

## Optimal Central Bank Conservatism and Monopoly Trade Unions

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*The “conservative central banker” has come under attack recently. Explicitly modeling the interaction of a trade union with monetary policy, it has been argued that the standard solution to the inflationary bias in monetary policy might actually be welfare-reducing if the trade union has an exogenous preference against inflation. We reframe this discussion in a standard trade union model. We show that the case against the conservative central banker rests on the assumption of a strictly nominal outside option (for instance, unemployment benefits) for the union. There is no welfare gain associated with making the central bank less conservative than society, however, if the outside option is in real terms. As the nominal components of the trade union’s outside option are mainly public transfers, we also show that the conservative central banker is always optimal if the government can choose the level of nominal unemployment benefits as well as the degree of central bank conservatism. [JEL E50, E58, J50, J51]*

**T**he “conservative central banker” has come under attack lately. Rogoff (1985) had suggested reducing the inflationary bias of monetary policy by delegating monetary policy to an independent and conservative central bank that cares less about unemployment than the government does. Changing the preferences would reduce the expected rate of inflation and thus the factual rate. While other solutions to this problem have been suggested (see, among others, Lohmann, 1992; and Walsh, 1995), the conservative central banker remains the most popular point of

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reference regarding institutional remedies against inflation suggested by economists. And indeed, a numerous and still growing empirical literature often finds a negative relationship between central bank independence and inflation across countries and time (see, e.g., Berger, Eijffinger, and de Haan, 2001).

Recently, however, a series of papers have questioned the theoretical foundation of the conservative central banker solution. One strand links labor market reform with monetary policy. The basic argument is that while such reform might be politically costly, it will help to lower the inflationary bias (e.g., Calmfors, 1998 and 2001; and Sibert and Sutherland, 2000). A second strand endogenizes the inflation bias by allowing for direct interaction of nonatomistic trade unions and monetary policy (Cubitt, 1992; Skott, 1997; Cukierman and Lippi, 1999; Grüner and Hefeker, 1999; Guzzo and Velasco, 1999; and Lawler, 2000). The argument builds on a nonatomistic trade union model of the labor market, where nominal wage setters take into account the reaction of the central bank to the implied real wage. What sets these models apart from the standard labor market literature is that they assume that trade unions are “inflation averse,” that is, that their target functions include not only some real wage and employment target, but also costs of inflation.

The effect of this change can be quite dramatic, turning the traditional argument for a conservative central banker on its head. Because trade unions dislike inflation, they moderate their wage claims to limit the central bank’s incentives for an inflationary policy. This has two important consequences for the traditional monetary policy model. First, the behavior of inflation-averse trade unions establishes a direct link between central bank characteristics and real labor market outcomes—a link that does not exist in the standard framework.<sup>1</sup> Second, a more conservative central bank will prefer tolerating the higher unemployment rate to increasing inflation. A trade union that is inflation averse will be more moderate; the stronger nominal wage increases raise inflation. Hence, a liberal central bank rather than a conservative central bank will induce trade unions to moderate wages. In fact, there even seems to be a case for an “ultraliberal” or “populist central banker.” (See Cukierman and Lippi, 1999; Guzzo and Velasco, 1999; Lippi, 2002; and Berger, Eijffinger, and de Haan, 2001, for a survey.)

The case against the conservative central banker is clearly the strongest in a single trade union model. Obviously, a very small or atomistic trade union will disregard any effect wages have on inflation.<sup>2</sup> But even with a single trade union, the result hinges on the “unusual assumption” (Soskice and Iversen, 2000, p. 266) of inflation aversion on the trade union’s side. Virtually the entire literature so far

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<sup>1</sup>Note that the real nonneutrality of monetary policy as such does not necessarily depend on the trade union’s aversion to inflation (Lippi, 1999; and Soskice and Iversen, 2000). For earlier examples of models with nonneutrality building on the interaction of different labor market and policy regimes, see Driffill (1985) and Jensen (1993).

<sup>2</sup>As stressed by Lippi (1999) and Coricelli, Cukierman, and Dalmazzo (2000), in the intermediate case of multiple but large trade unions, the effect of inflation on the sectoral real wage set by a trade union might produce a competition effect that could moderate the case for a liberal central banker. Another moderating effect operating in a monopolistic competition framework is discussed in Soskice and Iversen (2000) and Coricelli, Cukierman, and Dalmazzo (2000). Lawler (2000) stresses that, in line with Rogoff’s (1985) original contribution, reintroducing stabilization issues also strengthens the case for a conservative central banker.

relies on an exogenous and ad hoc specification of the trade union's target function that *postulates* that trade union utility is decreasing in deviations of inflation from a target level of zero. Such a specification is a marked departure from more standard models of trade union behavior (compare Oswald, 1982). Therefore, the question arises as to how the inflation aversion of a monopoly trade union could come about.

Probably the most natural way to model the dislike of inflation is by introducing nominal income components in a traditional trade union optimization problem. To follow up on this notion, we will contrast the behavior of a trade union with an outside option defined in *real* terms with the behavior of a trade union with a *nominal* outside option. Building on a simple model (presented in Section I) of the goods and labor market with decreasing returns to scale in which the price level is controlled by the central bank, we discuss how inflation aversion affects trade unions by looking at two benchmark cases in Section II. In Section III we then show that the conservative-central-banker result is socially optimal when the outside option is defined in real terms. The opposite might be true, however, when the trade union's outside option—for instance, the unemployment benefit payments—is defined in nominal terms. In this case, the trade union will enforce a higher real wage if the nominal outside option faced by its members improves due to a more conservative monetary policy. Section IV generalizes these results and discusses the extent to which the latter result is a consequence of restricting the government's set of policy instruments. We show that the Rogoff solution always prevails if the government can choose the level of unemployment benefits as well as the degree of central bank conservatism and there is a minimum real living standard. Section V summarizes the conclusion.

## I. Model

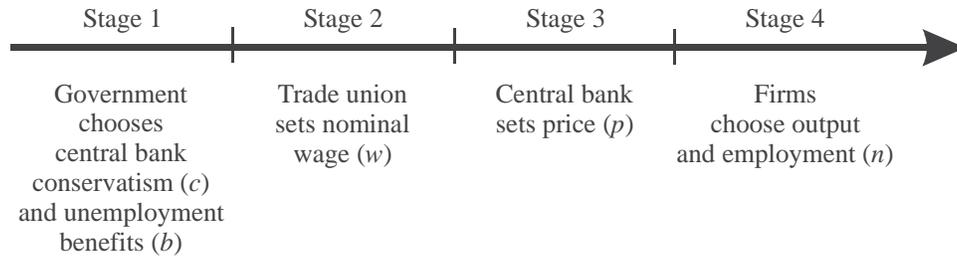
The model considers four stages. In the first stage the government chooses the degree of conservatism,  $c$ , of the central bank, that is, the weight the central bank gives to inflation relative to unemployment in its objective function. In Section IV we will, in addition, allow the government to choose unemployment benefits. In the second stage we assume a single monopolistic trade union in the economy that maximizes the income of its members by fixing the wage rate,  $w$ .

