Wage Indexation, Central Bank Independence and the Cost of Disinflation

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Abstract

Recently, Fischer [1996] and Posen [1998] demonstrated empirically that countries with less independent central banks enjoy lower output losses during disinflationary cycles. Since independence is presume to provide a credibility bonus to the monetary policy, this conclusion looks surprising. To explain their paradoxical result, these authors put forward that independent central banks probably face a flatter short-run Phillips curve. In this paper, we provide a formal demonstration of this point. More precisely, we demonstrate that the private sector has less incentive to index its nominal wages when the central bank is granted with a large amount of independence. Since an increased indexation steepens the short-run Phillips curve, our result is consistent with the view that where central bank independence is greater, the cost of disinflation is higher. Our empirical tests, for a sample of 19 OECD countries, support our theoretical analysis. In particular, a negative and significant relationship is found between indexation and independence.

Résumé

Fischer [1996] et Posen [1998] ont récemment démontré empiriquement que les pays dotés des banques centrales les moins indépendantes payaient moins cher, en terme réels, leurs épisodes désinflationnistes. Dans la mesure où l'indépendance des banques centrales est supposée fournir un supplément de crédibilité à la politique monétaire, cette conclusion est surprenante. Afin d'expliquer ce résultat, ces auteurs soulignent que les banques centrales les plus indépendantes sont probablement celles qui font face aux courbes de Phillips de court-terme les plus plates. L'objectif de cet article est de fournir une démonstration formelle de ce point. Plus précisément, nous démontrons que les salariés sont moins incités à indexer leurs salaires nominaux lorsque la banque centrale est caractérisée par une large autonomie. Dans la mesure où un accroissement de l'indexation salariale se traduit par une courbe de Phillips de court-terme plus verticale, notre résultat est compatible avec le fait que les politiques monétaires désinflationnistes sont plus coûteuses dans les pays où les banques centrales sont les plus indépendantes. Nos tests empiriques, pour un échantillon de 19 pays membres de l'OCDE, semblent corroborer notre analyse théorique. En particulier, une relation négative et statistiquement significative est mise en évidence entre l'indexation et le degré d'indépendance des banques centrales.

Key words : central bank independence, indexation, sacrifice ratio
JEL Classification : E52, E58

1 Introduction

A broad consensus have rallied around the idea that central bank independence eases the attainment of price stability at little or no real economic cost. In Rogoff [1985] the establishment of an independent central bank is seen as a way to credibly commit the state against the temptation of inflationary surprise. Several empirical studies have found a negative correlation between inflation and central bank independence and no systematic relationship between central bank independence and real economic performances (Grilli Masciandaro and Tabellini [1991], Cukierman [1992] and Alesina and Summers [1993] for example). The credibility bonus of central bank independence is presumed to be the source of these results, even if it can be argued that these results are insufficient to establish a causal link. Recently, Fischer [1996] and Posen [1998] examined directly the credibility effect of central bank independence. However, as credibility is not observable, these authors use a proxy developed by Ball [1994], the Sacrifice Ratio which is an indicator of the real costs of disinflationary policy. Their results do not support the view that central bank independence increases credibility. More precisely, their main conclusion is that countries with independent central banks suffer more output losses over a disinflationary cycle than countries with less independent central banks.

The objective of this paper is to explain formally the negative relationship between central bank independence and the sacrifice ratio. Our framework is a game-theoretic model of monetary policy developed by Rogoff [1985] and extended to allow for indexed nominal wage contracts. In this analysis, we demonstrate that the optimal degree of wage indexation is negatively affected by the central bank independence. As increased indexation steepens the short-run Phillips curve, our conclusion is that independent central banks face a flatter short-run Phillips curve and hence, their disinflationary policies are more costly since they are less credible. As stated by Posen [1998, p.338], *"There are, of course, other factors that determine the slope of the Phillips curve or output-inflation trade-off, but to whatever extend people are able to react to policy (for example, are not bound by long-term contracts), the clearer signal that a more credible policy conveys must translate into a smaller real effect of monetary policy".*
Moreover, we demonstrate that central bank independence, by lowering the optimal degree of nominal wage indexation, increases the output losses of disinflationary policies since it reduces the speed of disinflation.

