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Bevger, H.; de Haan, J.; Eijffinger, S.C.W.

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CENTRAL BANK INDEPENDENCE: AN
UPDATE OF THEORY AND EVIDENCE

Helge Berger
Jakob de Haan
Sylvester C. W. Eijffinger

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Abstract

This paper reviews recent research on central bank independence (CBI). After we have distinguished between independence and conservativeness, the literature on optimal inflation contracts is discussed, followed by research in which the inflationary bias is endogenised. Finally, the various challenges that have been raised against previous empirical findings on CBI are reviewed. We conclude that the negative relationship between CBI and inflation is quite robust.

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Helge Berger
University of Munich and CESifo
Center for Economic Studies
Schackstr. 4
80539 Munich
Germany
e-mail: h.berger@ces.vwl.uni-muenchen.de

Jakob de Haan	*Sylvester C. W. Eijffinger*
University of Groningen	*Tilburg University and CEPR*
Department of Economics	*CentER*
The Netherlands	*The Netherlands*

1. Introduction

Nowadays is it widely believed that a high level of central bank independence (CBI) coupled with some explicit mandate for the bank to restrain inflation are important institutional devices to assure price stability. Indeed, quite a few countries have recently changed their central bank laws accordingly. The theory underlying this view is the time inconsistency model by Kydland and Prescott (1977) and Barro and Gordon (1983). The basic message of this theory is that government suffers from an inflationary bias and that, as a result, inflation is sub-optimal. Rogoff (1985) has proposed to delegate monetary policy to a an independent and 'conservative' central banker to reduce this inflationary bias. Conservative means that the central banker is more averse to inflation than the government, in the sense that (s)he places a greater weight on price stability than the government does.

There is quite some empirical evidence suggesting that CBI helps to reduce inflation. This evidence generally consists of cross-country regressions using proxies for CBI either based on the statutes of the central bank or the turnover rate of central bank governors. Cukierman (1994) summarises the empirical regularities in the correlation between CBI on the one hand and inflation and economic growth on the other as follows:

(1) among industrialised countries, legal central bank independence indices are negatively correlated with inflation, but the turnover rate (TOR) of central governors has no correlation with inflation;

(2) among industrialised countries the legal CBI indices have no correlation with economic growth;

(3) among developing countries, the legal CBI index of Cukierman et al. (1992) is not correlated with inflation, but the TOR of Cukierman et al. (1992) – which was, until recently, the only one available for developing countries – is significantly related to inflation;

(4) among developing countries, after controlling for other factors, the TOR is correlated with

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economic growth; the legal index is not correlated with economic growth.

The purpose of this paper is to update the survey of Eijffinger and De Haan (1996). Since this survey was published an enormous amount of studies has been published, many of which challenge the theoretical foundations of CBI and/or the empirical regularities as summarised above. The paper is organised as follows. The next section clarifies the distinction between independence and conservativeness. Section 3 reviews recent literature on optimal inflation contracts. The fourth section discusses recent research on endogenising the inflationary bias. Section 5 summarises recent empirical studies. The final section offers some concluding comments.

2. Independence versus Conservativeness

In much of the literature on CBI, independence is often not distinguished carefully from conservativeness. In fact, most of the legal indicators for CBI give a central bank a higher score if price stability is the (primary) objective of the central bank concerned, while it, of course, implies less goal independence. The reason for doing so is that in the theoretical set-up both independence and conservativeness matter for the inflation performance. We can exemplify this as follows.

It is assumed that policy-makers seek to minimise the following loss function, which represents the preferences of the society:

$$L^G = \frac{1}{2}\pi_t^2 + \frac{\chi}{2}(y_t - y_t^*)^2 \tag{2.1}$$

where y_t is output, y^* denotes desired output and χ is government's weight on output stabilisation $(\chi > 0)$. Output is driven by a simplified Lucas supply function[1]:

$$y_t = (\pi_t - \pi_t^e) + \mu_t \tag{2.2}$$

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where π is actual inflation, π^e is expected inflation, and μ_t is a random shock with zero mean and variance σ_μ^2. Policymakers minimise (2.1) on a period by period basis, taking the inflation expectations as given. With rational expectations, inflation turns out to be:

$$\pi_t = \chi y_t^* - \frac{\chi}{\chi+1}\mu_t \tag{2.3}$$

The first term at the right hand side of equation (2.3) is the inflationary bias. A country with a high inflationary bias has a credibility problem, as economic subjects realise government's incentives for surprise inflation. The second term in equation (2.3) reflects the degree to which stabilisation of output shocks influence inflation.

Suppose now that a 'conservative' central banker is put in charge of monetary policy. Conservative means that the central banker is more inflation-averse than government. The loss function of the central banker can therefore be written as:

$$L^{cb} = \frac{1+\varepsilon}{2}\pi_t^2 + \frac{\chi}{2}(y_t - y_t^*)^2 \tag{2.4}$$

where ε denotes the additional inflation aversion of the central banker. The preferences of the central banker do not matter, unless (s)he is able to determine monetary policy. In other words, the central bank should be able to pursue monetary policy without (much) government interference. This can simply be modelled as follows (Eijffinger and Hoeberichts, 1998):

$$M_t = \gamma L^{cb} + (1-\gamma)L^G \tag{2.5}$$

where γ denotes the degree of *central bank independence*, i.e. to which extent the central banker's loss function affects monetary policy-making.. If $\gamma = 1$, the central bank fully determines monetary policy M. With rational expectations and minimising government's loss function, inflation will be:

$$\pi_t = \frac{\chi}{1+\gamma\varepsilon}y_t^* - \frac{\chi}{1+\gamma\varepsilon+\chi}\mu_t \tag{2.6}$$

Comparing equations (2.3) and (2.6), one can immediately see that the inflationary bias (the first term at the right hand of the equations) is lower for positive values of γ and ε. In other words,

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delegating monetary policy to an independent and 'conservative' central bank will yield a lower level of inflation. There is an optimal level of independence cum conservativeness ($\gamma\varepsilon^*$). Under certain assumptions, this is shown graphically in Fig. 1.

It also follows from equation (2.6) that both independence and the inflation aversion of the central bank matter. If the central banker would have the same inflation aversion as government (i.e. $\varepsilon = 0$), the independence does not matter. And similarly, if the central bank is fully under the spell of government (i.e. $\gamma = 0$), the conservativeness of the central bank does not matter. There are various combinations of γ and ε that may yield the same outcome, including the optimal one. Ceteris paribus an increase (a decrease) in the bank's conservativeness or independence will lead to a more inflation-averse monetary policy.

Fig. 1 The optimal level of central bank independence and conservativeness
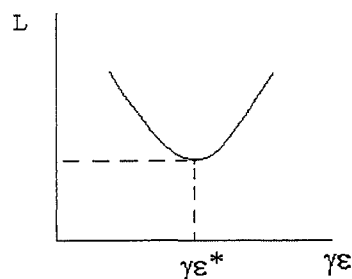
The solution to reduce the inflationary bias by delegating monetary policy to a conservative and independent central banker has been criticised by McCallum (1995). His argument is that if the time inconsistency problem is present when the government performs monetary policy, it is remains when policy is delegated as government can still create surprise inflation by changing the terms of delegation. In other words, delegation does not resolve the time inconsistency problem, it

merely relocates it. Implicitly it has been assumed in the analysis as presented above, that the costs of changing the 'rules of the game' are prohibitive. Jensen (1997) addressed this issue in a model where the choice of delegation is part of the strategic interaction and where a formal commitment technology is considered explicitly. When it is costly to change delegation, Jensen shows that delegation to some extent reduces the time inconsistency problem. However, only in the special case where costs is all that matter for the government is the inconsistency problem resolved completely by delegating monetary policy to a conservative and independent central banker.[2]

The evidence presented by Moser (1999) is in line with the analysis of Jensen (1997). Moser argues that almost any central bank is in fact dependent on the legislators who can change the law. Countries with a legislative system that comprises at least two veto players with different preferences have higher costs of withdrawing the independence and are thereby more credible in supplying a legally independent central bank. Moser has classified all OECD countries according to the criteria whether the legislative function is shared equally between at least two decision bodies and whether they have different preferences. Regression analysis reveals that these conditions are significant and of major importance in explaining differences in legal central bank independence. The negative relation between inflation and legal bank independence, is stronger in countries with forms of checks and balances than in those without any checks and balances.

