation rates below 1 percent. In the extreme case with an inflation target equal to zero, the maximum output loss is in the order of one-eighths to one-fourths percentage point, depending on the degree of inflation persistence.

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Appendix: The staggered wage contracting specifications

The staggered contracts models of Taylor (1980) and Fuhrer and Moore (1995) assume that workers negotiate long-term nominal wage contracts by comparing the current wage contract to past contracts that are still in effect and future contracts that will be negotiated over the life of this contract. As a result, only a subset of nominal wage contracts is adjustable at a given point in time. The distinction between Taylor and Fuhrer-Moore-type wage contracts concerns the definition of the wage indices that form the basis of this comparison.

Taylor-type wage contracts:

Under Taylor's specification, the nominal wage contract, x_t, is negotiated with reference to the price level that is expected to prevail over the life of the contract, p_{t+i}, adjusted for the expected deviations of output from its potential over this period, y_{t+i}, and the level of productivity, λ_t,

$$x_t = \mathrm{E}_t\left[\sum\nolimits_{i=0}^{3} f_i p_{t+i} + \gamma \sum\nolimits_{i=0}^{3} f_i y_{t+i}\right] + \lambda_t ,$$

where the aggregate price level, p_t, is expressed as the weighted average of productivity deflated current and previously negotiated contract wages, x_{t-i}, which are still in effect,

$$p_t = \sum\nolimits_{i=0}^{3} f_i (x_{t-i} - \lambda_{t-i}) + \tilde{\varepsilon}_t$$

with $f_i > 0$, $f_i > f_{i+1}$ and $\sum_i f_i = 1$.

The expectation operator $\mathrm{E}_t[\cdot]$ indicates the optimal forecast of a particular variable conditional on all information available in period t and the white-noise shock $\tilde{\varepsilon}_t$ summarises other short-term influences.

Since the price indices p_{t+i} reflect contemporaneous and preceding contract wages, Taylor's contracting specification implies that wage setters look at an average of overlapping nominal contract wages negotiated in the recent past and expected to be negotiated in the near future when setting the current contract wage. If wage setters expect output to exceed potential, $y_{t+i} > 0$, they adjust the current contract wage upwards relative to overlapping contracts. The parameter γ measures the sensitivity of contract wages to excess demand.

Fuhrer-Moore-type wage contracts:

Under the specification by Fuhrer-Moore, workers negotiating their nominal wage contract compare the implied productivity deflated real wage with the productivity deflated real wages on overlapping contracts in the recent past and near future. This specification implies that the real wage under contracts signed in the current period is set with reference to an average of real contract wage indices expected to prevail over the current and the next three quarters, v_{t+i},

$$x_t - p_t - \lambda_t = \mathrm{E}_t\left[\sum\nolimits_{i=0}^{3} f_i v_{t+i} + \gamma \sum\nolimits_{i=0}^{3} f_i y_{t+i}\right],$$

