Wage Indexation, Inflation Inertia, and the Cost of Disinflation[1]

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Abstract

Wage increases based on past inflation increase inflation inertia and hence increase the cost of disinflation. Higher central bank credibility and a higher frequency of wage negotiations correspond to lower inflation inertia and a lower cost of disinflation. We have come to these conclusions using two models where the determination of wages captures forward and backward looking wage indexation and wage contract length. The policy implications are that the cost of disinflation can be decreased by using target or forecasted inflation in the negotiations of wage increases and by making every effort to increase central bank credibility.

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Key words: wage indexation, inflation inertia, disinflation, sacrifice ratio, staggered wage contracts, credibility.

1 Introduction

Recurrently, workers and entrepreneurs, as well as the government and the Court debate and negotiate wage increases and on the ingredients of such negotiation. In the background of wage negotiations, economists often argue in articles about lawyers' interference in economic policy, and lawyers argue that economists ignore rights. The aim of this paper is to examine, within the field of economics, some key features in the negotiations of wage adjustments and how these features affect economic efficiency, output and real wages.

The starting point of the paper is statement C-1422/2000 of the Constitutional Court of Colombia:

"(…) wage increases must correspond at least to the amount of past inflation because this is the only way to adequately carry out the constitutional mandate of maintaining the real purchasing power of the workers' wages." (our translation).

After analyzing the economic implications of the Court's statement from the point of view of dynamic macroeconomics, we concluded that, contrary to the Court's stated purpose, under the disinflation program Colombia is undertaking, wage indexation based on past

inflation may lead to losses in both output and real wages. Using a model of the wage/price system calibrated for the case of Colombia, the effect of backward looking wage increases on the cost of disinflation was studied. The model also serves the purpose of studying the effect of central bank credibility (or absence of credibility), on the cost of disinflation. A second model helped analyze the effect of the frequency of wage increases on the cost of disinflation.

The implied wage rule in the Court's statement is:

$$W_t - W_{t-1} = P_{t-1} - P_{t-2} \quad (1)$$

where W_t is the (log of the) nominal wage during year t, and P_t is the (log of the) CPI and the end of year t.

For our purposes, one of the most salient features of rule (1) is that it is backward looking. In other words, wage increases follow past inflation. The core of the paper will show the effect of backward looking wage indexation and the effect of this practice on the cost of disinflation. Nonetheless, apart from backward looking indexation, two characteristics of rule (1) can be advanced.

The first characteristic is that rule (1) ignores the cycle. As real wages do not change according to supply and demand in the labor market, changes in the demand for labor must adjust via quantities. Employment would increase in expansions, unemployment would increase in recessions.

The second characteristic is the effect of rule (1) on real wage instability. Since food items in Colombia are about 30% of the CPI, changes in food prices cause large changes in CPI inflation. A drought decreases food supply and increases food price inflation. The increase in food price inflation increases overall CPI inflation. And the increase in CPI inflation, in turn, leads to high wage increases in the following year. However, poor harvests are usually followed by good harvests and low food prices. Hence, high wage adjustments are met with low inflation. Real wages rise. With supply shocks in agriculture like the ones experienced in Colombia, backward looking wage indexation increases real wage variability.

The Constitutional Court often defends wage increases based on past inflation. The Banco de la República (the central bank of Colombia) consistently proposes wage increases based on the inflation target. The lawyers' motivation is "(to maintain) the real purchasing power of the workers' wages." The economists' is, I would say, efficiency; specifically, they would like to prevent a decrease in output and real wages because backward looking indexation increases inflation inertia and the cost of disinflation.

One of the purposes of the paper is to show that large gains could be obtained in wage stability and in reducing the cost of disinflation if workers and employers negotiated cost of living adjustments based on one of the following: the central bank inflation target; the central bank inflation forecast; the central bank survey of inflation expectations; some kind of consensus inflation forecast; or some combination of the above. Using the central bank inflation target or forecast in wage negotiations, however, is not a straightforward matter. Do labor unions buy the central bank Inflation Report? Is central bank credibility that valuable?

A large part of the literature seems to have focused on explaining how wage indexation makes disinflation more costly compared to the case of no indexation and how wage indexation makes disinflation less costly compared to the particular case of the United States where wage contracts specify preset time varying wages. See, for instance, Gray (1983), Simonsen (1983), Ball and Ceccetti (1991), Jadresic (1996). We, instead, focus on whether wages should be indexed to past or future inflation.

In regards to our modeling strategy, we follow Taylor in giving the wage/price system the central role in the determination of wage and price rigidities:

"The (…) model I present (…) places considerable emphasis on the institutional detail of wage and price setting. In fact, the wage and price sector looms large and tends to dominate the rest of the model. Wage and price setting is responsible for much of the dynamics of the model." (Taylor 1993, p. 32).