The focus on a single trade union allows us to identify the assumptions underlying the unambiguous result that a benevolent government should choose an "ultraliberal" central bank. Given the nominal wage rate and the predetermined degree of conservatism in the third stage, the central bank then chooses the price level and therefore the inflation rate. In the fourth and final stage, profit-maximizing firms determine output levels and employment levels. The sequencing is illustrated in Figure 1. The model is solved backwards.

### Stage 4: Firms

In stage 4, profit-maximizing firms decide upon output and employment levels. We focus on centralized wage setting, the strongest case against the conservative

Figure 1. Sequence of the Model



central banker. To simplify, consider an economy that comprises only one sector in which firms produce a consumer good,  $Y$ , with a Cobb-Douglas technology,  $Y = AN^\alpha$ , with  $A > 0$  and  $0 < \alpha < 1$  being parameters of production and  $N$  denoting labor demand. It is convenient to express  $N$  as a percentage of total labor supply,  $M$ . So employment is  $n = N/M$ , with  $n \in (0, 1)$ . Firms are price takers. Labor demand thus becomes

$$n = \frac{1}{M} \left( \frac{d \cdot p}{w} \right)^\delta,$$

with  $d = \alpha A$  and  $\delta = 1/(1 - \alpha) > 1$ . Without loss of generality, we can normalize  $A \equiv 1/\alpha$  so that  $d = 1$  and also set  $M = 1$ . Unemployment is  $u = 1 - n$ . Note that a real wage of unity would ensure full employment (or zero unemployment) in the economy.

Output prices and the nominal wage rate are determined by the central bank and the trade union, respectively. To see the impact their decisions have on employment, note that employment is decreasing in the nominal wage  $n_w = -\delta n/w < 0$ , but increasing in the output price,  $n_p = \delta n/p = -\delta n_w/p$ , whereby we use subindices to indicate partial derivatives.

### Stage 3: Central Bank

In stage 3 the central bank determines the price level, taking into account the nominal wage set by the trade union in stage 2. The central bank's loss function,  $L$ , has the standard quadratic form,  $L = 0.5 zu^2 + 0.5 zc\pi^2$ , where  $\pi$  is the rate of inflation and  $c > 0$  is the weight attached to the inflation target, that is, the central bank's degree of conservatism. Both the unemployment and the inflation target have been set to zero. It is convenient to rewrite  $\pi = (p_t - p_{t-1})/p_{t-1}$  and normalize  $p_{t-1} \equiv 1$ . Dropping the time index, the loss function becomes

$$L = 0.5 \cdot u^2 + 0.5 \cdot c(p - 1)^2. \tag{1}$$

The central bank will set  $p$  (and thus inflation) to minimize equation (1), acting as *Stackelberg leader* vis-à-vis firms but as price taker (*Stackelberg follower*) vis-à-vis trade unions. The first-order condition is

$$L_p = -\frac{\delta}{p} n(1-n) + c(p-1) = 0, \quad (2)$$

implying that the central bank will equate the marginal benefit of a higher price level (first term) with its marginal cost (last term). Under the plausible assumption that, on average, at least half the workforce is employed, that is,  $n > 0.5$ ,<sup>3</sup> we have  $L_{pp}|_{L_p=0} > 0$ ,  $L_{pc} \geq 0$ , and  $L_{pw} < 0$ . Comparative statics yield

$$p_c = -\frac{L_{pc}}{L_{pp}} \leq 0, \quad (3)$$

that is, the price level will be lower, the more conservative the central bank is (for all  $p > 1$ ). We also find that the price level increases in the nominal wage:

$$p_w = -\frac{L_{pw}}{L_{pp}} > 0. \quad (4)$$

A convenient way to summarize the behavior of the central bank is to look at the nominal wage elasticity of the price level. Differentiating the first-order condition with regard to  $w$  and  $p$  and rearranging yields

$$\theta \equiv p_w \frac{w}{p} = \frac{\delta^2(2n-1)n}{\delta^2(2n-1)n + cp(2p-1)}. \quad (5)$$

The wage elasticity of the price level is less than unity if the central bank cares about inflation because, in this case, it is not willing to accommodate a nominal wage increase completely. Instead, it is willing to accept some unemployment in order to keep the inflation rate low. This follows directly from the concavity of the utility function. Note that  $\theta < 1$  for  $c > 0$ .

## Stage 2: Trade Union

In stage 2 the trade union is fixing the nominal wage rate to maximize a (utilitarian) welfare function incorporating the disposable real income of employed and unemployed members:

$$V = n \frac{w}{p} + (1-n) \left( b^{real} + \frac{b^{nom}}{p} \right). \quad (6)$$

The variable  $b^{real}$  can be interpreted as real unemployment benefits or *real opportunity costs* of labor supply. An example for the latter would be the real income in the shadow economy forgone by entering the labor market. Of greater importance, Blanchard and Katz (1999) argue that at least part of public unemployment benefits might be defined in real terms, too. To the extent that unemployment benefits

<sup>3</sup>Owing to the quadratic loss function and the concave technology, the first term is hump-shaped in  $p$ . The hump shape disappears for  $n > (\delta - 1)/(2\delta - 1)$ , a condition always fulfilled if  $n > 0.5$ .

are instead fixed in *nominal* terms, they are covered by the term  $b^{nom}$ . Other than the distinction between nominal and real outside options, the model is quite standard in the labor market literature (see Oswald, 1982).

The wage rate cannot fall short of the outside option, that is,  $w \geq b^{real} p + b^{nom}$ , because, otherwise, trade union members would refuse to work and prefer being unemployed. To restrict unemployment to occurrences of *involuntary unemployment*, we assume that full employment is reached at a real wage rate that exceeds the real outside option, that is,  $w/p = 1 \geq b^{real} + b^{nom}/p$ .

The trade union maximizes equation (6), taking unemployment benefits and the degree of conservatism as given. The trade union takes into account the reaction of the central bank and, by extension, of labor demand of the firms, when setting its nominal wage rate,  $w$ . Hence, in line with the standard literature, the trade union is acting as *Stackelberg leader* vis-à-vis the central bank and the firms.