The paper is organized as follow. Section 2 presents the model of monetary policy with indexed wage contracts. In section 3, we study the indexation behavior of the private sector and we demonstrate that the optimal degree of indexation is decreasing with central bank independence. Some empirical tests are presented in section 4. They seem support our theoretical analysis. Section 5 concludes.

2 The Model

The model developed here, is built around the Barro-Gordon [1983] and Rogoff [1985] models extended to allow for indexed wage contracts as in Gray [1976] and Fischer [1983]. It permits to study the strategic interactions between an optimizing monetary authority and rational individuals. This model consists of a simple aggregate supply-

aggregate demand model in which the supply side behavior is influenced by indexed wage contracts and the demand side is driven by the quantity of money.

On the supply-side of the economy, labor is assumed the factor of production in the short run and the output is given by the following production function:

$$y_t = al_t + u_t\,, \quad 0 < a < 1 \tag{1}$$

where y_t and l_t are the logs of the output and the employment levels respectively, u_t is a production shock which has a zero mean and a constant variance equal to σ_u^2. Profit maximization by competitive firms leads to the following labor demand function:

$$l_t^d = d + [1/(1-a)]\,(p_t - w_t + u_t) \tag{2}$$

where $d = \ln(a)/(1-a) > 0$, w_t is the log of the nominal wage, p_t is the log of price level in time t. On the other hand, the labor supply is given as:

$$l_t^s = d - \theta + \delta(p_t - w_t)\,, \quad \delta \geqslant 0 \tag{3}$$

where the intercept term in (3) is not set equal to that of the demand for labor because we assume that the labor supply is affected by distortions factor in the labor market, captured by the parameter θ. These distortions are assumed to be the result of either the income tax policies, or "insiders" behavior in the labor market which leads to an excessive base real wage, as in Blanchard and Summers [1986].Then, by equating (2) and (3) under the assumption that $\delta = 0$[1], we obtain the competitive equilibrium nominal wage level in the labor market as follows:

$$\widehat{w}_t = p_t + u_t + (1-a)\theta \tag{4}$$

This wage is the market wage that would arise in the absence of nominal wage contracts and leads, by using (2) and (1), to the following competitive equilibrium output level:

$$\widehat{y}_t = \overline{y} - k + u_t\,, \quad \text{with } \ \overline{y} = ad, \text{ and } \ k = a\theta \tag{5}$$

where the presence of the labor supply distortion factor, θ, is a key feature in this model since it causes a reduction in the optimal labor supply of workers. This distortion of output plays an important role in the policy decisions of the monetary authorities.

We assume that nominal wage contracts are signed at the beginning of each period. Then shocks occurred and finally, according to the wage level and the realization of the shocks, the monetary authorities set the money supply. Once wage contracts are signed, employment becomes demand determined. Thus, a moral hazard problem arise. This justifies the incentive of workers to index their nominal wages to unexpected price movements as in Gray [1976]. The indexing rule is given by:

[1]The inelastic labor supply assumption simplifies our calculus without any loss of generality of our results.

$$w_t = E_{t-1}\widehat{w}_t + \sigma(p_t - E_{t-1}p_t)\,, \quad 1 \geqslant \sigma \geqslant 0 \tag{6}$$

where E_{t-1} is the rational expectation operator and σ is the indexing parameter. For $\sigma = 1$, wages are fully indexed and for $0 < \sigma < 1$, wages are partially indexed. Finally, the case where $\sigma = 0$ (no indexation) corresponds to the Rogoff's [1985] set up. Integrating the equation (6) into (2) and using (1), we obtain the following aggregate output supply function:

$$y_t^s = \overline{y} - k + c(1-\sigma)(p_t - E_{t-1}p_t) + (1+c)u_t \tag{7}$$

where $c = a/(1-a)$.
Aggregate demand is assumed to be generated by a simple quantity theory equation:

$$y_t^d = m_t - p_t + v_t \tag{8}$$

where m_t is the logarithm of the nominal money supply and v_t is a zero mean demand shock with variance σ_v^2 and is assumed to be uncorrelated with the supply shock. The objective of the government is to minimize the following loss function:

$$L_t^G = E_{t-1}\left[(y_t - y_t^*)^2 + \beta\pi_t^2\right]\,, \quad \beta > 0 \tag{9}$$

where $y_t^* = \widehat{y}_t + k$ is the level of output desired by the government. Remember that the parameter k reflects the labor market distortions that the government seeks to offset through the use of monetary policy. In addition, the government aims to minimize deviations of the inflation rate from its socially optimal level which we set equal to zero for simplicity. The term β is the relative weight that the monetary authorities place on the inflation stabilization versus output stabilization. Following Rogoff [1985], we suppose an institutional arrangement in which monetary policy is delegated to an optimal conservative central banker whose loss function is:

$$L_t^{CB} = E_{t-1}\left[(y_t - y_t^*)^2 + (\beta+\varepsilon)\pi_t^2\right] \tag{10}$$

where $\varepsilon > 0$ is the optimal extra relative weight the central banker sets on inflation versus output stabilization[2]. The money stock is chosen by the central banker to minimize his loss function (10), taking price expectations as given. Then, from the first order condition for a minimum of (10) and under the rational expectation hypothesis, the equilibrium inflation rate and output level chosen by the conservative central banker are given by:

$$\pi_t^{CB} = \frac{c(1-\sigma)k}{\beta+\varepsilon} - \frac{c^2(1-\sigma)}{\beta+\varepsilon+c^2(1-\sigma)^2}u_t \tag{11}$$

[2]It can be demonstrated (see Rogoff [1985] for a formal proof) that the optimal degree of central bank conservativeness is strictly positive and finite : $0 < \varepsilon < +\infty$.

$$y_t^{CB} = \widehat{y}_t + \frac{c(\beta+\varepsilon)}{\beta+\varepsilon+c^2(1-\sigma)^2}u_t \tag{12}$$

where the subscript CB stands for the conservative central banker.
Equations (11) and (12) show that the monetary authority responds in such a way as to completely offset the aggregate demand shock because this is consistent with the stabilization of both output and price level. These two equations show the trade-off between credibility and flexibility. For a given value of the indexing parameter σ, an increase in ε induces a decrease in the inflationary bias and a decrease of the central bank stabilization response to output deviations. Finally, equations (11) and (12) also show that for a given value of ε (i.e. for a given precommitment technology), an increased wage indexation reduces the inflationary bias in the economy by making the Phillips curve steeper (see Devereux [1987] and Fischer-Summers [1989]) and increases the volatility of output since it reduces the monetary authority's stabilization power.

3 Indexation and central bank independence

The problem confronting the wage setters is to determine the degree of wage indexation to price surprises taking into account the policy implemented by the central bank. We assume that wage contracts are negotiated by a centralized union whose problem can be stated as:

$$\min_{\sigma} L_t^W = E_{t-1}\left[(y_t - \widehat{y}_t)^2 + \beta\pi_t^2\right] \tag{13}$$

As the union chooses optimally the degree of nominal wage indexation, σ must be solved endogenously in order to minimize the union's loss function. Thus, using (11) and(12) into the union loss function (13), we can determine the level of the union's loss as a function of the degree of indexation σ, as:

$$L_t^W = \frac{\beta c^2(1-\sigma)^2}{(\beta+\varepsilon)^2}k^2 + \frac{c^2\left[(\beta+\varepsilon)^2 + \beta c^2(1-\sigma)^2\right]}{\left[\beta+\varepsilon+c^2(1-\sigma)^2\right]^2}\sigma_u^2 \tag{14}$$

The union, like the government, faces the trade-off between inflation and stabilization. The first term of (14) is the welfare loss resulting from the inflationary bias and is decreasing with indexation (since the Phillips curve becomes steeper). The second term is the welfare loss resulting from the output and inflation variability. It can be easily demonstrated that this term is increasing with indexation. The union chooses the nominal degree of wage indexation in order to realize the optimal trade-off between inflation and stabilization. We now endogenize the degree of nominal wage indexation. Thus, solving for $\partial L_t^W/\partial\sigma = 0$ in equation (14), the following proposition can be established:

Proposition 1 *: When the optimal degree of indexation is not at a corner solution, it will be lower the higher the degree of central bank independence. In other words, if* $0 < \sigma < 1$*, then:*

$$\sigma = \sigma(\varepsilon) \quad with \quad \partial\sigma/\partial\varepsilon < 0$$

Proof: see the appendix A.