As for the treatment of real wages in the model, we follow the Bank of England (2000) as well as Taylor (1993) in postulating behavioral equations for prices and nominal wages and in checking whether the behavior of real wages is reasonable, that is, pro-cyclical. A different modeling strategy, which is not followed in this paper, is the one utilized by Whelan (1997). He posits behavioral equations for both real and nominal wages and, based on them, he derives the implications for the evolution of prices.

Another important factor about the modeling strategy is the interaction between wage rigidity, price rigidity, and the cost of disinflation. There are three aspects involved in the

interaction between them. First, the factors that may affect wage rigidity: whether past or future inflation is used in the negotiation of wage increases, central bank credibility, and the frequency of wage negotiations. Second, the two different ways wage rigidity impinges onto price rigidity in the two models in this paper. Third, the fact that price rigidities are the key element in explaining the cost of disinflation.

There are four sections including this introduction in this paper. The model that deals with the role of past and future inflation in cost of living wage negotiations is presented in Section II. Another model whose focus is the frequency of wage increases is presented in Section III. Each of the two modeling sections present the calibration and results. Finally, some conclusions are drown in Section IV.

2 Should wage increases be based on past or future inflation?

2.1 The first model

This model shows that even when the Phillips curve remains unchanged, higher wage inertia results in higher inflation inertia and hence in a higher cost of disinflation. Gómez and Julio (2000) showed that the greater the weight of the backward looking inflation indexation in the Phillips curve, the greater the inflation inertia, the lower the effect of monetary policy, and the higher the cost of disinflation are. The point of this model is to show the effect of wage indexation in the wage curve on the cost of disinflation.

The components of the model are a wage/price block, a real block and a forward looking interest rate rule. The model has been simplified so as to focus on one specific question in

the paper; that is, the effect of forward and backward looking wage indexation on the cost of disinflation. The model does not deal with features such as the pass-through, or the exchange rate. These issues are not relevant for the particular question addressed with this model.

In regards to the properties of the model, it displays Keynesian behavior in the short term and neoclassical behavior in the long term. In the short term, monetary policy is not neutral. In the long term, it is neutral and super neutral. Neutrality and super neutrality hold because the long run solution of the real variables is independent of the price level and of the rate of inflation. To achieve these properties, we imposed static homogeneity in the wage/price system.

Super neutrality is an important property for a model that seeks to analyze the disinflation experiment. It implies that, in the long run, the output gap converges to zero. In a model that is not super neutral, monetary policy has permanent effects on output; in such a model, policy could, in theory, increase output. This is a view that few economists would share. The consensus is that output cannot be increased by monetary policy but only by improvements in technology or in the inputs that are utilized.

Let us turn to the description of the model in detail. Following Fischer (1977, 1986), Simonsen (1983), Sahinbeyoglu (2000), the Bank of England (2000), we postulate a rule of thumb for wage adjustments:

$$\omega_t = c_1 \pi^4_{t+4|t} + c_2 \pi^4_t + c_3 \pi^*_t$$

$$+ 0.25c_4(y_{t+3|t} + y_{t+2|t} + y_{t+1|t} + y_t) - c_5(W_{t-1} - V_{t-1}) + \varepsilon_t^1 \quad (2)$$

where $\omega_t = 4(W_t - W_{t-1})$ is the quarterly increase in the (log of the) nominal wage W_t at an annual rate, $\pi_t^4 = P_t - P_{t-4}$ is the annual inflation rate, P_t is the (log of the) price level, $x_{t+k|t}$ is the expectation of variable x for k periods ahead given the information available at time t, π_t^* is the inflation target, y_t is the output gap, $V_t = P_t + Y_t - L_t$ is the (log of the) value of average output per worker, Y_t is (the log of) output, L_t is (the log of) labor.

In Eq. (2) wage increases depend on three factors. First, they depend on inflation expectations. Inflation expectations are given, in turn, by a combination of the inflation forecast, past inflation, and the inflation target. Different specifications for the c_1, c_2 and c_3 weights account for different relative emphases on past and future inflation in wage negotiations and correspond to both different levels of inflation inertia and distinct levels of the cost of disinflation.

Second, in Eq. (2), wage adjustments also depend on the expected output gap. The purpose of this is to capture the fact that wage negotiations depend on the economic conditions expected to prevail during the lifetime of the new wage agreement.

And third, Eq. (2) states that, in the long term, nominal wages converge to the value of average output, an equilibrium condition that has to be satisfied in the labor market in the long term.

As to the determination of inflation, it is defined by the Phillips curve:

$$\pi_t = c_6\pi_{t+1} + c_7\pi_{t-1} + c_8 y_t - c_9(P_{t-1} - C_{t-1}) + \varepsilon_t^2 \quad (3)$$

where $C_t = W_t + L_t - Y_t$ is unit labor cost.