Although it may work in theory, from a practical point the concept of a 'conservative' central banker seems void, if only since the preferences of possible candidates for positions in the governing board of a central bank are generally not very easy to identify and may change after they have been appointed. So, it is hard to find some real world example of a 'conservative' central banker. Still, one could argue that the statute of the central bank can be relevant here, especially with respect to the description of the primary goal of monetary policy. Whether the statute of a central bank defines price stability as the primary policy goal, can be considered as a proxy for the 'conservative bias' of the central bank as embodied in the law (Cukierman, 1992). Following this line of reasoning, De Haan and Kooi (1997) have decomposed the indicators of

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central bank independence of Cukierman (1992) and Grilli et al. (1991) into an indicator for the 'conservative bias' of the central bank as embodied in the law and an indicator for independence proper. They show that notably instrument independence, i.e. the degree to which the central bank can freely decide about use of monetary policy instruments, matters for the inflation performance whereas the conservativeness of the central bank and other aspects of independence (like personnel independence) have little or no impact on inflation (variability). Debelle and Fischer (1995) reach a similar conclusion as far as the importance of instrument independence is concerned. Interestingly, Kilponen (1999a), who decomposes the Cukierman index in a similar way as De Haan and Kooi (1997), finds that the degree of conservativeness as embodied in the law affects the wage growth, while instrument independence matters for inflation.

Banaian et al. (1998) also look at the components of the Cukierman legal index and how well its components are related to inflation. Principal component analysis is used for 27 industrial and developing countries. The authors conclude that most components appear to have an insignificant or 'wrongly' signed relation with inflation failing to yields insights into the aspects of institutional design that would be most effective for central bank independence. However, in line with the summary of the empirical evidence in the Introduction, one may wonder whether the legal indicator can be employed for developing and industrial countries in the same way (see Section 5 for further discussion).

Berger and Woitek (1999) follow a very different approach, employing a single country (Germany) time series set up. They assume that the members of the governing council of the Bundesbank share the partisan views of the governments that nominated them and that governments dominated by the conservative party are more inflation-averse than governments dominated by social-democrats. Using a Vector Autoregressions model, they find that more conservative council majorities indeed follow a more inflation-averse policy.

3. Inflation Targeting

Apart from a legislative approach to create by law an independent central bank and to mandate it to direct its policies towards achieving price stability, other mechanisms have been suggested to overcome the incentive problems of monetary policy. The so-called contracting approach regards design of monetary institutions as one that involves structuring a contract between the central bank and the government. The optimal contract is an application of ideas from the principal-agent literature. In this application government is viewed as the principal and the central bank as the agent. The principal signs a contract with the agent according to which the bank is subject to a penalty schedule that is linear in inflation. The nature of the contract will affect the incentives facing the bank and will, thereby, affect monetary policy. Walsh (1995) has shown that an optimal linear *inflation contract* can eliminate the inflationary bias without distorting stabilisation policy. Svensson (1997a) has shown that the linear contract can be mapped into an optimal *inflation target*. This means that the delegation arrangements are equivalent. They are both able to produce the pre-commitment outcome.

The optimal contract for the central banker, as described by Walsh (1995) achieves the first best solution: no inflationary bias (which is equal to the distance between expected inflation rate and the target inflation rate) and optimal stabilisation (where we need to look at the variances of inflation and output). The central banker's utility depends on the social loss and a transfer (s)he receives: U_t = $T_t - L_t$, where U is the central banker's utility, T is the transfer and L is the social loss given by:

$$L_t = \frac{1}{2}(\pi_t - \pi^*)^2 + \frac{\chi}{2}(y_t - y^*)^2 \tag{3.1}$$

where the weight on output stabilisation $\chi > 0$ and $y^* > 0$, so that the desired level of output, y^*, is above the natural level. The target level of inflation is given by $\pi^* > 0$.

In the optimal contract, the transfer T is chosen so that the inflationary bias disappears. The transfer will typically be of the form:

$$T_t = C - \chi y^* \pi_t \tag{3.2}$$

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where C is a constant, needed to meet the central banker's participation constraint. Abstracting from the constant, the central bankers loss function is:

$$I_t = \frac{1}{2}(\pi_t - \pi^*)^2 + \frac{\chi}{2}(y_t - y^*)^2 + \chi y^* \pi_t \qquad (3.3)$$

The central banker will set the following (optimal) policy rule:

$$\pi_t = \pi^* - \frac{\chi}{1+\chi}\mu_t \qquad (3.4)$$

where and μ_t is the productivity shock with mean zero and variance σ_μ^2 introduced in eq. (2.2). The expected inflation is $\pi^e = \pi^*$ and output is given by:

$$y_t = \frac{1}{1+\chi}\mu_t \qquad (3.5)$$

As pointed out by McCallum (1995), the problem with this result is that the government has no incentive to enforce the contract when inflation is high. The government will still try to induce the central bank to be more expansionary when unemployment is high, e.g. by giving rewards to the central bank when it accommodates.

When the Lucas supply curve (eq. 2.2) is extended to *allow for output persistence*, the supply function changes to:

$$y_t = \rho y_{t-1} + \pi_t - \pi^e + \mu_t \qquad (3.6)$$

where ρ is the persistence parameter ($0 < \rho < 1$). We also generalise the social loss function (3.1) to

$$V = E_0\left[\sum_{t=1}^{\infty} \beta^{t-1} I_t\right] \qquad (3.7)$$

where E_0 denotes expectations at $t=0$ and β is the discount rate.

Under discretion, the following expression for the inflation can be derived:

$$\pi_t = \pi^* + \frac{\chi y^*}{1 - \beta\rho - \beta\hat{c}} - \hat{c} y_{t-1} - \frac{\chi + \beta\hat{c}^2}{1 + \chi - \beta\rho^2 + \beta\hat{c}^2}\mu_t \qquad (3.8)$$

where $\hat{c} = \frac{1}{2\beta\rho}\left[1 - \beta\rho^2 - \sqrt{(1-\beta\rho^2)^2 - 4\chi\beta\rho^2}\right] > 0$.

The inflationary bias in eq. (3.8) depends on past output and is therefore state-dependent. The

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average inflationary bias is $\dfrac{\chi y^*}{1-\beta\rho-\beta\hat{c}}$, which is larger than in the case without output persistence.

Also, the response to supply shocks, as in the last term of eq. (3.8), is larger than in case of the

optimal rule. In the optimal rule, the response to the supply shock is given by $\dfrac{\chi}{1+\chi-\beta\rho^2}\mu_t$.

When the central banker's loss function is changed in the way Walsh proposes, by adding a cost

term that is linear in inflation, we get the following:

$$V^b = E_0\left[\sum_{t=1}^{\infty}\beta^{t-1}I^b_t\right] \tag{3.9}$$

with

$$I^b_t = \frac{1}{2}(\pi_t-\pi^*)^2 + \frac{\chi}{2}(y_t-y^*)^2 + \frac{\chi y^*}{1-\beta\rho-\beta\hat{c}}\pi_t \tag{3.10}$$

This constant linear inflation contract eliminates the average inflationary bias, but not the state-

contingent part of it and the response to supply shocks remains stronger than optimal. The state-

contingent part of the inflationary bias can be eliminated when we allow for state contingent

linear inflation contracts (dependent on past output). Then, we can achieve the first best

solution.

Yet another way to achieve the first best solution, is suggested by Svensson (1997a). In his model,

an *explicit inflation target* is assigned to the central banker that may differ from the socially optimal

inflation target. In the simple set-up used here, an inflation target of $\pi^*-\chi y^*$ (which offsets the

inflationary bias in the discretionary model) for the central banker will do the trick and gives the

same results as Walsh's model. The central bank's loss function changes to:

$$I_t = \frac{1}{2}(\pi_t-\pi^b)^2 + \frac{\chi}{2}(y_t-y^*)^2 \tag{3.3'}$$

where the central bank's inflation target $\pi^b=\pi^*-\chi y^*$.

The first order conditions are identical for both Walsh's and Svensson's model. Both add the

same constant marginal cost of inflation to the central banker's loss function.