### Stage 1: Government

In stage 1 the government determines the degree of conservatism,  $c$ , and (see Section IV) the unemployment benefits,  $b$ . Conceptually, the existence of stage 1 allows us to undertake comparative statics with respect to variations in  $c$  or  $b$ . We do not consider the objective function of the government at this point, but we will return to the government's decision below.

### Solving for the Equilibrium

In order to describe the equilibrium where both the trade union and the central bank have made their optimal decisions given the degree of conservatism,  $c$ , we need to take explicit account of the first-order conditions of both the central bank and the trade union. Using the partial characteristics of the two first-order conditions we get the following linear equation system,

$$\begin{vmatrix} 0 & V_{ww} \\ L_{pp} & L_{pw} \end{vmatrix} \begin{vmatrix} dp/dc \\ dw/dc \end{vmatrix} = - \begin{vmatrix} V_{wc} \\ L_{pc} \end{vmatrix}, \quad (7)$$

which combines the second-order conditions for the central bank and trade union. The system has a positive determinant,  $D = -L_{pp}V_{ww} > 0$ . Applying Cramer's Rule, we get

$$\frac{dp}{dc} = \frac{1}{D} (-V_{wc}L_{pw} + L_{pc}V_{ww}) = \frac{V_{wc}}{V_{ww}} \frac{L_{pw}}{L_{pp}} - \frac{L_{pc}}{L_{pp}} = p_w w_c + p_c. \quad (8)$$

The result implies that the equilibrium price change due to an increase in the degree of the central bank's conservatism,  $dp/dc$ , is the result of two—possibly opposing—effects. On the one hand, there is the *direct effect* on central bank behavior, induced by the changed weights in its loss function. This unambiguously tends to lower the price level, that is,  $p_c \leq 0$  (compare equation (3)). On

the other hand, there is the implied change in the wage rate,  $w_c$ , and its *indirect effect* on the central bank’s price setting. From the optimal reaction of the central bank, we know that higher wages are unambiguously translated into higher prices, that is,  $p_w > 0$  (compare equation (4)). However, the change in the nominal wage rate depends on trade union behavior and might go either way. If the trade union decreases the nominal wage when the central bank becomes more conservative,  $w_c < 0$ , it follows that the observed equilibrium price level is decreasing as well:  $dp/dc < 0$ . By contrast, if the trade union increases the nominal wage when the central bank becomes more conservative,  $w_c > 0$ , the overall price decrease becomes smaller or might even turn into an equilibrium price increase.

It can be shown that the—intuitively appealing—negative relation  $dp/dc < 0$  always holds if the outside option is defined strictly in real terms (see Appendix I). What is more, even if the outside option was defined in nominal terms only,  $dp/dc < 0$  would prevail as long as inflation is not too high, that is,  $p < (\delta - (1 - n))/(\delta - 1)$ .<sup>4</sup> This result is independent of the level of  $c$ . To summarize,

**PROPOSITION 1 (inflation):** An increase in the central bank’s conservatism decreases the equilibrium price level (or inflation) if and only if the direct effect on the central bank’s price-setting behavior is not overcompensated by the incentive to respond to trade union behavior, that is, if  $w_c p_w < -p_c$ . This is always the case for moderate price levels (or moderate levels of inflation)  $p < (\delta - (1 - n))/(\delta - 1) > (\delta - 0.5)/(\delta - 1)$ .

In what follows, we focus on the normal reaction that an increase in the central bank’s conservatism decreases the equilibrium price level. This seems to be well in line with the inflation rates and unemployment rates we observe in countries with a unionized labor market as well as with the stylized fact that an increase in central bank conservatism empirically reduces (rather than increases) inflation, both across time and countries (Berger, Eijffinger, and de Haan, 2001).

## II. The Role of the Trade Union’s Outside Option

What are the real effects of a variation in central bank conservatism? The change in the nominal wage rate can be derived from equation (7) as

$$\frac{dw}{dc} = -\frac{V_{wc}}{V_{ww}} = w_c \begin{matrix} \left[ \begin{matrix} > \\ & \\ < \end{matrix} \right] \\ \left[ \begin{matrix} > \\ & \\ < \end{matrix} \right] \end{matrix} \Leftrightarrow V_{wc} \begin{matrix} \left[ \begin{matrix} > \\ & \\ < \end{matrix} \right] \\ \left[ \begin{matrix} > \\ & \\ < \end{matrix} \right] \end{matrix} = 0. \tag{9}$$

As the trade union is a *Stackelberg* leader with respect to the central bank, the equilibrium effect  $dw/dc$  is equal to the union’s wage-setting reaction to an increase in conservatism. With  $w_c$  identified, the sign of the employment effect

<sup>4</sup>See Appendix I. For instance, in case of a strictly nominal outside option, if the labor share was  $\alpha = 2/3$  and the unemployment rate was at 20 percent, an inflation rate below 40 percent would still guarantee  $dp/dc < 0$ . Note that inflation could be even higher if part of the outside option was defined in real terms.

depends inversely on the real wage reaction (by substituting in equations (5), (8), and (9)):

$$\frac{d \frac{w}{p}}{dc} = \frac{\frac{dw}{dc} p - \frac{dp}{dc} w}{p^2} = \frac{w_c(1 - \theta) - p_c \frac{w}{p}}{p}. \quad (10)$$

Thus  $w_c > 0$  is a sufficient condition for the equilibrium real wage to increase and, thus, for employment to decrease in  $c$ . As we will show below, however, the union's reaction depends critically on the trade union's outside option.

### Real Outside Option for the Trade Union

Let us start with the case where there is no nominal element in the outside option ( $b^{nom} = 0$ ). Then the trade union's objective function and first-order condition become

$$V = n \frac{w}{p} + (1 - n)b^{real}, \quad (6a)$$

$$V_w = -w(\delta - 1) + \delta p b^{real} = 0, \quad (11)$$

where we used the fact that the wage elasticity of labor demand is  $n_w w/n = -\delta$ .<sup>5</sup> The change in the *nominal wage* with respect to changes in conservatism is given by  $V_{ww} dw + V_{wc} dc = 0$ . Using the definition of  $\theta$ , applying the first-order condition from equation (11) and rearranging yields

$$w_c = p_c \frac{w}{p} \frac{1}{(1 - \theta)} < 0. \quad (12)$$

Note that, because of equation (8), this implies that *prices* fall as conservatism increases when the trade union's outside option is real. With regard to the implied change in the *real wage*, substituting equation (12) in equation (10) gives

$$\frac{d \frac{w}{p}}{dc} = \frac{p_c \frac{w}{p} \frac{1}{(1 - \theta)} (1 - \theta) - p_c \frac{w}{p}}{p} = 0. \quad (10a)$$

With complete control over the real wage, the trade union will set real wages equal to the real unemployment benefit payments times a markup, independently of the price level. Hence, the degree of conservatism does not affect the real wage nor employment.