As is the case for the overall model, the simplified version of the Phillips curve puts aside other features that are not relevant for the disinflation experiment in the paper and focuses on the salient features that are relevant during a period of disinflation. These are the weight of forward and backward looking expectations, the effect of the output gap on inflation, and a well defined long run.

In addition, the real sector of the economy is given by the aggregate demand equation (4), by a production function that for simplicity uses a single input (5), and by the definition of the output gap (6):

$$y_t = c_{10}y_{t-1} - c_{11}r_t + \varepsilon_t^3 \quad (4)$$

$$Y_t^P = gt + L_t + \varepsilon_t^4 \quad (5)$$

$$Y_t = y_t + Y_t^P \quad (6)$$

where $r_t = i_t - \pi_t^4$ is the real interest rate, i_t is the nominal interest rate, Y_t^P is (the log of) potential output, Y_t is (the log of) output, g is the growth of technology, and t is the time trend.

Finally, the reaction function of the central bank depicts the behavior of interest rates as a feedback mechanism defined on the basis of the deviation of the inflation forecast from target:

$$i_t = \bar{r} + \pi_t^4 + c_{12}(\pi_{t+k|t} - \pi_{t+k}^*) + \varepsilon_t^5 \quad (7)$$

where $\bar{r}$ is a long run equilibrium real interest rate.

2.2 Calibration

The model was calibrated in order to satisfy two properties. The first one was a reasonable effect of monetary policy on economic activity and inflation. The second one was a pro-cyclical behavior of (the change in) real wages.

As far as the effect of monetary policy on the economy is concerned, the calibration required that an increase in interest rates have an effect on the output gap within one year and on inflation within two years. Based on our experience, we picked 0.4 as a reasonable magnitude for the effect of a 100 bp increase in nominal interest rates on the output gap and inflation (see Figure 1).

While studying the subject of the pro-cyclicality of wages, we found that real wages were not pro-cyclical, but that their change was pro-cyclical as can be seen in the following equation:

$$\Delta(W_t - P_t) = \underset{(0.002)}{0.013} + \underset{(0.075)}{0.262}\, y_t + \varepsilon_t^6 \quad (8)$$

Sample: 1983:3 2002:4. $R^2 = 0.137$, SE = 0.019, DW 1.760.[3] The equation was run by OLS.

Hence, the model was calibrated so that the change in real wages was pro-cyclical. The standard shock of an increase in interest rates served as the relevant shock for the calibration of the pro-cyclicality of real wages. The reason is that we regarded the standard shock to the interest rate, like the one presented in Figure 1, as relevant on empirical grounds. During the nineties, interest rates in Colombia and, in general, in many emerging markets tended to defend crawling bands under sharp movements in the capital account of the balance of payments.

In the model, the effect of the output gap on the change in real wages is 0.3. This effect is of the same sign and order of magnitude as the estimated one of 0.262.

The calibrated coefficients are: $c_1 = 0.25,\ c_2 = 0.75,\ c_3 = 0,\ c_4 = 0.5,\ c_5 = 0.02,\ c_6 = 0.4,\ c_7 = 0.6,\ c_8 = 0.1,\ c_9 = 0.02,\ c_{10} = 0.9,\ c_{11} = 0.1,\ c_{12} = 0.75,\ k = 6.$

[3] Wages are for white collar workers ("empleados") in the industrial sector, deflated by the producer price index in the same sector. We use wages in the industrial sector because data is available from the beginning of the eighties. We also used wages for white collar workers because they seem more market sensitive than wages for blue collar workers ("obreros"). Wages are deflated by producer prices in the industrial sector so that real wages are relevant from the point of view of supply.

2.3 Results

The disinflation experiment that serves the purpose of examining the sacrifice ratio for backward and forward looking wage indexation consists of a permanent decrease in the inflation target of one percentage point. The disinflation experiment is reported in Figures 2, 3 and 4. The downward shift in the inflation target, by the policy rule (7), increases the nominal and real interest rates. If interest rates increase, output enters a recession. The nominal interest rate increases but, then, decreases along with the inflation rate. Wage adjustments decrease along with inflation.

The effect of indexing wages to past inflation and to target or expected inflation is summarized in Table 1. A positive sign means an output loss. The result is that the greater the weight of backward looking wage indexation (c_2), the higher the sacrifice ratio. The greater the weight of inflation expectations or central bank credibility (c_1 or c_3), the lower the cost of disinflation. A high enough weight of forward looking expectations may even make the output sacrifice negative. Here, disinflation entails an output gain.