where

$$v_t = \sum\nolimits_{i=0}^{3} f_i (x_{t-i} - p_{t-i} - \lambda_{t-i}) .$$

Figure 1: The frequency of bind of the constraint on wage adjustments

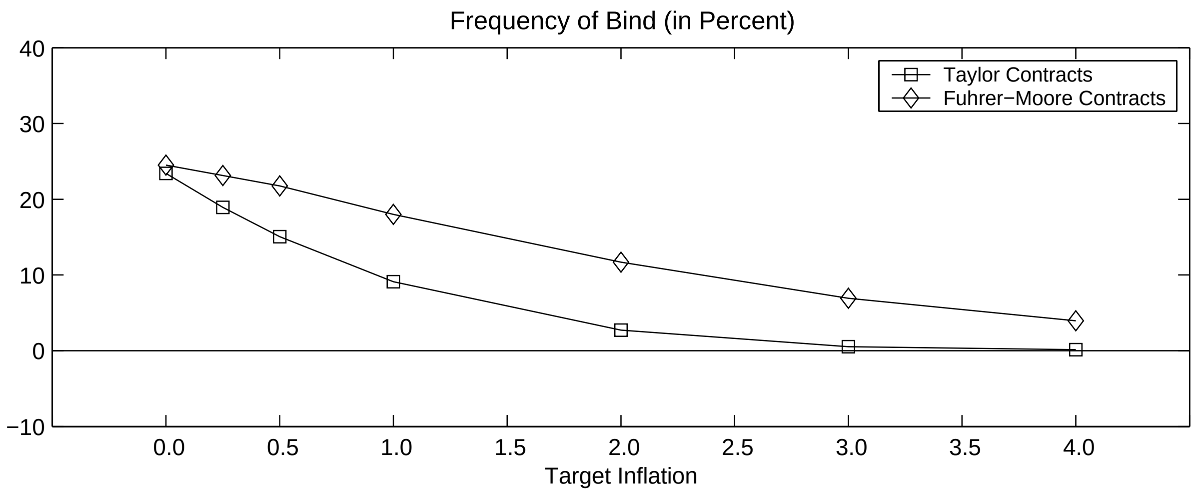
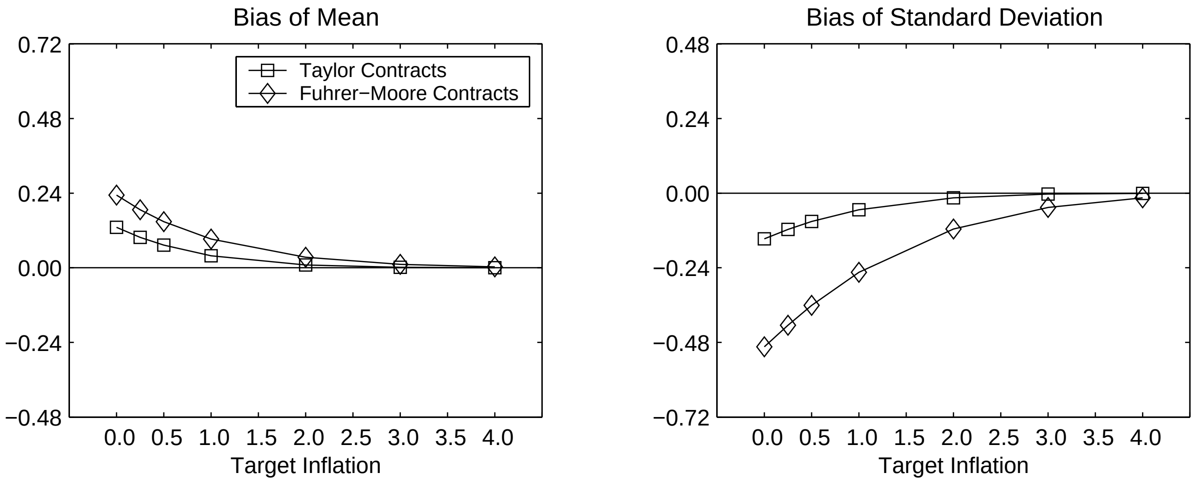