**PROPOSITION 2 (real outside option):** If the outside option of the monopoly trade union is defined in real terms only, the real wage and employment are independent of the degree of central bank conservatism. The price level is decreasing in the degree of central bank conservatism.

<sup>5</sup>An optimum exists if  $V_{ww} < 0$  in the optimum. This is always true for the case of a real outside option.

The intuition behind this result is quite straightforward. If the trade union does not care about nominal values (and in the absence of uncertainty or shocks), it can always enforce its preferred real wage. Since a variation in nominal values such as the price level does not affect the trade union's outside option, the trade union will change the nominal wage in response to changes in  $c$  only in order to keep the optimal real wage constant.

### Nominal Outside Option for the Trade Union

We now turn to the case where the unemployment benefit payments are nominally fixed only ( $b^{real} = 0$ ). Obviously, the trade union is now inflation averse, as a higher price level implies a lower income for all unemployed for any given real wage rate. Equation (6) then becomes

$$V = n \frac{w}{p} + (1 - n) \frac{b^{nom}}{p}, \quad (6b)$$

and the first-order condition (see Appendix I)

$$V_w = \frac{n}{pw} (-w(1 - \theta)(\delta - 1) + b^{nom} \left[ \delta(1 - \theta) - \frac{1 - n}{n} \theta \right]) = 0. \quad (13)$$

An ultraliberal central bank with  $c = 0$  will always choose  $w = p$  and thus guarantee full employment, that is,  $n = 1$ . Since there is no unemployment in this case, the trade union does not care about inflation, even though inflation affects the real value of nominal unemployment benefits. Note that in this special case, the nominal wage rate and thus the price level would remain undetermined.

Assuming that the second derivative is negative, that is,  $V_{ww} < 0$ , the sign of  $w_c$  is given by the sign of  $V_{wc}$ . Appendix I shows that with  $p_c < 0$ , we have  $V_{wc} > 0$  and hence  $w_c > 0$ . A more conservative central bank reduces the negative effect of higher nominal wages on the outside option, making trade unions more demanding. This renders the *price* effect of higher conservatism ambiguous (see Proposition 1). Regarding *real wages* it follows that

$$\frac{d \frac{w}{p}}{dc} = \frac{w_c(1 - \theta) - p_c \frac{w}{p}}{p} > 0, \quad (10b)$$

implying a decrease in *employment*. This can be summed up as follows:

**PROPOSITION 3 (nominal outside option):** If the outside option of the monopoly trade union is defined in nominal terms only, the nominal wage and the real wage are both increasing and employment is decreasing in the degree of central bank conservatism.

The proposition reflects the spirit of results by (among others) Cubitt (1992) or Cukierman and Lippi (1999)—but it is based on an explicit description of the

trade union's outside option, rather than on assumed trade union preferences against inflation.

In Appendix II we show that Proposition 3 can be generalized to the case where the trade union has to consider *both a real and a nominal outside option*. In this case, the nominal wage may increase or decrease in the degree of central bank conservatism, depending on the relative weights of the nominal and the real outside option. However, the real wage is always increasing, and employment is decreasing, as soon as there is a nominal outside option for the trade union to consider.

### III. The Government Decision

So far the discussion of the role of government has been limited to comparative statics. As shown, a change in central bank conservatism imposed by the government has different repercussions for inflation and unemployment, depending on whether the trade union's outside option is defined in nominal or real terms. However, the government might also have a significant influence on the nature of the trade union's outside option. Given this possible menu of policy tools and policy effects, how will the government set its instruments?

A natural assumption is that the government values both price stability and employment. Assume that the social loss function is of the standard quadratic form,

$$L^{gov} = 0.5 \cdot u^2 + 0.5 \cdot g\pi^2, \quad (14)$$

where  $0 < g < +\infty$  is the weight the government attaches to losses from inflation. The derivative of equation (14) with respect to the degree of central bank conservatism is

$$L_c^{gov} = L_p^{gov} \frac{dp}{dc} + L_w^{gov} \frac{dw}{dc},$$

where the change in the price level and the nominal wage is determined by equation (7). Substituting in the partial derivatives,

$$L_p^{gov} = -\delta(1-n) \frac{n}{p} + g(p-1), \quad L_w^{gov} = \delta(1-n) \frac{n}{w},$$

and making use of the first-order condition of the central bank in equation (2), we can rewrite the first-order derivative of the government in the following way:

$$\begin{aligned} L_c^{gov} &= \frac{(p-1)}{w} \left[ (g-c)w \frac{dp}{dc} + cp \frac{dw}{dc} \right] \\ &= \frac{(p-1)}{w} \left[ gw \frac{dp}{dc} + c \left[ p \frac{dw}{dc} - w \frac{dp}{dc} \right] \right]. \end{aligned} \quad (15)$$

First, we consider the case of a given *real outside option* for the trade union. Substituting and making use of equations (2), (10), and (10a) gives

$$L_c^{gov} = (p - 1)g \frac{dp}{dc}. \quad (16)$$

From equations (12) and (8) we can infer that  $dp/dc < 0$  and hence  $L_c^{gov} < 0$ . It is therefore optimal for the government to choose an ultraconservative central bank with  $g < c \rightarrow +\infty$ . In summary:

**PROPOSITION 4a (ultraconservative central bank):** If the outside option of the monopoly trade union is fixed in real terms only, the central bank should be *ultraconservative*, that is, the government should set  $c$  such that  $g < c \rightarrow +\infty$ .

This confirms the well-known result that, if the trade union's objective function is not affected by nominal values (and in the absence of shocks or uncertainty), the government should credibly commit itself to a noninflationary policy to minimize the inflationary bias (see, among others, Cukierman and Lippi, 1999).

Now we turn to the nominal outside option. In this case, both the nominal and real wage increase in  $c$ , that is,  $dw/dc > 0$  (compare equation (9)) and  $d(w/p)/dc > 0$  (compare equation (10b)). By inspection of equation (15), one can infer from the last equation that an interior solution for  $L_c^{gov} = 0$  requires  $dp/dc < 0$ . If this is the case, the first equation shows that the optimal degree of central bank conservatism is in the interval  $0 < c^* < g$ .<sup>6</sup> This leads to

**PROPOSITION 4b (liberal central bank):** If the outside option of the monopoly trade union is fixed in nominal terms only, and if the price level decreases in central bank conservatism, the central bank should be *liberal* in the sense that  $0 < c^* < g$ .