Going back to the figures, when wage adjustments are based on *past inflation*, the output gap remains in recession for a period that is long compared to the length of recession in the other disinflation experiments (Figures 2, 3 and 4, dotted line). When wage adjustments are based on the inflation forecast, a shorter recession is followed by a boom.[4] The boom

[4] A similar boom was also found by Jadresic (1996) in a model with money.

arises as a consequence of an overshooting of the inflation target. The overshooting leads to a period of expansionary monetary policy (real interest rates fall below their long run). The output boom decreases the cost of disinflation.

When wages are indexed to the *inflation target*, disinflation does not entail a net output loss but an output gain. Compared to the case in Figure 2, where wages are indexed to the inflation forecast, in Figure 3, where wages are indexed to the inflation target, the boom after the recession is longer and takes place sooner. Since the inflation target is overshot by a larger number of percentage points, monetary policy has to engineer a longer boom.

Figure 4 presents the case in which wages are indexed to *a combination* of the inflation target, forward looking expectations, and backward looking expectations. In this case, also, recession is followed by a boom.

Overall, when wages are indexed looking backward, disinflation causes an output cost. When they are indexed looking forward, disinflation entails an output gain.

3 Is the frequency of wage increases responsible for the high cost of disinflation in Colombia?

3.1 The second model

The frequency of nominal contracts in Colombia is lower than in Chile. In Chile, cost of living adjustments are granted every six months and monthly rental for housing

automatically increases every quarter. In Colombia, wages and rental for housing are typically adjusted once a year[5].

Would a higher frequency of wage increases decrease inflation inertia and hence the cost of disinflation? In this section, we use a different model where contract length is important to the sacrifice ratio; the model closely follows Taylor (1993).

In contrast to the previous model, price and wage equations determine the level and not the change of the nominal variables. In the base specification, wages are determined by one year staggered contracts:

$$X_t = 0.25(W_t + W_{t+1|t} + W_{t+2|t} + W_{t+3|t})$$

$$+ 0.25c_{13}(y_t + y_{t+1|t} + y_{t+2|t} + y_{t+3|t}) + \varepsilon_t^7 \quad (9)$$

$$W_t = 0.25(X_t + X_{t-1} + X_{t-2} + X_{t-4}) \quad (10)$$

where W_t is the (log of the) nominal wage, and X_t is the (log of the) contract wage. Wages enter Eq. (9) with a weight of 0.25. This weight indicates the percentage of workers that sign their contract every given quarter. For simplicity, we assume uniform staggering, that is, all coefficients are 0.25 and all contracts last four quarters.

[5] As inflation erodes real wages, a shorter contract length is better on the grounds of wage stability. Ball and Ceccetti (1991) point out that real wage variability is one of the costs of inflation.

Eq. (9) indicates that the contract wage at time t, X_t, is negotiated according to the wages and the economic conditions expected to prevail during the year of the contract, $W_{t+k|t}$, $y_{t+k|t}$. Eq. (10) states that, in the aggregate, wages are an average of the wages that were contracted in the current and past quarters.

In this model, in contrast to the previous one, prices are a mark up over costs with partial adjustment:

$$P_t = c_{14}P_{t-1} + c_{15}W_t + \varepsilon_t^8 \quad (11)$$

The interest rate follow a standard Taylor rule:

$$i_t = \bar{r}_t + \pi_t^4 + 0.5\pi_t + 0.5y_t + \varepsilon_t^9 \quad (12)$$

and the output gap is determined by the IS curve:

$$y_t = c_{16}y_{t-1} - c_{17}r_t + \varepsilon_t^{10} \quad (13)$$

Apart from Eq. (13), the real block is completed by Eqs. (5) and (6).

Our base specification of one year contracts, Eqs. (9) and (10), is compared with the alternative specification Eqs. (13) and (14) where wage contracts last half a year:

$$X_t = 0.5(W_t + W_{t+1|t}) + 0.5c_{18}(y_t + y_{t+1|t}) + \varepsilon_t^{11} \quad (14)$$

$$W_t = 0.5(X_t + X_{t-1}) \quad (15)$$

3.2 Calibration

The contract length model was calibrated with the same criteria in mind. The effect of monetary policy should be reasonable and (the change in) real wages should be pro-cyclical. The strongest effect of monetary policy on inflation was similar to the previous model. It is an effect of 0.4 percentage points that takes place during the seventh quarter. This required, however, that the effect of monetary policy on output be somewhat stronger compared to the previous model, that is, and effect of 0.6. As regards calibrating real wages, the calibration of the model implies an effect of 0.353 of the output gap on the change in real wages. The size of this effect is of the same sign and order of magnitude as the estimated one of 0.262.

The calibrated coefficients are $c_{13} = 0.075$, $c_{14} = 0.7$; $c_{15} = 0.3$, $c_{16} = 0.9$, $c_{17} = 0.15$, $c_{18} = 0.075$.

3.3 Results

Contract length can change the following: inflation stickiness, the output inflation trade off and the cost of disinflation. Compared to one year contracts, half year contracts decrease the sacrifice ratio from 0.233 to 0.100.