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In the case with output persistence – i.e. eq. (3.6') – assigning an explicit inflation target to the central banker gives the same result as in the Walsh model with a constant linear inflation contract. However, a state-contingent inflation target for the central banker does not immediately yield the first best solution. The inflationary bias can be eliminated, but the response to the supply shock stays the same as in the model with the constant inflation target. So the response to supply shocks is too strong. This can be eliminated by choosing a conservative banker à la Rogoff. Then the first best solution can also be reached with a state-contingent inflation target.

Walsh (1995) and Svensson (1997a) assume that both the political principal and the private sector know the central banker's preferences. This assumption has been abandoned in some recent contributions. Herrendorf and Lockwood (1997) demonstrate that if a monopolistic trade union has more *information about productivity shocks* than the principal, maximum social welfare can be achieved by having a conservative central banker with perverse preferences on top of the contract. So, notwithstanding an optimal contract, Rogoff's conservative central banker is restored.

Beetsma and Jensen (1998), Schaling et al. (1998), Muscatelli (1998a,b) and Eijffinger et al. (1999) assume that monetary policy is delegated to a central bank with *uncertain preferences*. They show that if the private sector and the political principal have imperfect information about the central banker's preferences, the equivalence between the linear Walsh contract and the Svensson inflation target breaks down. Beetsma and Jensen and Eijffinger et al. (1999) conclude that in presence of uncertain preferences a linear incentive contract in the sense of Walsh (1995) performs better in terms of social welfare than an explicit inflation target as proposed by Svensson (1997a). The reason is that, although both approaches can get rid of the inflationary bias, the impact of uncertain preferences on the variance of inflation will be considerably higher with an inflation contract.

Still, there are some important differences between these papers. E.g., in the model of Beetsma and Jensen (1998) private sector inflation expectations are invariant to preference uncertainty. Schaling et al. (1998) investigate the effects of relaxing this assumption. In contrast to Beetsma and Jensen (1998), who conclude that the optimal inflation target does not depend on the degree of preference

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uncertainty, Schaling et al. find that the optimal inflation target in that case depends on the degree of uncertainty about the central bank's preferences. For a Walsh-type contract the conclusions also differ. Whereas Beetsma and Jensen (1998) conclude that the optimal linear contract depends on the degree of preference uncertainty, Schaling et al. (1998) find that this is not the case.

Muscatelli (1998a,b) argues that allowing for uncertain preferences of the central bank leads to the conclusion that delegation of monetary policy may not always be optimal. A no-delegation solution might be optimal, depending on the degree of consensus that exists in society about the relative costs and benefits of inflation and output stabilisation. In case of a low degree of consensus, the potential distortions from uncertain central bank preferences are such that delegation will not be desirable at all.

4. Endogenising the Inflationary Bias

Recent research has focused on the inflationary bias in the standard model. The bias is usually viewed as stemming from market failures or distortionary taxation that decrease output below its efficient level. Since these inefficiencies are exogenous to monetary policy, they pose a temptation to raise inflation above its optimum rate to boost real activity. An obvious point is that monetary policy is never a first best policy instrument to tackle, for instance, price rigidities in the labour market caused by trade unions or excessive regulation. But it is less clear how these inefficiencies might interact with monetary policy.

As an example, consider *labour market regulation*. This topic is usually discussed in connection with Economic and Monetary Union in Europe (EMU): will monetary union increase or decrease the incentives of participants and possible entrants to deregulate their labour markets, and how will this influence monetary policy?

There are two views. The pessimistic view rests mainly on an externality. Assume that policy-makers decide on labour market deregulation before monetary policy is implemented. If deregulation is politically costly, the incentives to reform depend, among other things, on their

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effect on the inflationary bias.[3] A more efficient labour market will reduce equilibrium inflation and thus make regulatory reform more attractive to policy-makers. The smaller the positive externalities that accrue and the less conservative the central bank, the stronger is the effect. EMU might have a negative impact on the willingness to deregulate on both accounts. First, all members benefit from national labour market reform but only the reforming country bears the political cost associated with it (Calmfors 1998a, 1998b; Berthold and Fehn, 1998). Second, since most countries have seen the level of central bank conservatism raised by delegating monetary policy to the European Central Bank (ECB), the gain in credibility provided by EMU makes structural reform to lower the inflationary bias less attractive (Ozkan et al., 1998). Since the only way to internalise the positive externalities of structural labour market reforms under EMU is centralisation, the policy recommendation would be to make regulatory policy the prerogative of the federal European level.

But there might also be reason to assume that labour market reform and the advent of EMU are positively correlated. One argument points out that deregulation might not only reduce the inflationary bias but also increase wage flexibility. To the extent that countries suffer from strong and uncorrelated idiosyncratic shocks, the loss of the exchange rate instrument within EMU might actually foster labour market reform with regard to wage flexibility (Sibert and Sutherland, 1998). This argument rests critically on the assumption that the political costs of such reforms do not increase with the introduction of the euro. Whether this is a valid simplification is hard to tell in the absence of a general theory of how labour market institutions evolve.[4]

A second argument put forward by Sibert (1999) rests upon the idea that EMU might change the incentives to deregulate if governments engaged in policy co-ordination before monetary union. Consider a model in which at stage 1 governments decide on the amount of costly labour market deregulation before they, at stage 2, determine monetary policy. All decisions are decentralised and implemented on a national level. But monetary policy has negative externalities, as higher inflation works as a beggar-thy-neighbour policy, thus helping to transfer jobs to the home economy. Clearly, there is an incentive to co-ordinate monetary policy even in the absence of monetary union. If binding contracts can be formed, countries with a relatively high inflationary bias, i.e. highly

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regulated labour markets, will receive side-payments to abstain from over-expansionary monetary policies. This, however, produces an incentive for governments to strategically under-invest in labour market reform to extract larger subsidies. This incentive disappears under EMU simply because monetary policy is no longer conducted at a national level. In that sense, centralised monetary policy-making might actually lead to more labour market deregulation.

Another extension looks at the role of *trade unions*. The idea of incorporating union behaviour in the standard monetary policy model is, again, to endogenise the inflationary bias. Consider a single monopoly union that, given its expectations about the price level determined by the central bank, sets the nominal wage. The union aims at a real wage that maximises its members' rents, but which creates unemployment and, thus, an incentive for surprise inflation. Since the union rationally anticipates the central bank's behaviour, the equilibrium will be characterised by an inflationary bias and less than full-employment. Alternatively, one could argue that the inflationary bias is due to the lobbying activities of outsiders which pressure monetary policy to increase employment by surprise inflation (Piga, 1998). However, since unionised insiders have rational expectations, this pressure only increases nominal wages and, thus, equilibrium inflation. While here the mechanism that produces the inflationary bias is strictly political, the basic reason is still trade union power and the bias would disappear in a competitive labour market.[5] In fact, if the story ended here, not much would have been gained beyond Kydland and Prescott's (1977) basic reasoning.

What distinguishes the recent literature from this basic model is that it introduces inflation aversion into the union's preference set on top of a high real wage (see, for example, Cubitt 1992, 1995; Agell and Ysander, 1993; Gylfason and Lindbeck, 1994; Al-Nowaihi and Levine, 1994).[6] The reason usually given for this additional target variable is consistency: a monopoly union encompasses most of society, which in its majority is inflation-averse, at least according to the standard model of monetary policy. While the assumption seems reasonable in models with a single union, it is also used in models with multiple smaller unions (see, for example, Cukierman and Lippi, 1999; Grüner and Hefeker, 1998; Velasco and Guzzo, 1999). In this case the assumption

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looks slightly less innocuous, since the degree of inflation-aversion might vary widely across branches or crafts and some unions might simply be insensitive to the costs of rising prices.[7]