How to interpret Propositions 4a and 4b? If the outside option of the monopoly trade union is fixed in real terms ( $b^{real}$ ),  $c$  has no influence on the real economy, as was shown in Proposition 2. However, an increase in  $c$  unambiguously lowers inflation. Thus, making the central bank infinitely conservative will lower inflation without affecting employment. This policy is second best because the real wage set by the monopoly trade union is too high to allow full employment. Things change, however, if the outside option of the monopoly trade union is defined in nominal terms ( $b^{nom}$ ) and the trade union is thus inflation averse. Then, the government's best choice will always be  $c^* < g$  because a reduction in  $c$  will now have real effects on employment (Proposition 3). When the central bank becomes more liberal, the trade union becomes less successful in increasing the real wage by marginally increasing the nominal wage. By contrast, however, the opportunity cost of a nominal wage increase rises as the real value of the unemployment benefits falls more when the central bank is more liberal.

<sup>6</sup>Note that for  $dp/dc > 0$ , we have no interior solution. If increasing  $c$  unambiguously *increases* inflation, the outcome is completely undetermined. As long as  $p > 1$ , there is no reason for a conservative central bank, as both government objectives are served best by a completely permissive monetary policy. Choosing  $c = 0$ , that is, the case for an "ultraliberal" central bank made by Cukierman and Lippi (1999) and Guzzo and Velasco (1999), implies that prices are determined by the trade union rather than the central bank, which sets  $p = w$ ;  $c = 0$  is only optimal for the government, however, as long as  $p > 1$ . If  $p < 1$  at  $c = 0$ , we will have an interior solution for  $dp/dc > 0$  with  $c > 1$ .

Committing to a policy that puts less weight on inflation will therefore be beneficial.

#### IV. Do We Need a Liberal or Conservative Central Bank?

So far we have considered two benchmark cases: the case of a trade union that faces a real outside option only, and a trade union that faces a nominal outside option. As has been pointed out at the end of Section II, however, if the outside option of the trade union consists of *both* nominally fixed and real values, the change in the nominal wage due to a change in the degree of central bank conservatism is undetermined (compare Appendix II). As before, one can see from inspecting equation (15) that an interior solution requires  $dp/dc < 0$ . For this case, the following condition for the optimal degree of central bank conservatism applies:

$$c^* \begin{cases} > \\ = \\ < \end{cases} g \Leftrightarrow \frac{dw}{dc} \begin{cases} < \\ = \\ > \end{cases} 0.$$

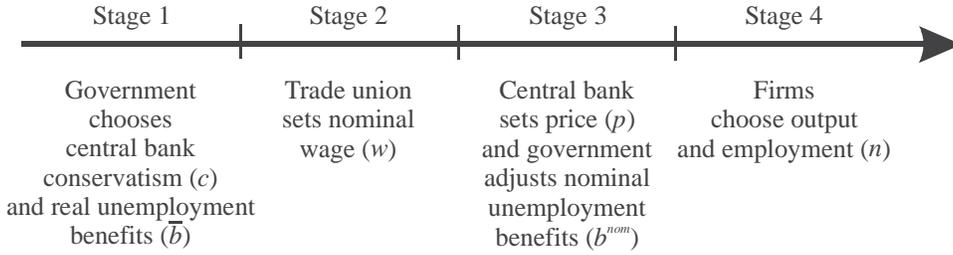
If the nominal wage does *not* react to a change in the degree of central bank conservatism at all, there is no incentive for the government to commit itself to a more conservative monetary policy compared to its own preferences. The reason is simply that with inflation-invariant wage setting there is no time-inconsistency problem to deal with. If instead a conservative central bank forces the trade union to moderate the nominal wage, the government gains from committing itself and making the central bank more concerned about inflation. If the nominal outside option dominates, however, inflation aversion makes the trade union more moderate when monetary policy is more permissive. The government should then commit to a central bank that is more liberal than the government itself in order to exploit the trade union's dislike of inflation.

**PROPOSITION 5 (general case):** If the outside option of the monopoly trade union consists of both nominal and real elements, the central bank should be *conservative* in the sense that  $c^* > g$  if the nominal wage is decreasing in central bank conservatism. It should be *liberal* in the sense that  $0 < c^* < g$  if the nominal wage is increasing in central bank conservatism.

Proposition 5 leads us to the core of the debate over whether the government should choose a conservative or liberal central bank. It shows that the answer critically hinges on the composition of the trade union's outside option. In particular, a liberal central bank is justified only if a sufficiently large nominal outside option exists for the trade union. Only a thorough understanding of the trade unions' outside options can provide us with a definite answer.

As argued earlier, the most likely candidate for introducing a nominal element in the outside option of the trade union is the *government* itself. Assume for a moment that government provisions for unemployment relief are not indexed to

Figure 2. Sequence of the Model with Nominal Unemployment Benefits



inflation and thus encompass a nominal part. Then, if the nominal element is sufficiently large, the general case would indeed allow an argument in favor of a “liberal” central bank in the sense of Proposition 5. Or does it?

Careful consideration shows that the argument focusing on the government itself as the source of the nominal element in the trade union’s outside option might be inconsistent. A crucial observation in this regard is that, de facto, the government will always determine a real rather than a nominal outside option for the union, even when de jure unemployment benefits are defined in nominal terms. An illustrative example is the case when we acknowledge that, for social reasons, the government pledges to secure a certain minimum real living standard, say  $b^{nom} / p = \bar{b} > 0$ .<sup>7</sup> In this case, the government would always adjust  $b^{nom}$  such that

$$db^{nom} = \bar{b} dp \Leftrightarrow \frac{d b^{nom}}{dp} = 0.$$

Such a policy would effectively change the apparently nominal outside option into a real outside option for the trade union. With a real outside option set at its minimum, the trade union will decide to set its wage rate such that employment is maximized relative to the fixed outside option  $\bar{b}$ . Thus, the sequence of decisions will be different. In the first stage, the government chooses the degree of conservatism,  $c$ , of the central bank and the real unemployment benefit level,  $\bar{b}$ . In the second stage, the trade union fixes the wage rate,  $w$ . Given the nominal wage rate, the central bank then chooses the price level and therefore the inflation rate, and the government adjusts  $b^{nom}$  so that  $b^{nom} / p = \bar{b}$ . In the fourth and final stage, profit-maximizing firms determine output levels and employment levels as before. The new sequencing is illustrated in Figure 2.

As Proposition 2 shows, setting  $c \rightarrow +\infty$  will then achieve zero inflation. Using its two instruments to tackle its two policy targets, zero inflation and minimum unemployment, the government can unambiguously improve welfare compared to the initial equilibrium, even when ( $b^{nom} > 0, c < +\infty$ ).

<sup>7</sup>Alternatively, we could argue that the government might not be able to commit itself to a zero level of nominal unemployment benefits in a time-consistent way. Then  $\bar{b}$  might be the real outcome of the underlying political economic equilibrium.