The frequency of wage negotiations can help explain why the cost of disinflation was smaller in Chile than in Colombia. The results may not necessarily imply that a different wage setting structure needs to be implemented in Colombia, a country with a different

inflation history. The higher frequency of wage negotiations in Chile is a heritage of the hyperinflation period.

4 Conclusions

The conclusions are that wage increases based on past inflation increase inflation inertia and hence, during the period of disinflation, increase the cost of disinflation. Higher central bank credibility and wage contracts that are shorter in length correspond to lower inflation inertia and to a lower cost of disinflation.

We have come to these conclusions using two models where the determination of wages capture forward and backward looking wage indexation and wage contract length. The models were calibrated so that the effect of monetary policy on output and inflation was "reasonable," and (the change in) real wages was pro-cyclical.

The policy implications are that the cost of disinflation can be decreased by using any of the following in the negotiations of wage increases: the central bank inflation target, the central bank inflation forecast, the central bank survey of inflation expectations, some consensus measure of inflation expectations, or a combination of them. The cost of disinflation can also be decreased by making every effort to increase central bank credibility. Another policy implication is that the Court's dictum of using past inflation in the negotiations of wage increases can have implications that are opposite the goal of maintaining the real purchasing power of the workers' wages.

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Table 1. The sacrifice ratio under different specifications of wage indexation

c_1	c_2	c_3	Sacrifice ratio	
		Backward and forward looking expectations		
0	1	0	0.675	
1/4	3/4	0	0.308	Figure 2, solid line
1/2	1/2	0	-0.012	
3/4	1/4	0	-0.342	Figure 2, dotted line
1	0	0	-0.662	
		Backward expectations and the inflation target		
0	1	0	0.675	
0	3/4	1/4	0.092	Figure 3, solid line
0	1/2	1/2	-0.163	
0	1/4	3/4	-0.296	Figure 3, dotted line
0	0	1	-0.372	
		Backward expectations and combination of forward looking expectations and the inflation target		
0	1	0	0.675	
1/8	3/4	1/8	0.182	Figure 4, solid line
1/4	1/2	1/4	-0.119	
3/8	1/4	3/8	-0.316	Figure 4, dotted line
1/2	0	1/2	-0.450	
		One year and half year wage contracts		
		One year contracts	0.233	Figure 6, solid line
		Half year contracts	0.100	Figure 6, dotted line