Proposition 1 is the major new result of this paper. The intuition behind this proposition is straightforward. As central bank independence reduces the mean inflation rate and its variance, it seems plausible that people would contract in longer nominal term in order to economize on the costs of information or renegotiation for example. A more analytical explanation can be provided if we note that indexation and central bank independence have qualitatively the same impact on inflation and output. They both reduce the inflationary bias and increase the output variability. If the government increases the degree of central bank independence, the inflationary bias will be lower whereas the output variability will increase. The union will find it optimal to reduce its wage indexation in order to realize the optimal trade-off between inflation and output stabilization.

This result explains why increased indexation lowers the real cost of disinflationary policies since it steepens the short-run Phillips curve. But it can also be demonstrated[3] that the speed of disinflation is a positive function of the degree of nominal wage indexation. This is another channel by which indexation lowers the sacrifice ratio since, as demonstrated by Ball [1994], "cold turkey" is less costly than "gradualism". In the next section, we investigate empirically these results.

4 Empirical evidence

In this section, the theoretical insights offered by the model discussed before are empirically investigated. The first testable implication of the theory is that there may be significant interactions between the degree of nominal wage indexation and the central bank independence (Proposition 1). From this perspective, the main empirical implication of the model concerns the relation between the degree of the nominal wage indexation, σ, and the degree of central bank conservativeness, ε. In order to test these theoretical results, we need quantitative measures of central bank independence and nominal wage indexation. Since these theoretical concepts cannot be directly observed, this investigation requires the use of some empirical proxies for the above variables.

In order to proxy ε, we use four alternative indices of the legal degree of central bank independence. The first index used here is the legal index (CUK) developed by Cukierman [1992]. The second index is the total index of political and economic independence (GMT) developed by Grilli, Masciandaro and Tabellini [1991].The third index is the index (BP) developed by Bade and Parkin [1988]. The fourth index of central bank independence (AS) is developed by Alesina and Summers [1993] and is a measure based on Grilli et al. (1991) index of central bank independence and Bade and Parkin [1988] index extended by Alesina [1988]. The first index ranges between zero (least independent) and one (most independent), the second between one and fifteen, the third and the fourth between one and four. The nominal wage indexation is approximated by two alternative proxies. The first measure is the legal wage indexation (LWI) taken from Bruno and Sachs [1985]. For a given country, these authors assign a value zero (no indexation clauses), one (partial indexation) or two (widespread indexation). The

[3]See appendix B.

Dependent variable: LWI[4]	CUK	GMT	AS	BP
Constant	2.182^{**} (4.569)	2.311^{**} (3.433)	2.827^{**} (5.102)	2.814^{**} (7.368)
CBI	-2.703^{*} (-2.297)	-0.126 (-1.626)	-0.655^{*} (-2.983)	-0.714^{**} (-4.405)
R^2	0.25	0.18	0.41	0.60
Sample Size	18	14	15	15
S.E. of Reg.	0.767	0.861	0.707	0.581

Table 1: Legal Wage Indexation (LWI) and central bank independence (CBI)

Notes : t-statistics in parentheses. $*(**) =$ significant at the 5(1)% level

second measure used in this paper is Bruno and Sachs's [1985] index of "nominal wage responsiveness"(NWR). Higher values mean greater flexibility (that is, shorter, more indexed and more synchronized wage agreements). This index runs from zero to six.

Dependent variable: NWR[5]	CUK	GMT	AS	BP
Constant	5.442^{**} (5.208)	6.829^{**} (4.999)	7.225^{**} (5.904)	6.725^{**} (6.454)
CBI	-4.303 (-1.692)	-0.356^{*} (-2.315)	-1.376^{*} (-2.904)	-1.275^{*} (-2.965)
R^2	0.17	0.33	0.41	0.42
Sample Size	16	13	14	14
S.E. of Reg.	1.623	1.634	1.463	1.450

Table 2: Nominal Wage Responsiveness (NWR) and central bank independence (CBI)

Notes : t-statistics in parentheses. $*(**) =$ significant at the 5(1)% level

For our cross-country estimations, a sample of nineteen industrial OECD member countries (Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, New Zealand, the Netherlands, Norway, Spain, Sweden, Switzerland, the United Kingdom, and the United States) is used in this paper. To test Proposition 1 suggested by the theoretic model, our regression analysis (OLS method) assumes the various indices of central bank independence to be the explanatory variables of nominal wage indexation.