Hence, from the viewpoint of the government, determining the trade union's real outside option  $\bar{b}$  *directly* (for instance, by setting  $b^{real} > 0$  and  $b^{nom} = 0$ ) or *indirectly* (for instance, by setting  $b^{real} = 0$  and  $b^{nom} > 0$  and taking into account the implied price level) is perfectly equivalent with respect to the resulting real transfers to the unemployed and thus the outside option of the trade union.

A consequence of this thought experiment is that the use of *both* policy instruments will reintroduce the Rogoff solution, even to the single monopoly trade union case with a de jure nominal outside option but de facto real objectives. Consequently, setting  $c \rightarrow +\infty$  would be the government's preferred choice. A similar reasoning applies if the monopoly trade union's outside option would be forgone real income in the shadow economy.

**PROPOSITION 6 (government and outside option):** If the nominal outside option of the monopoly trade union can be set by the government but there is a real floor (a social minimum) limiting the choice of the nominal outside option, the government will choose the minimum real option *and* resurrect the conservative-central-bank solution ( $c \rightarrow +\infty$ ).

Proposition 6 is of some empirical relevance, as the structure of unemployment benefits varies across countries. In a number of countries, unemployment insurance is linked to previous gross or net earnings. Payments may be strictly proportional, as in Belgium and Germany, or may increase linearly with previous earnings, starting from a minimum compensation, as in Austria and France. These payments can be regarded as nominal payments, as they are dependent on nominally fixed previous wages. By contrast, unemployment benefits in the United Kingdom, as well as the unemployment assistance and welfare payments in many other countries, are often fixed in nominal terms but are adjusted regularly according to the inflation rate; they can be considered as being held constant in real terms.<sup>8</sup> The fact that different countries have unemployment benefits that are predominantly defined in either nominal or real terms suggests that deriving the implications for monetary policy arrangements is of some importance. At the same time, one should acknowledge that countries' choices of nominal or real benefits and central bank conservatism need not be as unconstrained in reality as this section has assumed.

## V. Conclusion

The standard monetary policy model supports Rogoff's (1985) view that making the central bank more conservative than society will reduce inflation at no cost, because a more inflation-averse central bank will be less tempted to trade off higher inflation for (short-term only) gains in output and employment. Lower unemployment is a worthwhile policy target in the standard model because rigidities such as trade union market power render equilibrium employment too low. A major drawback of this

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<sup>8</sup>For a survey of country-specific treatment of unemployment benefit payments, see Koskela and Schöb (1999). For detailed institutional arrangements of both unemployment benefit payments and welfare benefit payments, see MISSOC (2003).

argument is, however, that this incentive is introduced as an exogenous assumption rather than an outcome of, for instance, monopolistic trade union behavior.

By explicitly modeling the behavior of a monopoly trade union and its interaction with monetary policy, Cukierman and Lippi (1999) and Guzzo and Velasco (1999) have recently argued that a conservative central bank might actually be welfare-reducing. The reason is that, if a conservative central bank keeps prices in check even when nominal wages rise, the trade union will not have to suffer the same inflationary consequences as with a less conservative monetary policy. Because more aggressive wage demands will also drive up real wages, an important consequence of this interaction between the central bank and the trade union is that now monetary policy also has real effects. The more conservative the central bank, the less moderate wage claims are and the higher unemployment is. As a result, an “ultraliberal” rather than a Rogoff-type central bank will maximize welfare in such a model.

So, is the institutional remedy for inflation suggested by Rogoff (1985) erroneous in the presence of strong labor unions? Our answer is no. The present paper shows that the “ultraliberal” central bank result is based on a specific assumption about the nature of the monopoly trade union’s outside option. In fact, it is only if significant parts of the outside option of the trade union are defined in strictly *nominal* terms that the case against the conservative central bank can be made. Only then will the threat that wage-induced price increases pose to unemployed trade union members effectively moderate trade union wage demands. If, however, the outside option of the trade union is defined in *real* terms, trade union behavior and monetary policy are no longer interconnected. In this case, the incentive to trade off inflation against employment is again exogenous from the perspective of monetary policymakers—central bank characteristics no longer matter for trade union behavior. Consequently, there is no welfare gain associated with making the central bank less conservative than society—quite the contrary. An important question raised by this dichotomy is which scenario is more likely? Probably the most likely reason for the existence of a *nominal* outside option is the government itself. It might be argued that unemployment benefits are sometimes specified in strictly nominal terms, while other important outside options for trade union members—for instance, leisure or black market activities—are almost exclusively defined in real terms. But does the government actually leave the determination of real benefits of unemployed trade union members in the hands of the central bank and the trade union? In general, there will be an explicit or implicit guarantee of a minimum real standard of living. Such a real floor to the government-provided outside option has important consequences.

If the government is to guarantee a certain *ex post* real outside option for the unemployed, it is always better off by announcing *ex ante* that, for instance, unemployment benefits are defined in real terms. The reason is that, while the *ex post* real wage and thus employment would be similar, under both real and nominal outside options, inflation would be higher in the latter case. This is because with a nominal outside option, the government would choose a more “liberal” central bank to run monetary policy in order to moderate trade union wage claims. This will raise inflation above the level that would prevail with the same (*ex post*) real outside option prespecified *ex ante*. In other words, a government that values employment and stable prices is *always* better off fixing the level of unemployment

benefits and social transfers in real terms ex ante and, at the same time, choosing a conservative, Rogoff-type central banker. Once both instruments of government policy are taken into account, the standard solution is resurrected.

A key insight given by the above discussion is that important institutions governing labor market performance and inflation are not independent, but rather are connected by the interaction of monetary policy and trade union behavior. The present paper has shown that institutional design has to be elaborated by taking account of an economic policy that combines fiscal measures and institutional design to achieve a desired outcome in the presence of trade union monopoly power.