Figure 1. A shock to monetary policy in the rule of thumb model

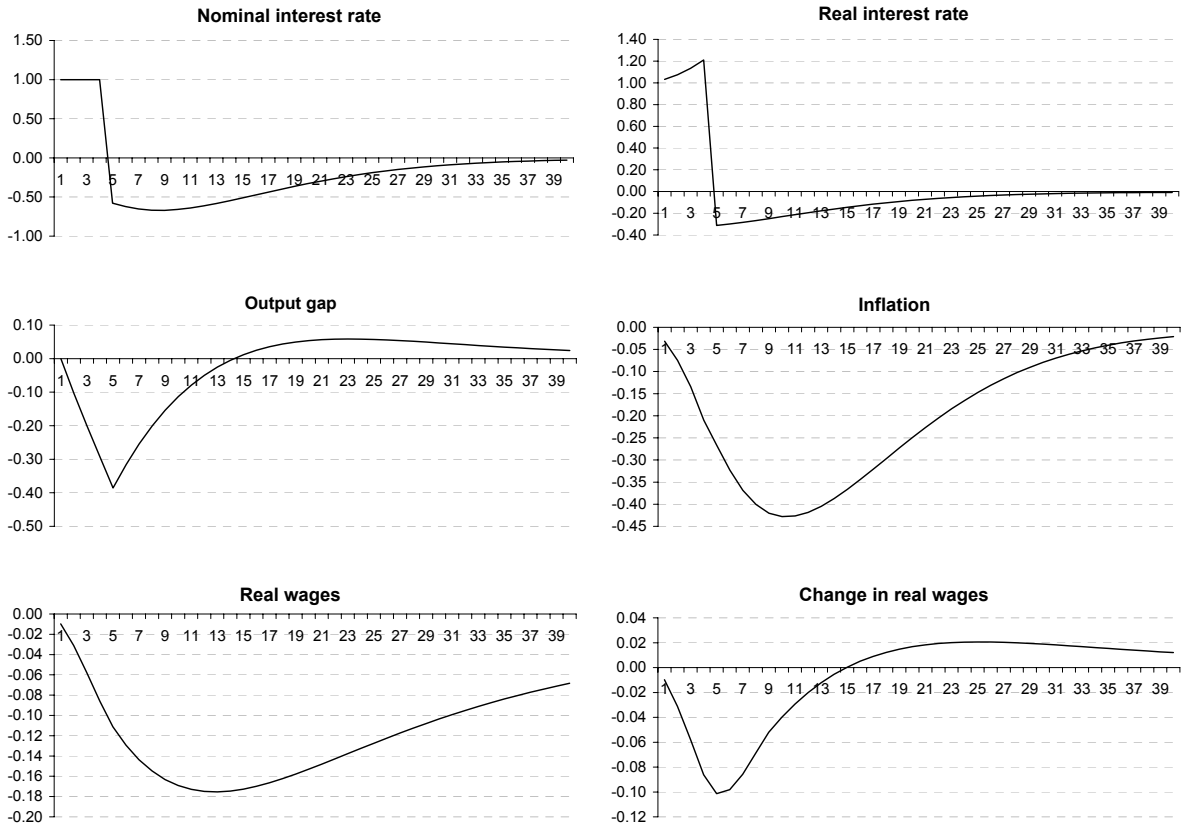

Figure 2. Disinflation: backward and forward looking expectations

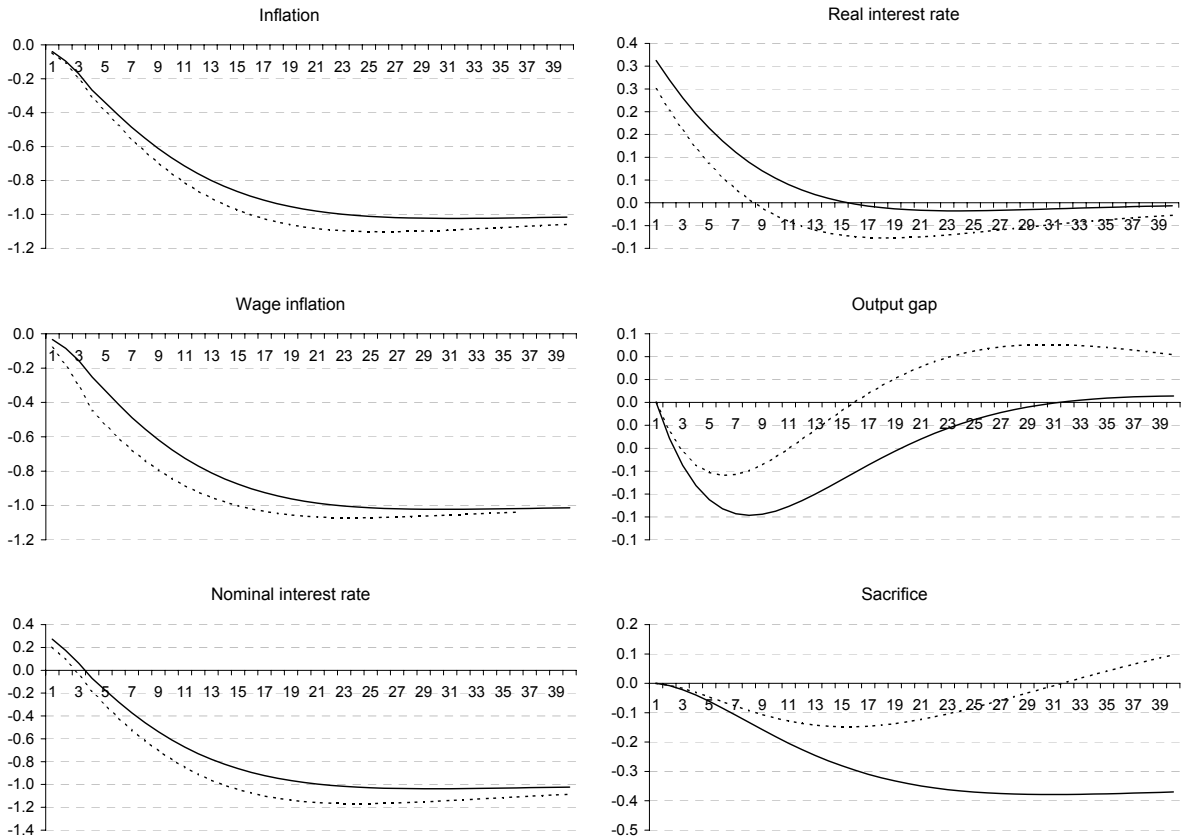