The effect of introducing inflation aversion into a union's welfare function is quite dramatic. Since wage setters dislike inflation, they will moderate their effective real wage claims, in order to reduce the central bank's incentive for surprise inflation. In short, inflation-averse unions will make real variables in equilibrium a function of the institutional set-up like the degree of central bank conservatism given a certain degree of independence. The more conservative the central bank, the lower output will be and the higher the level of unemployment in equilibrium. In that sense, monetary policy has real effects in these models. To illustrate, let us consider a simple model in which, at the first stage, a single monopoly union sets nominal wages before, at the second stage, the central bank chooses inflation.[8] We will solve the model backwards. At the second stage, the central bank chooses inflation to minimise its per period loss function. The loss function resembles eq. (2.1) but for the suppressed time indices:

$$L^{CB} = \frac{1}{2}\pi^2 + \frac{\chi}{2}(y - y^*)^2, \tag{4.1}$$

where χ is a positive constant, y is output, y^* is the central bank's output target and π the rate of inflation defined as the difference between the present period's and the last period's price level ($p - p_{-1}$). Small letters indicate logs. In a standard right-to-manage model (cf. Nickel and Andrews, 1983), output will be a function of the nominal wage w set by the union and the price level. The latter is implicitly set by the central bank when choosing inflation, since last period's prices p_{-1} are exogenous. In particular, labour demand will satisfy the condition that the real wage rate $w - p$ is equal to the marginal product of labour l:

$$w - p = \frac{\partial y}{\partial l}. \tag{4.2}$$

From eq. (4.2) output can be derived in general form as:

$$y = \tilde{y} + \theta(p - w) \tag{4.3}$$

where, for instance in case of a Cobb-Douglas production function, $\tilde{y}, \theta > 0$ are constants.[9]

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Without loss of generality, we set $\theta = 1$. Define the actual real wage rate as $w_r = w - p$. In addition, let w_r^* be the real wage rate prevailing under a perfectly competitive labour market and y^* the implied full-employment output level that is also the central bank's output target. Then we can conveniently rewrite eq. (4.1) as:

$$L^{CB} = \frac{1}{2}\pi^2 + \frac{\chi}{2}(w_r^* - w + \pi + p_{-1})^2. \tag{4.1'}$$

From eq. (4.1') we can derive the central bank's reaction function as:

$$\pi = \frac{\chi}{1+\chi}\left(w_r + \pi^e - w_r^*\right) \tag{4.4}$$

where we have made use of the fact that $w = w_r + p^e$. Under rational expectations $\pi = \pi^e$. Therefore, equilibrium inflation will be a positive function of the real wage premium ($w_r - w_r^*$), i.e. the difference between the actual real wage stemming from the union-controlled labour market and the real wage securing full-employment, and the central bank's degree of conservatism:

$$\pi = \chi\left(w_r - w_r^*\right) \tag{4.5}$$

The union takes the central bank's reaction function into account when it sets the nominal wage rate at the first stage of the game. The union is assumed to choose wages so as to minimise a per period loss function of the form:

$$L^U = E\left(-2(w - p) + \rho(y - y^*)^2 + \psi \pi^2\right)$$

$$\tag{4.6}$$

where $\rho, \psi \geq 0$ are parameters and E is the expectations operator. The weight given to the real wage argument is a technical convenience. The union's welfare is rising in real wages and decreasing in deviations from output (or, equivalently, employment) from its first best level (or from full-employment). In addition, if $\psi > 0$, the union dislikes inflation. Since the union is effectively choosing both the nominal wage rate and, via eq. (4.4), prices, it is convenient to express its behaviour in terms of the real wage premium. Taking the derivative of eq. (4.6),

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using eq. (4.5) and rearranging, yields the equilibrium real wage premium:

$$w_r - w_r^* = \frac{1}{\rho + \psi \chi^2}$$ (4.7)

The premium also determines inflation and output. Substituting eq. (4.7) into eq. (4.5) we learn that inflation is:

$$\pi = \frac{\chi}{\rho + \psi \chi^2}$$ (4.8)

and, since eq. (4.3) implies that $y - y^* = w_r^* - w_r$, equilibrium output can be written as:

$$y = y^* - \frac{1}{\rho + \psi \chi^2}$$ (4.9)

Quite intuitively, the real wage premium and inflation are decreasing and output is increasing in the union's preference for output (or employment) (ρ). But the more interesting result is that central bank conservatism has negative real effects if (and only if) the union is inflation-averse. Clearly, if $\psi > 0$ a decrease in χ decreases the real wage premium demanded by the union and, as a consequence, increases output. In other words, central bank conservatism ceases to be a free lunch even when we abstract from stabilisation policy. Behind this is the fact that, as already pointed out by Cubitt (1992), the union's incentive to internalise the inflationary consequences of an excessively high real wage will be lower, the more inflation-averse the central bank itself is. If, however, the union is indifferent towards inflation ($\psi = 0$), we are back to the standard model as discussed in Section 2, where the real side of the economy is independent of central bank characteristics.

Interestingly, the model also qualifies the conventional wisdom that inflation is decreasing in conservatism. With an inflation-averse monopoly union, this result only holds as long as the level of conservatism is already sufficiently high. In fact, inflation is hump-shaped in central bank conservatism. A higher degree of conservatism (a lower χ) first increases and then decreases inflation. It is only after the level of conservatism exceeds a certain threshold

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($\chi < \sqrt{\rho/\psi}$) that the standard results reappears. The threshold increases with the union's preference for reaching its output goal and decreases in its inflation aversion. The reason for this is that an increase in central bank conservatism has a two-sided effect on monetary policy. On the one hand, it increases the real wage premium and lowers output, which gives the central bank a greater incentive for an expansionary policy (see above). Ultimately, this leads to higher inflation (see the squared χ-term in the denominator of eq. (4.7)). On the other hand, a more conservative central bank finds inflation more costly, which lowers the incentive to increase inflation (see the χ-term in the nominator of eq. (4.7)). Obviously, the latter effect will dominate only at lower levels of χ, i.e. at higher levels of conservatism.[10]

An interesting, albeit somewhat counterintuitive, consequence of these results is that they reverse the normative implications of the Rogoff (1985) and Barro and Gordon (1983) models. If the union is inflation-averse, only a highly non-conservative central bank can achieve the first best solution. Behind this is the fact that the real wage premium diminishes (and equilibrium output increases) as the union reacts to the central bank's growing willingness to inflate the economy (see above). While inflation will initially increase for lower degrees of central bank conservatism, it will eventually decrease simply because even a highly liberal central bank loses its interest in surprise inflation if output approaches its full-employment equivalent. Consequently, an infinitely liberal central bank can ensure zero inflation and full-employment. This is the case for a "radical-populist" or "ultra-liberal" central banker relative to society made by Skott (1997), Cukierman and Lippi (1999) and Guzzo and Velasco (1999) that runs opposite to Rogoff's (1985) advice to appoint a conservative central banker. As Velasco and Guzzo (1999, p.1320) note, the result can be interpreted as a typical example of the theory of the second best: "Introducing a second distortion (opportunistic central bank behaviour) into an economy already distorted by monopolistic behaviour in the labour market can be welfare improving."

Endogenising the inflationary bias also allows a closer look at the interaction between central bank

conservatism and the organisation of the labour market beyond the simple monopoly union model. The terminology in the literature with regard to labour market organisation is sometimes confusing. Most of the economic literature follows Calmfors and Driffill (1988) in characterising labour markets with respect to the level of effective *centralised wage bargaining* (CWB). CWB is high if the number of unions that actually participate in wage setting is low. In the political science literature the term *co-ordinated wage bargaining* is often used, meaning the extent of consensus between the participating unions (cf. Soskice, 1990). From a theoretical perspective both definitions are quite similar, as a high degree of CWB encompasses binding wage negotiations on an aggregated level as well as other effective means of co-ordinating wage negotiations across the labour market, such as reliable bargaining patterns or co-operation among unions.[11] The differences between both concepts are somewhat more important in empirical work because of measurement problems with regard to effective centralisation and co-ordination (see below).

The complication associated with the introduction of a central bank in a standard CWB model is that the monetary authority sets prices instead of the unions. This makes it hard to preserve the hump-shaped relation between unemployment and CWB as suggested by Calmfors and Driffill (1988).[12] The hump shape originates from two opposing effects within a standard wage bargaining or right-to-manage model. On the one hand, an increase in the degree of CWB decreases labour market competition, raises wage claims and, ultimately, unemployment, as the bargaining position of unions improves.[13] On the other hand, the ability of firms to partially externalise the costs of higher wages by increasing the bargaining sector's relative product price (and, thus, the overall price level) is much higher at lower levels of centralisation in the above-defined sense. This will increase their resistance to wage demands as the degree of CWB increases. The introduction of a price-setting central bank in the model effectively voids this moderating effect of higher degrees of CWB, because it robs firms of the possibility to externalise wage costs no matter what the level of centralised bargaining.