## APPENDIX I

The sign of equation (8) is given by

$$\text{sign}\left(\frac{dp}{dc}\right) = \text{sign}(-V_{wc}L_{pw} + L_{pc}V_{ww}) = \text{sign}\left(-V_{wc}\frac{L_{pw}}{L_{pc}} + V_{ww}\right) = \text{sign}\left(-V_{wc}\frac{P_w}{P_c} + V_{ww}\right).$$

The first-order condition of the trade union's maximization problem is given by (using equation (5))

$$V_w = \frac{n}{pw} \left[ -w(1-\theta)(\delta-1) + b^{real} p\delta(1-\theta) + b^{nom} \left[ \delta(1-\theta) - \frac{1-n}{n}\theta \right] \right] = 0,$$

or

$$V_w = \frac{n(1-\theta)}{pw} \left[ -w(\delta-1) + b^{real} p\delta + b^{nom} \left[ \delta - \frac{1-n}{n} \frac{\theta}{(1-\theta)} \right] \right] = 0. \quad (A1)$$

The last term in brackets in condition (A1) can be simplified by substituting in equation (5)

$$\frac{1-n}{n} \frac{\theta}{(1-\theta)} = \frac{\delta^2(2n-1)(1-n)}{cp(2p-1)} < 1.$$

The inequality must hold for condition  $V_w = 0$  to be fulfilled throughout. Applying the first-order condition of the central bank (equation (2)), we can show that

$$\begin{aligned} \delta - \frac{1-n}{n} \frac{\theta}{(1-\theta)} &= \frac{\delta cp(2p-1) - \delta^2(2n-1)(1-n)}{cp(2p-1)} \\ &= \frac{\delta[cp^2 + cp(p-1) + \delta(2n-1)n - \delta(2n-1)]}{cp(2p-1)} \\ &\stackrel{foc}{=} \delta \frac{[cp^2 + \delta n^2 - \delta(2n-1)]}{cp(2p-1)} \\ &\stackrel{foc}{=} \delta \frac{cp + \delta(1-n)}{cp(2p-1)} \\ &\stackrel{foc}{=} \delta \frac{n + (p-1)}{(2p-1)n}. \end{aligned}$$

Hence equation (A1) becomes

$$V_w = \frac{n(1-\theta)}{pw} \left[ -w(\delta-1) + b^{real} p\delta + b^{nom} \left[ \delta \frac{(p-1)+n}{(2p-1)n} \right] \right] = 0. \quad (A2)$$

The first-order condition can thus be rewritten as

$$-wn + b^{real} p \frac{\delta}{(\delta-1)} n + b^{nom} \left[ \frac{\delta}{(\delta-1)} \frac{(p-1)+n}{(2p-1)} \right] = 0. \quad (A3)$$

From this it follows that

$$\begin{aligned} V_{wc}|_{V_w=0} &= -wn_p p_c + b^{real} \frac{\delta}{(\delta-1)} (np_c + n_p p_c p) \\ &\quad + b^{nom} \frac{\delta}{(\delta-1)} \left[ \frac{1}{(2p-1)^2} + \frac{n_p(2p-1)-2n}{(2p-1)^2} \right] p_c \\ &= -\frac{\delta}{p} wn_p c + b^{real} \delta n_p c \frac{(1+\delta)}{(\delta-1)} \\ &\quad + b^{nom} \frac{\delta}{(\delta-1)} \left[ \frac{1}{(2p-1)^2} + \frac{\frac{\delta}{p} n(2p-1)-2n}{(2p-1)^2} \right] p_c \\ &= \frac{\delta}{p} p_c \left[ -wn + b^{nom} \frac{\delta}{(\delta-1)} \frac{n}{(2p-1)} \right] + b^{real} \delta n_p c \frac{(1+\delta)}{(\delta-1)} \\ &\quad + b^{nom} \frac{\delta}{(\delta-1)} \left[ \frac{1-2n}{(2p-1)^2} \right] p_c. \end{aligned} \quad (A4)$$

Applying the first-order condition (A3), the term in the first brackets changes so that

$$\begin{aligned} V_{wc}|_{V_w=0} &= -\frac{\delta}{p} p_c \left[ b^{nom} \frac{\delta}{(\delta-1)} \frac{(p-1)}{2(p-1)} \right] + b^{nom} \frac{\delta}{(\delta-1)} \left[ \frac{1-2n}{(2p-1)^2} \right] p_c \\ &\quad + b^{real} \delta n_p c \frac{(1+\delta)}{(\delta-1)} \\ &= \frac{b^{nom}}{(2p-1)} \frac{\delta}{(\delta-1)} p_c \left[ -\frac{\delta}{p} (p-1) + \frac{1-2n}{(2p-1)} \right] \\ &\quad + b^{real} \delta n_p c \frac{(1+\delta)}{(\delta-1)}. \end{aligned} \quad (A5)$$

Thus, applying the conditions for  $p$  and  $n$ , we have  $V_{wc} > 0$  for  $b^{real} = 0$  and  $V_{wc} < 0$  for  $b^{nom} = 0$ . Next, calculate the second derivative  $V_{ww}$ . From equation (A3), it follows

$$\begin{aligned}
 V_{wc}|_{V_w=0} &= -n - wn_w + b^{real} \frac{\delta}{(\delta-1)} n_w p + b^{nom} \frac{\delta}{(\delta-1)} \frac{1}{(2p-1)} n_w \\
 &\quad - wn_p p_w + b^{real} \frac{\delta}{(\delta-1)} (np_w + n_p p_w p) \\
 &\quad + b^{nom} \frac{\delta}{(\delta-1)} \left[ \frac{1}{(2p-1)^2} + \frac{n_p(2p-1) - 2n}{(2p-1)^2} \right] p_w.
 \end{aligned} \tag{A6}$$

Substituting the first line of equation (A4) in the second and third line of equation (A6), and rearranging the first line, we obtain

$$\begin{aligned}
 V_{wc}|_{V_w=0} &= -n(1-\delta) - \frac{b^{real} p}{w} \frac{\delta^2}{(\delta-1)} n - \frac{b^{nom}}{w} \frac{\delta^2}{(\delta-1)} \frac{1}{(2p-1)} n \\
 &\quad + \frac{p_w}{p_c} V_{wc}|_{V_w=0}.
 \end{aligned} \tag{A7}$$

Thus we have at the optimum

$$\text{sign}\left(-V_{wc} \frac{p_w}{p_c} + V_{ww}\right) = \text{sign}\left(n\left(\delta - 1 - \frac{b^{real} p}{w} \frac{\delta^2}{(\delta-1)} - \frac{b^{nom}}{w} \frac{\delta^2}{(\delta-1)} \frac{1}{(2p-1)}\right)\right).$$

From equation (A2), we have

$$w = \frac{\delta}{(\delta-1)} \left( b^{real} p + b^{nom} \frac{(p-1) + n}{(2p-1)n} \right).$$

Thus

$$\begin{aligned}
 \text{sign}\left(\frac{dp}{dc}\right) &= \text{sign}\left(\delta - 1 - \frac{\delta^2}{(\delta-1)} \left( \frac{b^{real} p}{w} + \frac{b^{nom}}{w} \frac{1}{(2p-1)} \right)\right) \\
 &= \text{sign}\left(\delta - 1 - \delta \left( \frac{b^{real} p(2p-1)n + b^{nom} n}{b^{real} p(2p-1)n + b^{nom}((p-1) + n)} \right)\right) \\
 &= \text{sign}\left(-1 + \delta \left( \frac{b^{nom}(p-1)}{b^{real} p(2p-1)n + b^{nom}((p-1) + n)} \right)\right)
 \end{aligned}$$

Consider the case with  $b^{nom} = 0$ . In this case, we can see immediately that  $dp/dc < 0$ . In the case  $b^{real} = 0$ , we have

$$\text{sign}\left(\frac{dp}{dc}\right) = \text{sign}\left(\delta - 1 - \frac{n\delta}{[(p-1) + n]}\right) = \text{sign}((\delta-1)(p-1) - n).$$

Given the assumption about the labor market,  $n > 0.5$ , we have

$$p < \frac{\delta - (1-n)}{\delta-1} > \frac{\delta - 0.5}{\delta-1} \Rightarrow \frac{dp}{dc} < 0.$$

Note that the higher  $b^{real}$ , the higher  $p$  can be without changing the sign.