Figure 3. Disinflation: backward expectations and the inflation target

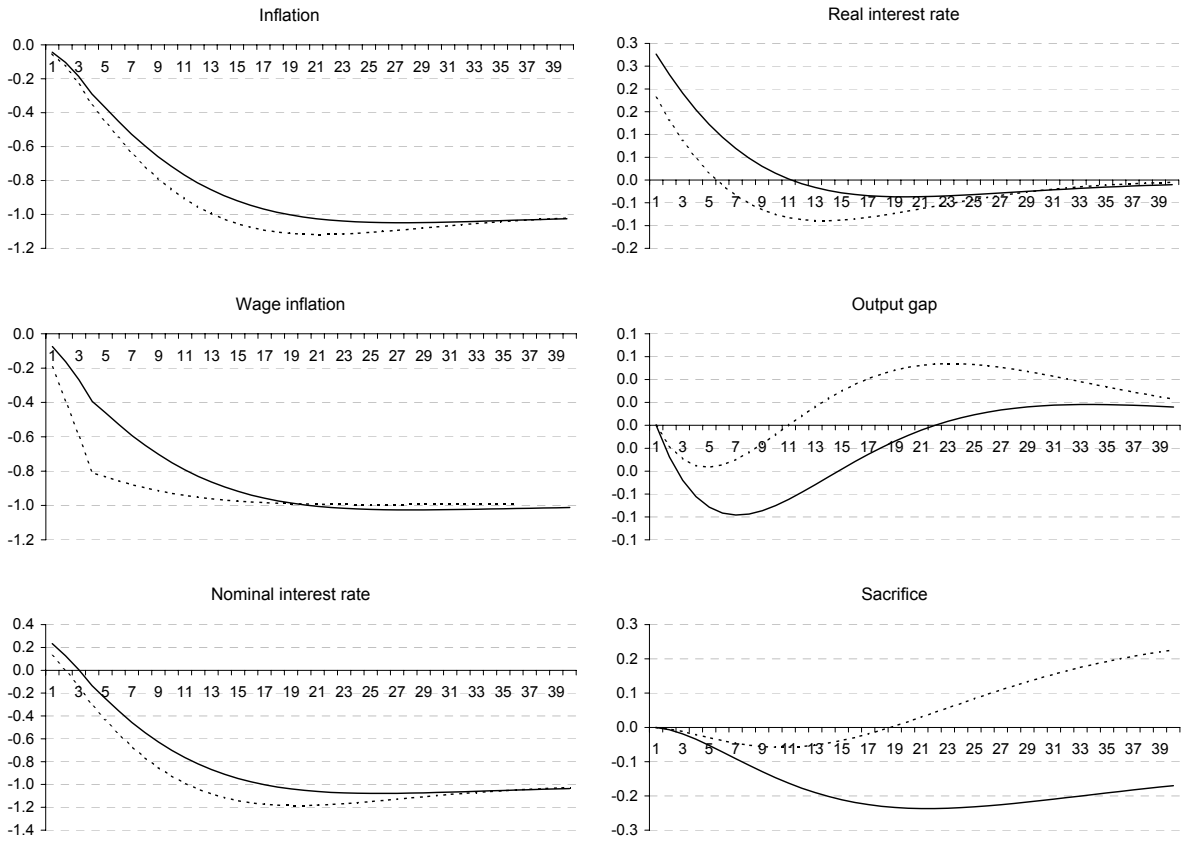

Figure 4. Disinflation: backward expectations and combination of forward expectations and the inflation target