Figure 2: The distortion of the stationary distributions of inflation and output

a) Distortion of the stationary distribution of inflation



b) Distortion of the stationary distribution of output

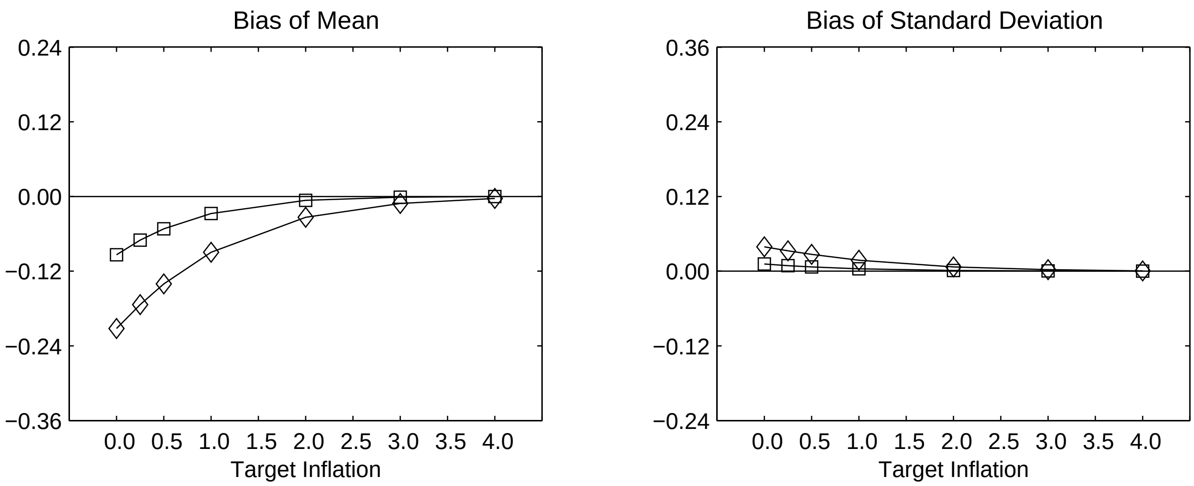
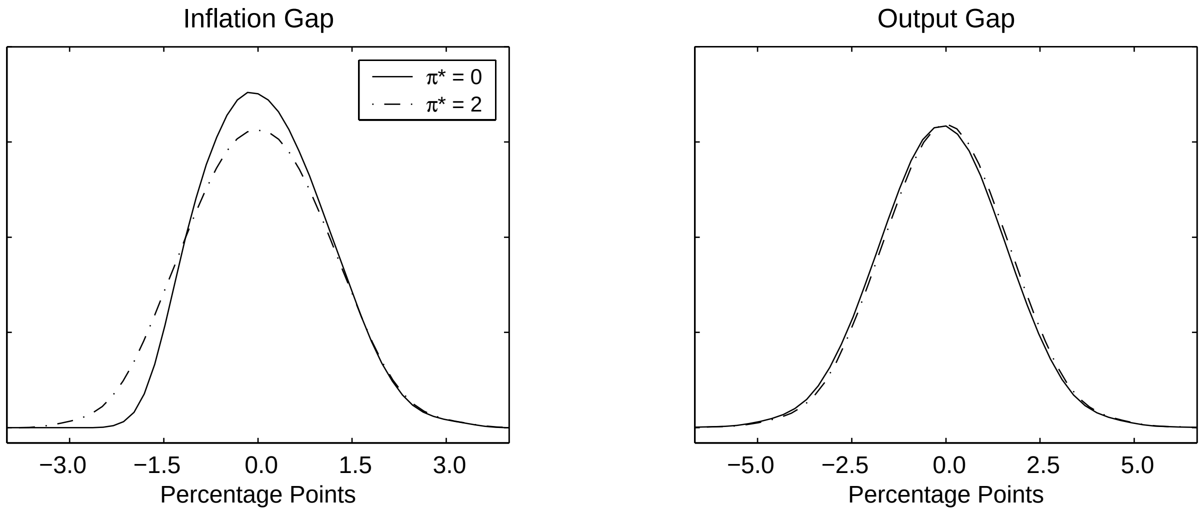