## APPENDIX II

It is shown that Proposition 3 also holds for the more general case where the trade union has to consider both a real and a nominal outside option:

$$V = n \frac{w}{p} + (1 - n) \left( b^{real} + \frac{b^{nom}}{p} \right).$$

The first-order condition is given by

$$V_w = \frac{n}{pw} \left[ -w(1 - \theta)(\delta - 1) + b^{real} p \delta (1 - \theta) + b^{nom} \left[ \delta(1 - \theta) - \frac{1 - n}{n} \theta \right] \right] = 0 \quad (A8)$$

or, by following the steps for  $b^{nom}$  above

$$V_w = \frac{n(1 - \theta)}{pw} \left[ -w(\delta - 1) + b^{real} p \delta + b^{nom} \left[ \delta \frac{(p - 1) + n}{(2p - 1)n} \right] \right] = 0.$$

Hence we have

$$-w(\delta - 1) + \delta \left[ b^{real} p + b^{nom} \frac{(p - 1) + n}{(2p - 1)n} \right] \equiv -w(\delta - 1) + \delta [b^{real} p + b^{nom} Z] = 0, \quad (A9)$$

where we have defined  $Z \equiv [(p - 1) + n]/[(2p - 1)n]$ . Note that the second part of equation (A8) consists simply of the sum of the changes in the outside option in the two special cases of  $b^{nom} = 0$  and  $b^{real} = 0$  for a marginal increase in  $w$ . In the latter case, this is obvious from a comparison with equation (A1). In the former case, just multiply equation (11) through by  $1/(1 - \delta)$ . The derivative of equation (A9) with regard to  $w$  is

$$V_{ww} = -(1 - \delta) + \delta b^{real} p_w + \delta b^{nom} Z_w,$$

where the second and third term can be interpreted in a similar fashion as equation (A9) above as the sum of the second derivatives of the outside option at the extremes  $b^{nom} = 0$  and  $b^{real} = 0$ . As  $V_{ww} < 0$  must hold if it is optimal for the trade union to raise the wage rate above the outside option, we can again concentrate on the sign of  $V_{wc}$  at  $V_w = 0$ .

$$V_{wc} = \delta [b^{real} p_c + b^{nom} Z_c] \quad (A10)$$

with  $Z_c > 0$ . Using the first-order condition for  $V_w = 0$ , (A8), we can solve for  $w_c = -V_{wc}/V_{ww}$ :

$$w_c = - \frac{\delta [b^{real} p_c + b^{nom} Z_c]}{-(1 - \delta) + \delta b^{real} p_w + \delta b^{nom} Z_w}.$$

Substituting in the first-order condition yields

$$w_c = - \frac{\delta [b^{real} p_c w + b^{nom} Z_c w]}{-\delta [b^{real} p + b^{nom} Z] + \delta b^{real} p_w w + \delta b^{nom} Z_w w}. \quad (A11)$$

Defining  $A \equiv -\delta b^{real} p + \delta b^{real} p_w w < 0$  since  $\theta < 1$  and  $B \equiv -\delta b^{nom} Z + \delta b^{nom} Z_w w < 0$ ,<sup>9</sup> we can split equation (A11) in the following way:

$$w_c = -\frac{\delta b^{real} p_c w}{-\delta b^{real} p + \delta b^{real} p_w w} \cdot \frac{A}{(A + B)} - \frac{\delta b^{nom} Z_c w}{-\delta b^{nom} Z + \delta b^{nom} Z_w w} \cdot \frac{B}{(A + B)}.$$

Rearranging the first term yields

$$w_c = p_c \frac{w}{p(1 - \theta)} \cdot \frac{A}{(A + B)} - \frac{\delta b^{nom} Z_c w}{-\delta b^{nom} Z + \delta b^{nom} Z_w w} \cdot \frac{B}{(A + B)}. \quad (A12)$$

As  $p_c < 0$ , the sign of the first term is negative, but the second is positive as  $Z_c > 0$  and  $B < 0$ . Thus, as was to be expected, the influence of the nominal and real outside options determines the reaction of wages to an increase in  $c$ . If the absolute size of the first term is smaller than that of the second, an increase in  $c$  leads to higher wage demands. This result shows that the change in nominal wage can go either way.

Using equation (A12) allows us to rewrite equation (10) as follows:

$$\begin{aligned} \frac{d \frac{w}{p}}{dc} &= \frac{p_c \frac{w}{p} \frac{1}{(1 - \theta)} (1 - \theta) - p_c \frac{w}{p} \cdot \frac{A}{(A + B)}}{p} \\ &+ \frac{\frac{-\delta b^{nom} Z_c w}{-\delta b^{nom} Z + \delta b^{nom} Z_w w} (1 - \theta) - p_c \frac{w}{p} \cdot \frac{B}{(A + B)}}{p}. \end{aligned} \quad (A13)$$

As the first term is zero, this reduces to

$$\begin{aligned} \frac{d \frac{w}{p}}{dc} &= \frac{\frac{-\delta b^{nom} Z_c w}{-\delta b^{nom} Z + \delta b^{nom} Z_w w} (1 - \theta) - p_c \frac{w}{p} \cdot \frac{B}{(A + B)}}{p} \\ &= \frac{-\delta b^{nom} Z_c w}{(A + B)p} (1 - \theta) - p_c \frac{w}{p} \cdot \frac{B}{(A + B)p}. \end{aligned} \quad (A14)$$

As  $p_c < 0$ ,  $B < 0$ , and  $A + B < 0$  the sign of the second term is positive. The first term is also positive as  $Z_c > 0$ . Hence, if the nominal outside option is positive, the real wage always increases in the degree of central bank conservatism.

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<sup>9</sup> $B < 0$  if  $n > (p - 1)(\delta - 1)$ . Otherwise, the second-order condition is not fulfilled for the case with the trade union facing a nominal outside option only.

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