Tables 1 and 2 report the main regression results of the two indices of nominal wage indexation on the four alternative indices of central bank independence. The key result

reported in these tables is consistent across all regressions and shows that the degree of central bank independence has always a negative coefficient. This negative coefficient is statistically significant for six out of the eight regressions performed.

Dependent variable: Sacrifice Ratio[6]	LWI	NWR
Constant	0.946^{**}	1.390^{**}
	(4.145)	(4.302)
Indexation	-0.128	-0.153^{*}
	(-0.809)	(-2.007)
R^2	0.01	0.07
Sample Size	60	57
S.E. of Reg.	1.049	0.977

Table 3: Sacrifice ratio and nominal wage indexation

Notes : t-statistics in parentheses. $*(**) =$ significant at the 5(1)% level

Therefore, in these empirical results we find evidence to support our first theoretical proposition according to which an increase in the degree of central bank independence reduces the degree of wage indexation.

The second testable implication of our analysis is that nominal wage indexation by making the short-run Phillips curve steeper reduces the sacrifice ratio[7]. On the contrary, central bank independence should increase the sacrifice ratio. Tables 3 and 4 report respectively the results of our regressions concerning the relationships between the sacrifice ratio and our two indices of indexation and the relationships between the sacrifice ratio and the four indices of independence. These regressions were performed using the sacrifice ratio quarterly datas provided by Ball [1994].

Our results concerning the impact of central bank independence on the sacrifice ratio are qualitatively the same as those obtained by Fischer [1996] and Posen [1998]. They suggest that central bank independence does not provide a credibility bonus but increases the cost of disinflation. The effect of indexation on the sacrifice ratio is negative, even if only the nominal wage responsiveness (NWR) is significant.

Finally, we test the effect of indexation and independence on the speed of disinflation. The speed of disinflation is defined as the ratio between the total change in inflation during the disinflationary cycle and the length in years of this disinflationary cycle.

From our theoretical analysis, indexation increases the speed of disinflation and hence, central bank independence reduces it. Tables 5 and 6 report our empirical results. All the coefficients have the expected sign. But these coefficients are only significant for the central bank independence.

[7]See appendix B for a formal proof.

Dependent variable: Sacrifice Ratio[8]	CUK	GMT	AS	BP
Constant	0.160 (0.483)	−0.063 (−0.139)	−0.160 (−0.365)	0.161 (0.432)
CBI	1.692* (2.061)	0.114* (2.176)	0.418* (2.404)	0.313* (1.967)
R^2	0.07	0.09	0.10	0.07
Sample Size	64	48	52	52
S.E. of Reg.	1.003	1.076	1.045	1.063

Table 4: Sacrifice ratio and central bank independence (CBI)

Notes : t-statistics in parentheses. $*(**) =$ significant at the 5(1)% level

Dependent variable: Speed of disinflation[9]	LWI	NWR
Constant	1.681** (10.474)	1.450** (5.443)
Indexation	0.051 (0.459)	0.085 (1.352)
R^2	0.00	0.03
Sample Size	60	57
S.E. of Reg.	0.738	0.806

Table 5: Disinflation speed and nominal wage indexation

Notes : t-statistics in parentheses. $*(**) =$ significant at the 5(1)% level

5 Conclusion

Our objective in this paper was to explain why independent central banks face flatter short-run Phillips curve. We demonstrate that independence reduces the optimal degree of nominal wage indexation since it reduces the variance of inflation. However, a reduced indexation means a flatter short-run Phillips curve and a lower speed of disinflation. These two elements explain why the sacrifice ratio is positively correlated with central bank independence whereas it is negatively affected by the degree of nominal wage indexation. The results of our empirical work seem to support our theoretical analysis. There is a clear and negative relationship between the degree of central bank independence and the degree of indexation.