Cukierman and Lippi (1999) succeed though in resurrecting the hump-shaped relation between unemployment and CWB by introducing inflation aversion into the unions' target function. The

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unions' inflation aversion ensures that an increase in the degree of CWB also raises the extent to which the unions internalise the inflationary consequences of higher wage demands. A complementary feature of their model is that they – somewhat unrealistically – assume that unions are organised horizontally along professions (craft unions). The assumption ensures that a union's wage increase will never result in relative product price changes. As a consequence, the moderating effect of higher degrees of CWB present in Calmfors and Driffill (1988) does not exist and there is no conflict with the central bank setting the price level. Otherwise the model follows Calmfors and Driffill (1988) in assuming that the elasticity of labour demand is close to zero for high degrees of CWB and approaching infinity for very small degrees. As a consequence, the unbounded strengthening of the competition effect is likely to compensate the lack of internalisation at low degrees of CWB and, similarly, the fading of competition helps to ensure that the internalisation effect dominates at high degrees of CWB. This is what drives the hump shape of the CWB-unemployment relation.

The Cukierman and Lippi (1999) analysis suggests that changes in the degree of central bank conservatism will shift the hump-shaped curve. For instance, a more conservative monetary policy will simultaneously raise the curve's maximum and shift it to the right. The reason is that, as already discussed, the central bank's decreased tolerance for inflation will dampen the inflationary effects of a wage increase. This will motivate unions to increase their wage demands and ultimately unemployment at any level of CWB. The latter prediction is in line with the monopoly union model discussed earlier, which can be interpreted as a special case of the Cukierman and Lippi (1999) model. Not surprisingly, the interaction between central bank conservatism and inflation is less clear. The CWB-inflation curve is also hump-shaped, but an increase in central bank conservatism will only shift it sideways to the right. Consequently, the model predicts the conventional decrease of inflation only for lower levels of CWB. As already suggested by the monopoly union model, at higher levels of centralisation the direction of the effect depends, among other things, on the prevailing degree of central bank conservatism and the unions' inflation aversion.

Guzzo and Velasco (1999) also introduce inflation aversion into a set-up that combines a CWB

model with unions organising different types of labour and a price-setting central bank. But in their model the unions supply work to a single representative firm that trades off different kinds of labour when maximising profits under a CES production function. The assumption of a constant elasticity of substitution across types of labour turns out to be crucial for the net-effect of CWB on unemployment. In contrast to the previously discussed set-up, the elasticity of labour demand is now bound by the CES production function for low degrees of CWB.

Consider, first, the consequences of a decrease of CWB at an already low level of centralisation. If labour demand remains rather inelastic, the increase in competition might not be able to compensate for the lack of internalisation of the inflationary consequences of wage demands. In this case, the overall impact of a decreasing degree of CWB on unemployment may well be positive instead of negative as in the Cukierman and Lippi (1999) model. Turning to high degrees of CWB, the opposite might be true. Since the elasticity of labour demand is never reduced to zero, the loss in competition induced by a further increase in centralisation could be severe enough to overcompensate the internalisation effect. In fact, if the elasticity is sufficiently large, unemployment is increasing in CWB at high levels of CWB. In other words, the Guzzo and Velasco (1999) model predicts a u-shaped instead of a hump-shaped relation between CWB and unemployment.[14]

Unfortunately, Guzzo and Velasco (1999) have to rely on simulations to describe the effects of varying degrees of central bank conservatism on the CWB-unemployment relation in their model. Their numerical exercises suggest that the non-monotonicity of the relation tends to be more severe at higher degrees of conservatism. Moreover, unemployment seems to decrease at any CWB-level as the bank becomes less concerned with inflation. The intuition behind both claims is similar to the monopoly union and the Cukierman and Lippi (1999) model: unemployment approaches its first best as the central bank becomes ultra-liberal. Since this is true no matter what the degree of CWB, the unemployment-CWB relation should have less of a u-shape as the central bank becomes less conservative. Again, the interaction between central bank conservatism and inflation tends to be non-monotonic. The conventional result that inflation decreases in conservatism only applies to

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already sufficiently conservative central banks.

Another set of papers that aims at integrating central bank and CWB models comes from the political science literature. Franzese (1999b), Hall and Franzese (1998), and Franzese and Hall (1999) argue that the centralisation (or, equivalently, co-ordination) of wage bargaining influences the ability of the central bank to *signal* its intentions to the public.[15] The more centralised the bargaining process, so the argument goes, the more responsive wage setters will be to signals from the monetary authority and the less likely it is that the central bank has to resort to policies that raise the level of real activity and, thus, unemployment. In other words, the real costs of anti-inflationary policies are thought to be unambiguously declining in the degree of CWB. In addition, the model predicts an unambiguously negative impact of central bank conservatism on inflation.

But not all sectors in the economy may be alike.[16] For instance, there will be differences in the way wage bargaining in *traded and public sectors* will react to tighter monetary policy (Franzese, 1999c). Since the former is much more sensitive than the latter to the demand and exchange rate effects of higher interest rates, a high ratio of trade to public sector employment will lower the real costs associated with a more conservative central bank. Moreover, unions might be interested not only in absolute but also in *relative real wages* (Iversen 1998a, 1998b). Monetary policy might have real effects in such a model, since a less conservative central bank will allow for higher inflation and, thus, lower real wage disparity.

5. Empirical evidence

In quite a number of recent studies the summary of the empirical evidence on the consequences of CBI of Cukierman (1994) – as referred to in the Introduction of the present paper – has been challenged on various grounds (see table 1 for a summary).[17] First, the reliability and usefulness of CBI indicators has been questioned. Second, the issue of causality has been raised. Third, the robustness of previous studies has been questioned on various grounds, including sensitivity for

estimation period, lack of control variables, employed methodology and lack of a proper check on influential observations. In this section we discuss these criticisms in turn before we draw attention to the issue of credibility. Finally, we review empirical evidence on models as discussed in Section 4.

5.1 Reliability and Relevance of CBI indicators

The scores of an indicator for legal CBI depend on:

1. the criteria contained in the index;

2. the interpretation and evaluation of the law with regard to these criteria;

3. the way in which the criteria are aggregated.

Various authors have pointed out that existing indicators of CBI differ substantially in these respects. Mangano (1998) compares the Grilli-Masciandaro-Tabellini (GMT) index and the Cukierman index (LVAU) and concludes that 40% of the criteria in the first are not regarded as relevant in the second (vice versa the level is 45%). There are also enormous interpretation differences: according to Mangano (1998) virtually a third of the values attributed to the nine common criteria in both indicators are subject to interpretation differences. This conclusion is, however, severely affected by the normalisation procedure followed by Mangano. Take, for instance, the criterion whether CB lending to the government is allowed. Austria gets a score of 1 by GMT (1 if temporary, 0 otherwise) and 0.67 by Cukierman (borrowing limited to 12 months). Despite similar scores, Mangano (1998) argues that there exists an interpretation difference. Furthermore, the criteria are sometimes different in a very subtle sense which makes it sometimes almost impossible to compare them. Take, for instance, the criterion relating to CB activities with respect to government debt. Cukierman asks whether the CB is allowed to deal in the primary government debt market, whereas GMT ask whether the CB is active in this market. Both are, of course, not the same. For instance, the Dutch central bank was not prohibited to deal at the primary government debt market (LVAU score 0), but was not active on this market in the 1980s (GMT score 1).

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The choice of the criteria is quite crucial and most indicators have been criticised in this regard. For instance, Neumann (1996) argues that from the fifteen aspects of the Grilli-Masciandaro-Tabellini index at least seven are "misleading" or not relevant.[18] At a more fundamental level, Forder (1999, p. 28) argues "what are the criteria for a good measure? It cannot be 'one which gives a relation with inflation' since that makes the hypothesis unfalsifiable..... What we are lacking is an objective reason to prefer one [measure] over the other. Without this, there can be no test of the independence hypothesis." Although Forder has a point, we would not conclude that legal indicators are useless. As follows from the analysis in Section 2, independence is a theoretical concept, which is defined on the basis of the unobservable concept of the loss functions of government and the central bank.[19] Legal indicators for CBI proxy the degree to which government is legally restricted in pushing the central bank in a certain direction.[20] However, they are noisy indicators and analyses of CBI should therefore not focus solely on one indicator as many studies do (see table 1).