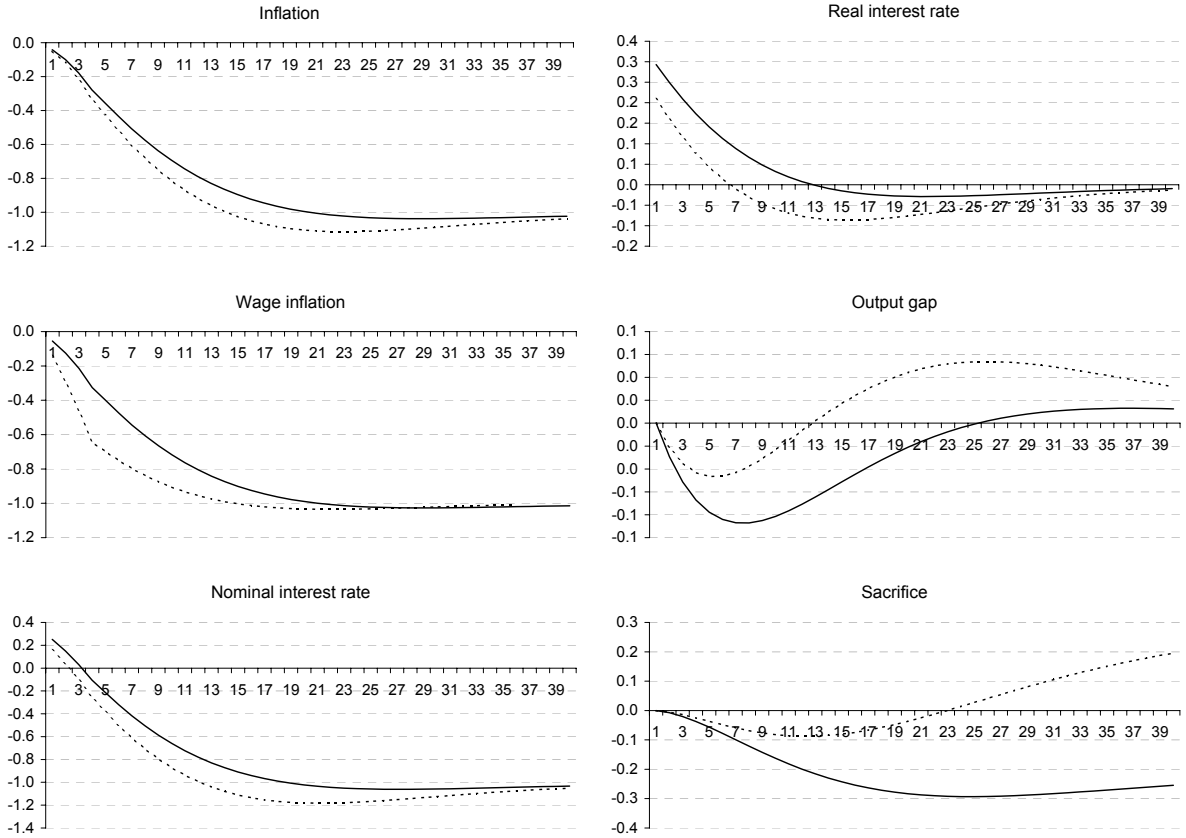

Figure 5. A shock to monetary policy in the staggered contracts model

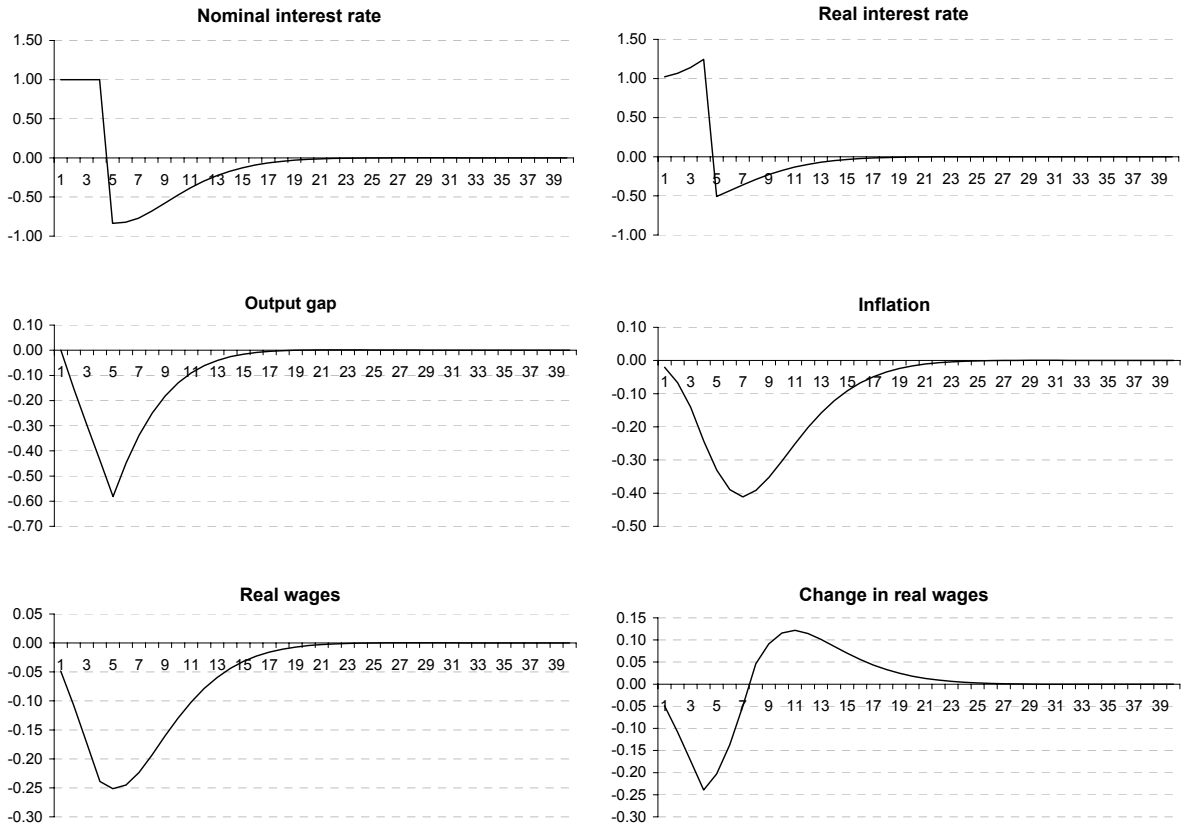

Figure 6. Disinflation: one year and half year staggered wage contracts