Dependent variable: Speed of disinflation[10]	CUK	GMT	AS	BP
Constant	2.298^{**} (9.293)	2.558^{**} (−0.139)	2.423^{**} (7.911)	2.159^{**} (8.240)
CBI	-1.972^{*} (−2.241)	-0.102^{**} (−2.916)	-0.286^{*} (−2.345)	−0.193 (−1.718)
R^2	0.07	0.16	0.10	0.06
Sample Size	64	48	52	52
S.E. of Reg.	0.748	0.716	0.732	0.750

Table 6: Disinflation speed and central bank independence (CBI)

Notes : t-statistics in parentheses. $*(**) =$ significant at the 5(1)% level

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Appendix

A Proof of Proposition 1

Proof. Using equation (14), the first-order condition for a minimum of the union's loss is:

$$2c^2(1-\sigma)\left[\frac{\left[(\beta+\varepsilon)(\beta+2\varepsilon)+\beta c^2(1-\sigma)^2\right]c^2\sigma_u^2}{\left[\beta+\varepsilon+c^2(1-\sigma)^2\right]^3}-\frac{\beta k^2}{(\beta+\varepsilon)^2}\right]=0$$

This equation has one obvious root: $\sigma = 1$. The second-order condition for a minimum is satisfied for this solution iff:

$$\beta k^2 > (\beta+2\varepsilon)c^2\sigma_u^2 \tag{A1}$$

When the condition (A1) is not fulfilled, we study the following equation:

$$f(\sigma\ ;\ \varepsilon)=\frac{(\beta+\varepsilon)^2\left[(\beta+\varepsilon)(\beta+2\varepsilon)+\beta c^2(1-\sigma)^2\right]}{\left[\beta+\varepsilon+c^2(1-\sigma)^2\right]^3}-\frac{\beta k^2}{c^2\sigma_u^2}=0 \tag{A2}$$

From (A2), it can be demonstrated after some algebra that:

$$\frac{\partial f}{\partial \sigma}>0 \ \text{ and } \ \frac{\partial f}{\partial \varepsilon}>0$$

Applying the implicit function rule, we get:

$$\frac{\partial \sigma}{\partial \varepsilon}=-\frac{\partial f/\partial \varepsilon}{\partial f/\partial \sigma}<0$$

■

B Sacrifice Ratio

We present here a modified version of the model used in the paper. This model is described by the following equations:

$$y = \widehat{y} + c(1-\sigma)(\pi - \pi^e) \tag{B1}$$

$$y = \phi(m - p) \tag{B2}$$

$$\pi^e = \overset{\bullet}{m} = m - m_{-1} \tag{B3}$$

From the second equation, we obtain after differentiation:

$$\overset{\bullet}{y} = \phi(\overset{\bullet}{m} - \pi) \tag{B4}$$

Then, extracting π from (B1) and using (B3), the relation (B4) can be written as:

$$\overset{\bullet}{y} = -h(y - \widehat{y})$$

where $h = \phi / [c(1-\sigma)]$. We can approximate the sacrifice ratio by $\overset{\bullet}{y}$ so that:

$$SR = \int_0^\infty (y - \widehat{y})dt = \int_0^\infty (y_0 - \widehat{y})e^{-ht} = \frac{y_0 - \widehat{y}}{h}$$

We assume that the monetary authority wants to fight inflation with its monetary policy and thus:

$$y_0 - \widehat{y} = \frac{\partial y}{\partial m} = \phi$$

Finally, we obtain

$$SR = \frac{\phi}{h} = \frac{1}{c(1-\sigma)}$$

The sacrifice ratio is negatively correlated with the degree of wage indexation. Since we demonstrated that indexation is a decreasing function of central bank independence, this result suggests that sacrifice ratio is positively correlated with central bank independence. These results are supported by our empirical investigations presented in section 4. Moreover, we can observe that the speed of convergence is positively affected by indexation and hence negatively affected by central bank independence. Our empirical tests seem to support the negative relationship between central bank independence and the speed of disinflation. However, the positive effect of indexation on the speed of disinflation does not appear to be statistically significant.