So, how different are the results when various indicators for CBI are taken up? Fuhrer (1997) stresses that the significance of the results reported by Alesina and Summers (1993) – who use a combined Alesina-GMT index – is lower if Cukierman's LVAW index is employed. Oakley (1999) finds that of the eight indices tested, only three yielded statistically significant and correctly signed coefficients in both estimation methods used. However, one of Oakley's indicators is Cukierman's TOR, which has never been found to be significant for OECD countries.

In their systematic study Eijffinger et al. (1997) analyse the sensitivity of the findings for 20 countries using various indices for two sample periods (1987-82 and 1983-93). The inverse relationship between CBI and inflation is confirmed for all indices, but this relationship is much more significant in the first than in the second subperiod. This is probably caused by the fact that monetary policy became more endogenous in the second period in the EMS countries (see below for a further discussion about sample period sensitivity).

So although much evidence points in the same direction, Forder (1999, p. 29) argues that "apparently mutually confirming studies are more in the nature of mutually contradictory: the empirical nature of the 'independence' that one finds to be a determinant of inflation is quite

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different, so they should really be thought of as tests of different hypotheses." This conclusion is, again, to farfetched. Although the various legal indicators vary to some degree (see also Eijffinger and De Haan, 1996), they are not so different as Forder suggests.[21] Part of the differences between the indicators is not due to divergent definitions of legal independence, but to diverging interpretations of national central bank laws.

The very first legal index for CBI has been developed by Bade and Parkin in a paper that was never published. Forder (1998b) points out that the original version of the Bade-Parkin index of CBI differs substantially from the one as used by Alesina in constructing his index. In subsequent work by Emerson et al. (1992) in which this index is also used some additional mistakes are made. Forder argues that "When these mistakes are corrected that relationship [between CBI and inflation] dissolves" (p. 54). However, De Haan (1999) argues that this conclusion is not correct. Starting with the very first version of the Bade-Parkin index and going via the second version of it and the Alesina version to the index used by Emerson et al. (1992), he shows that in all regressions the coefficient for the legal indicator of CBI is significantly different from zero, despite the sometimes large differences in the indices used.

Forder (1996, 43-44) put forward a far more serious objection towards the use of legal indicators for CBI, arguing that "a central bank may be independent by statute, and it is nevertheless accepted – on all sides – that the government will have its wishes implemented. .....it is quite clear that the reading of statutes is not a measure of independence in the sense required by the theory .... There is no theory that says it matters what the rules say. There is only a theory that says it matters what the behaviour is."[22] Of course, one could conjecture that regulations concerning the position of the central bank may (at least partially) shape the options for the central bank to pursue the kind of policies that it deems necessary. Still, as pointed out above, existing indices of central bank independence are often incomplete and noisy indicators of actual independence. E.g., laws cannot specify explicitly the limits of authority between central banks and the political authorities under all contingencies. And even when the laws are quite explicit, actual practice may deviate from them. However, this does not mean that legal indicators are uninformative. But it does imply that their use

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should be supplemented by judgement in light of the problem under consideration. Cukierman (1992) argues that some indices are more appropriate for some purposes than for others. For instance, legal independence measures may be a better proxy for actual independence in industrial countries than in developing countries. Cukierman (1992) and Cukierman et al. (1992) therefore developed a yardstick for central bank autonomy which is not based on regulation but on the actual average term of office of central bank governors in different countries during the period 1950-1989. This indicator is based on the presumption that, at least above some threshold, a higher turnover of central bank governors indicates a lower level of independence. Until recently, the TOR of Cukierman was the only one available. However, recently De Haan and Kooi (1999) came up with a new data set which is almost double the size of that of Cukierman in terms of the number of developing countries included.

5.2. Causality

The correlation between inflation and CBI could be explained by a third factor, e.g. the culture and tradition of monetary stability in a country. Indeed, Posen (1993, 1995) challenges the conventional view on this grounds arguing that the strength of the opposition of the financial sector against inflation both determines the degree of central bank independence and the level of inflation. According to Posen monetary policy is driven by a coalition of political interests in society, because a central bank will be prepared to take a strong anti-inflation line only when there is a coalition of interests politically capable to sustain such a policy stance. In industrial countries, the financial sector represents such a coalition. De Haan and Van 't Hag (1995) have criticised Posen's empirical results for OECD countries. Posen's view is only confirmed if Cukierman's legal indicator is used. There is less support if alternative indicators are employed.

For a larger sample of countries, Posen (1995) also finds that CBI does not help explain inflation if his measure of Effective Opposition towards Inflation (FOI) is included as explanatory variable. FOI consists of various elements which are supposed to indicate the effectiveness of opposition of the financial sector towards inflation. If we take Cukierman's view on the usefulness of legal

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indicators of CBI for developing countries serious, a problem with Posen's result is that Cukierman's legal index is also employed for the developing countries in his sample. De Haan and Kooi (1999) use the TOR of central bank governors for the developing countries in their sample instead and find that the coefficient of this variable remains significant even after the FOI variable is included as explanatory variable. The results of Campillo and Miron (1997) and Temple (1998) – who, like Posen (1995), employ legal indicators for CBI – also do not support Posen's (1995) view that the strength of financial sector opposition towards inflation is an important factor in explaining cross country inflation differentials.[23] Finally, Franzese (1999b) finds that CBI affects inflation, even controlling for financial-sector strength, which is proxied by the financial sector's share in total employment.

Hayo (1998) argues that people's preferences with respect to price stability matter. Differences in public perception explain inflation differentials in this view, and CBI is a reflection of this. Without public support – which itself is determined by the policies of the central bank – CBI alone will not be sufficient to reduce inflation. Using public opinion polls from 1976 to 1993 in nine EU countries, Hayo shows that in countries where the population reacts rather sensitively to an increase in the inflation rate have more stable prices. These sensitivity estimates are more highly correlated with inflation than with CBI indices. Berger (1997) and Berger and de Haan (1999) in their case studies of conflicts over monetary policy in Germany also stress the importance of public opinion for the Bundesbank's successful policy stance against inflation.

A very interesting analysis of the impact of the change of the legal position of the Bank of England on May 6, 1997, giving the bank 'instrument independence', has been done by Spiegel (1998). Comparing yields on nominal and index bonds, Spiegel finds that expected average inflation drops 60 basis points over the life time of the bond in a two-week event window. As it unlikely that other factors, such as financial market opposition to inflation or the attitude of the British public, changed markedly over the window, this 'natural experiment' therefore clearly suggests that institutional changes affect inflationary expectations.

In the studies by Posen (1995), Moser (1999) and Hayo (1998) the degree of CBI is endogenous. Only a few other studies have recently been published on the determinants of CBI. According to Maxfield (1997) politicians use central bank independence to signal their nation's creditworthiness to potential foreign investors. Maxfield argues that the likelihood that governments will use central bank independence to try to signal creditworthiness is greater (1) the greater the expected effectiveness of signalling; (2) the larger the country's financial needs; (3) the more secure politicians' tenure is; and (4) the fewer restrictions the country has on international financial transactions. Some studies report some evidence which (partially) supports this view. Bagheri and Habibi (1998) find that CBI is positively correlated with political freedom and political stability. Similarly, Clark (1998) finds some evidence that regime shifts (including coups) lead to less CBI. Crosby (1998) argues that countries which are more likely to have lower output variability are more likely to have an independent central bank. However, only for the industrial countries the variance in the terms of trade (i.e. the proxy for real shocks) is significantly related with CBI.

5.3 Robustness

Various authors have pointed out that the *results* for the relationship between inflation and CBI may *differ* across various *estimation periods*.[24] This finding may not be as serious as it may seem at first glance. For one thing, one would expect different results under fixed and under floating exchange rate regimes. Under the Bretton Woods system of fixed exchange rates, countries were committed to an exchange rate target and had little room to conduct an autonomous domestic monetary policy. Thus, the relation between central bank independence and inflation is likely to be much less straightforward before 1973. Various authors indeed report evidence in support of this reasoning (see e.g. Walsh, 1997).[25] This argument may explain why the relationship between CBI and inflation may not be stable over time. Indeed, Jonsson (1995) concludes that CBI has the strongest impact on inflation under floating exchange rates. However, CBI also matters under fixed exchange rates (see also Walsh, 1997).