Figure 3: The stationary distributions of the inflation gap and the output gap

a) Taylor-type wage contracts



b) Fuhrer-Moore-type wage contracts

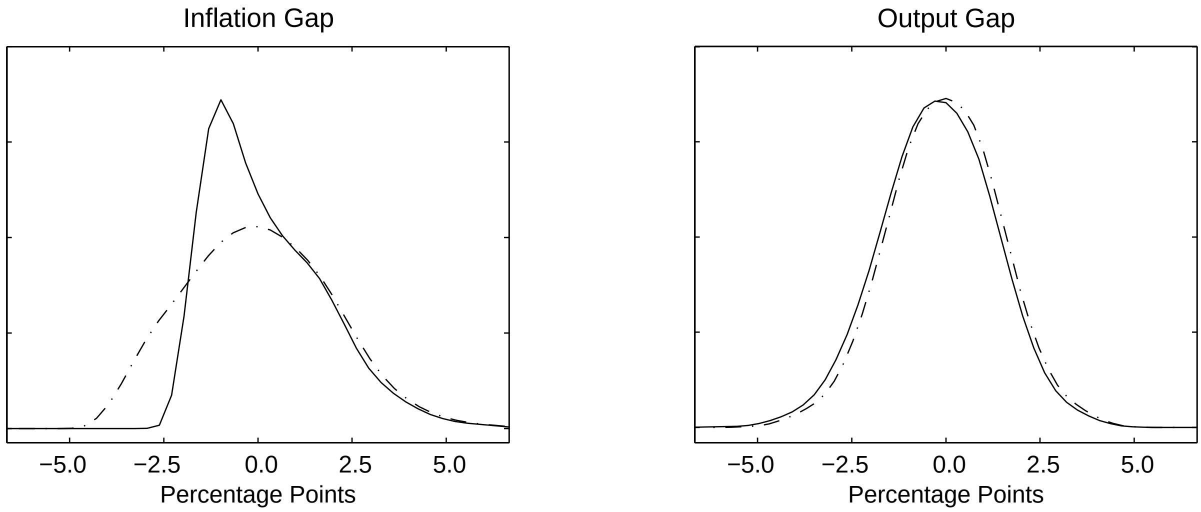
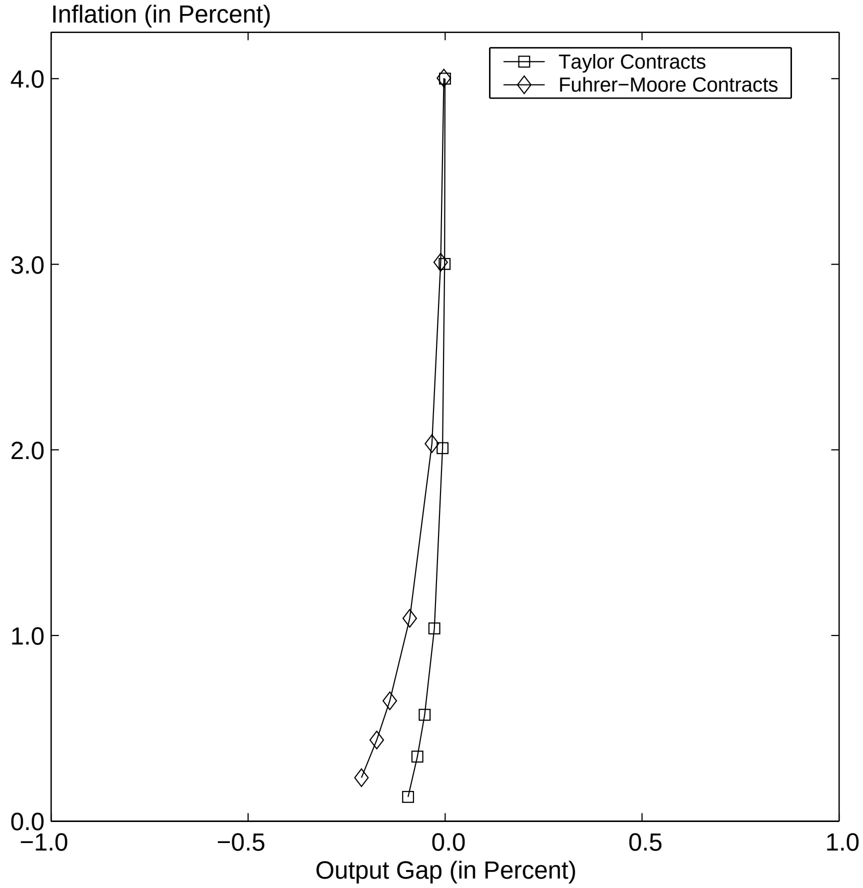


Figure 4: The non-vertical long-run Phillips curve



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