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As already pointed out by Giavazzi and Pagano (1988), fixed exchange rates may alleviate the credibility problem of monetary policy. Although Giavazzi and Pagano do not analyse this issue in these terms, the choice for an independent central bank or a fixed exchange rate regime boils down to balancing the costs and benefits of both options.[26] An explicit analysis of this trade-off is provided by Berger et al. (1998). They show that the choice of the exchange rate regime crucially depends on the stochastic nature of the economies involved. For instance, a highly volatile economy in the potential target country is often interpreted as implicating the need for an independent monetary policy at home. But things change if the correlation between shocks at home and in the target economy is sufficiently negative. In this case, a currency peg might actually help to perfectly stabilise the pegging country's economy. Of course, the exchange rate regime choice, in addition, also depends on a number of structural parameters such as openness, market integration, the flexibility of the home economy's labour market and, of course, on the relative conservatism and independence of the central banks at home and in the possible target country.

Some studies also find differences across periods which are not related to the exchange rate regime. Fujiki (1996), for instance, finds in his cross country regressions that in the period 1980-89 there is no significant relationship between the Alesina-Summers index and inflation.

Unfortunately, most of the earlier research consisted of simple bivariate regressions which may have yielded biased conclusions. As pointed out above, the exchange rate regime may be one of the *control variables* which should be taken into account. Apart from other control variables, Jonsson (1995) takes dummies up for the Bretton Woods period and EMS membership. He concludes that CBI has the strongest impact on inflation under floating exchange rates.

A number of other recent studies for industrialised countries also included control variables in their inflation regressions. These include Fujiki (1996), Jenkins (1996), Walsh (1997), Fuhrer (1997), Hall and Franzese (1998), Franzese (1999b,c) and Oakley (1999).[27] The most extreme conclusion is reached by Fuhrer (1997), who argues that "in general, the benefits imputed to CBI are evident only in the simplest bivariate cross-country regressions" (p. 34). There are, however, various

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reasons to question this conclusion. First, the study of Fuhrer (1997) can be criticised on various grounds (see below).[28] Second, in most of the other studies in which control variables are taken up the coefficient of the indicator for CBI remains significant. For instance, in his cross-country, pooled and fixed-effects models, Walsh (1997) includes openness, the natural rate of unemployment, the government budget deficit and a dummy for the conservativeness of the government. The coefficient of LVAU remains significant, except in the fixed-effects model when lagged inflation and oil prices are added.

In our view the relationship between legal indicators of central bank independence and inflation *in OECD countries* is quite robust, also if various control variables are included. Campillo and Miron (1997) conclude that regulations concerning the position of the central bank play almost no role in determining inflation outcomes in *developing countries*. These authors find that instead openness, political stability and proxies for government policy distortions are robustly related to inflation. Sturm and De Haan (1999), however, have estimated a similar model as Campillo and Miron (1997) and find that once so-called influential observations are removed Cukierman's legal indicator for CBI becomes significant even in their sample of developing countries (see below for further discussion).

The issue of control variables is, of course, also very crucial in estimating growth models to examine whether CBI affects economic growth. As far as we know, only a few studies have examined the impact of CBI on economic growth using some kind of Barro-type growth regression for a large group of countries. The most extensive study is by De Haan and Kooi (1999) who employ both the extreme bound analysis as well as the approach suggested by Sala-i-Martin (1997). It is very interesting that when the TOR index is added to the base regression its coefficient is not significant. However, if some other variables are added as explanatory variables the coefficient of TOR becomes significant at the 5% confidence level. So although it is possible to come up with a regression in which their proxy for CBI is significant, they conclude that there is no robust relationship between CBI and economic growth in their sample of developing countries. This conclusion holds for both the Cukierman TOR and their newly constructed TOR which spans

considerably more countries. This finding is in contrast to the conclusion of Cukierman et al. (1993). Similarly, Ahkand (1998) fails to find a robust relationship between CBI and economic growth, using also legal indicators for CBI.

One criticism that has been raised against the older empirical literature on CBI is the *cross country nature* of the regressions. As the CBI index is derived from central bank legislation it remains (more or less) constant in each country over the sample period. Therefore, the effects attributed to CBI may include the effects of other country-specific factors that have not explicitly been included in the model (Walsh, 1997; Fujiki, 1996). One way to deal with this problem is to use the differences in differences method. Taking the differences of inflation as a means of identifying the effect of CBI assumes that country-specific factors that account for average inflation differences are eliminated. The degree of CBI, by contrast, is assumed to influence the way in which economies react to economic shocks. Walsh (1997) finds that CBI seems to have played a role in which inflation responses to the first oil shock varied across industrialised countries, but the subsequent deflations of the 1980s were not correlated with CBI.

A few recent studies apply panel data or pooled time series (see table 1). Fujiki (1996) concludes that the support for a negative correlation between inflation and CBI is less in the panel data analysis than in the cross-country model. Similarly, Walsh (1997) finds that in his fixed effects model CBI becomes insignificant if lagged inflation and oil prices are added as explanatory variables. In his pooled regression CBI is always significant. Fuhrer (1997) finds that in none of the panel data regressions CBI is related to inflation. A serious problem with this latter study is that it also employs legal indicators for CBI to many developing countries. Furthermore, the author (nor, for that matter, Fujuki (1996) and Walsh (1997)) does not examine whether his results are influenced by outliers. A number of studies suggests that inclusion of high inflation countries seriously affect the relationship between legal indicators for CBI and inflation.

An issue that has received scant attention in the literature so far is *sample homogeneity*. Some

recent studies have found that the conclusions are quite sensitive to the inclusion of high inflation countries. Temple (1998) finds that if high inflation countries are added to his sample of OECD and developing countries, the effect of CBI (proxied by Cukierman's (1992) legal index) on inflation disappears. In sharp contrast, De Haan and Kooi (1999) conclude that in their sample of developing countries CBI (proxied by the TOR) only matters if high inflation countries are taken up in the sample. Sturm and De Haan (1999) employ a formal method developed by Rousseeuw (1984; 1985) to deal with so-called influential observations. They find that once these influential observations are given weight zero, all previous conclusions change. While the TOR becomes insignificant, Cukierman's legal index becomes significant, also if various control variables as suggested by Campillo and Miron (1997) are taken up.

Arguably, transition economies may be so special that they should not be included in a wider sample. Loungani and Sheets (1997) have examined the influence of legal CBI on the inflation rate in 1993 for 12 transition countries. They find a highly negative correlation with the index that measures similarity with the Bundesbank, also after controlling for various other factors.

An issue that has received hardly any attention so far is that the political system of a country may matter: what does CBI mean in a dictatorship? The only study that we are aware of in which the political system is taken up is Bagheri and Habibi (1998) who find that legal CBI is positively correlated with political freedom.

5.4 Credibility and Disinflation Costs

It is often argued that CBI will improve credibility of monetary policy. Indeed, this is what central bankers themselves seem to believe. In a survey under central bankers, Blinder (1999) asked how to build credibility. On a scale from 1 (unimportant) to 5 (of the utmost importance) the answer "granting a central bank independence" received an average score of 4.51, being the second highest score after "a history of honesty" (4.58), but before "a history of fighting inflation" (4.15). As pointed out by Forder (1998a), for CBI to affect credibility four conditions must hold. First,

expectations must be at least partly forward looking; second, expectations must affect private sector behaviour; third, the private sector must perceive a policymaker's incentive to lie about future policy, and fourth, the institutional change must affect the expectations.

Why is credibility important? One argument – that received a score of 4.13 in the survey of Blinder, in which 1 means strongly disagree and 5 means strongly agree – is that it will reduce disinflation costs. And here, the literature has come up with discomforting outcomes as almost all studies report that CBI worsens the trade-off (see e.g. Posen, 1998; the older literature is discussed in Eijffinger and De Haan, 1996). So it seems that credibility enhancing measures like granting a central bank more independence do not work. Forder (1998a) suggests various possible explanations. First, the private sector may not perceive policymakers' incentive to attempt to deceive them. As McCallum (1995) points out, the optimal policy is not infeasible and there is, therefore, no reason why it should not be followed. The policymaker should simply recognise the futility of seeking to exploit a non-existent trade-off and refrain. Second, a government which is elected to deliver low inflation will not expect credit for delivering low unemployment with high inflation, even if that combination is, after the event, preferred by the public. Elected policymakers will, in this view, pursue the public's desired policy, without any need for an independent central bank, so long as the public is well informed about what they are doing. Third, if wage determination is not a function of expected inflation, no time inconsistency problem would arise. Alternatively, the wage-setting process could be such as to the allow the setting of wages after policymakers have lost their influence over the determination of inflation (Goodhart and Huang, 1998). If policymakers determine inflation and the wage is set, there can be no credibility problem, because there is no promise for the government to make.

Cukierman (1998) argues that the relationship between social welfare and the sacrifice ratio – i.e. the cumulative increase in unemployment that is due to the disinflation effort divided by the total decrease of inflation – is not necessarily negative. A full welfare analysis should also take two other considerations into account. First, a higher sacrifice ratio also means that when monetary policy is expansionary it has a stronger positive impact on output, and, second, the permanent benefits from

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stable prices. When this is done, Cukierman finds that, on average a better record on dependability for achieving inflation that is backed by a higher level of CBI always increases welfare.[29] Furthermore, Cukierman (1998) criticises empirical studies on disinflation costs for not distinguishing carefully between the increase in unemployment due to the disinflation policies and the change in unemployment that would have occurred because of non-policy induced cyclical fluctuations. As a consequence, existing measures of the sacrifice ratio generally provide a distorted picture of the employment costs of disinflationary policies.

5.5 Labour market interaction

How do the predictions of the models discussed in Section 4 fare empirically? It is the mainly empirically-orientated political science literature, surveyed in Franzese (1999a), that has made the most progress in this direction. For instance, Hall and Franzese (1998) provide evidence from a pooled time-series model for inflation and unemployment based on annual as well as averaged data from 1955 to 1990 for 18 OECD countries. Their exogenous variables include an aggregated central bank independence (CBI) index, a 5-step index of CWB based on bargaining co-ordination and controls for openness, per-capita income, the partisan composition of governments and union density. They find that inflation decreases both in CWB and CBI, unemployment strictly decreases in CWB (i.e. is not hump-shaped) and that unemployment increases in CBI. An additional interaction term $CBI \cdot CWB$ has a negative impact on unemployment, which implies that the real costs of an increase in CBI are smaller for higher degrees of CWB. The interactive term is not significant in models of inflation, however. There is also some support for the hypothesis that the negative correlation between CWB and both inflation and unemployment is higher the more trade sector employment dominates public sector employment (cf. Franzese, 1999c).

Cukierman and Lippi (1999) explicitly look for a Calmfors-Driffill type of relationship between unemployment, inflation and CWB. They use a 3-step CWB index and Cukierman's (1992) legal CBI index in a pooled time-series model based on 5-year averages from 1980 to 1994 for 19 OECD countries. The CWB measure is based on bargaining centralisation.[30] The model estimated for

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unemployment includes an interaction term of the form $(a_i + b \cdot CBI) \cdot CWB_i$, where CWB_i is a dummy variable representing different levels of wage bargaining centralisation. There are also controls for other labour market conditions. Since the estimated a_i coefficient is largest for intermediate degrees of CWB, the hump-shape hypothesis is supported. The same holds for inflation. Cukierman and Lippi (1999, p.1423) also report that the relation between CWB, unemployment and inflation systematically "varies with the degree of CBI". Taking a closer look, their findings seem to indicate that increases in CBI shift the Calmfors-Driffill curve to the left, i.e. an increase in CBI raises unemployment and inflation at lower levels of CWB but tends to reduce both variables at intermediate and higher levels. The latter result is somewhat at odds with their theoretical work and the evidence put forward by Hall and Franzese (1998).[31]

A recent contribution by Kilponen (1999a) also provides evidence for the existence of a Calmfors-Driffill curve relating unemployment and measures of centralisation. Kilponen estimates a pooled annual time-series model for 17 OECD countries from 1973 to 1996 that includes a number of institutional variables controlling, for instance, for union power, bargaining co-ordination and elements of the decomposed Cukierman index measuring central bank characteristics. Moreover, the estimates suggest that central bank conservatism is positively correlated with unemployment but CBI (instrument independence) lowers unemployment. The second result contradicts Hall and Franzese (1998) but might help to explain why Cukierman and Lippi (1999) find a negative relation between unemployment and CBI at higher levels of CWB. Inflation is significantly negatively correlated with CBI but not with central bank conservatism. Unfortunately Kilponen (1999a) does not provide an explicit test for the interaction between CWB and central bank characteristics.

Yet another set of results comes from Iversen (1998a, 1998b, 1999). He reports broadly similar relations between CWB unemployment and inflation, but finds that increases in CBI lower unemployment at intermediate levels of CWB and increase it at higher levels of CWB. This implies a shift of the Calmfors-Driffill curve to the right and not to the left as suggested by Cukierman and Lippi (1999). Inflation strictly decreases in CBI.

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6. Conclusions

In much of the literature on CBI, independence is often not distinguished carefully from conservativeness. It is shown that both independence and the inflation aversion of the central bank matter for the inflation performance, provided that government cannot change the 'rules of the game' at zero cost. Within the Barro-Gordon/Rogoff framework there is an optimal level of independence cum conservativeness. Various combinations of independence and conservativeness may yield this optimal outcome.

Apart from a legislative approach to create by law an independent central bank and to mandate it to direct its policies towards achieving price stability, contracting between the central bank and the government has been suggested to overcome the incentive problems of monetary policy. Walsh (1995) has shown that an optimal linear inflation contract can eliminate the inflationary bias without distorting stabilisation policy, while Svensson (1997a) has illustrated that the linear contract can be mapped into an optimal inflation target. This means that both delegation arrangements are equivalent. However, both Walsh and Svensson assume that the central banker's preferences are known to the political principal and to the private sector. In more recent research it is assumed that monetary policy is delegated to a cental banker with uncertain preferences. In case of imperfect information about the cental bank's preferences, the equivalence between the linear Walsh contract and the Svensson inflation target breaks down.

In another recent turn, theoretical and empirical research has focused on the inflationary bias in the standard model of monetary policy. Conventional wisdom argues that the bias is due to exogenous inefficiencies such as labour market regulation or wage rigidities tempting the central bank to increase inflation. But what if the inflationary bias were in itself a function of central bank characteristics? A number of authors argue that, for instance, labour market deregulation will be negatively affected by the centralisation of monetary policy caused by EMU: more centralised

monetary policy-making could actually lead to a relatively larger inflationary bias.

Another fast-growing area of literature focuses on the behaviour of trade unions instead of regulators. It argues that, if trade unions are inflation-averse, many of the positive and normative results stemming from more traditional monetary policy models are turned upside-down. While the idea that unions, in addition to aiming at a high real wage bill for their members, also have a genuine dislike for inflation might be problematic in some set-ups, the investigation into its consequences proves to be quite interesting. One of the results is that if unions have some market power and are averse to inflation, real economic activity tends to be negatively related to the central bank's degree of effective inflation aversion. In other words, central bank independence and conservatism have real costs even in models that abstract from the issue of stabilisation policy. The basic intuition behind this finding is that unions are more likely to internalise the inflationary consequences of higher wages if the central bank stops fighting inflation. As a consequence, the traditional Rogoff result is turned on its head: it might actually be welfare-enhancing to appoint a liberal instead of a conservative central banker.

Recent contributions to this line of work extend the model to allow for continuous degrees of centralised wage bargaining. As a rule, these papers find the relation between bargaining institutions and economic variables to be non-monotonic, which re-enforces the link to the earlier labour market literature. Still, the evidence for the real costs of central bank independence is far from conclusive. The empirical set-ups and data-sets differ widely and so do results. For instance, unemployment has been found both to increase and decrease in central bank independence at any level of bargaining centralisation. Interestingly, however, the majority of papers surveyed find the negative correlation between central bank independence and inflation to be quite robust. It would seem that there is some support in recent empirical work for the existence of a Calmfors-Driffill type of relationship between unemployment, inflation and CWB. The fact that the earlier CWB literature was less successful in this regard – see, for instance, the survey in OECD (1997) – points towards the merits of models that merge aspects of CWB and CBI. Moreover, most studies agree that an increase in CBI lowers inflation independent of the CWB level.[32] But there is little

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consensus with regard to the predicted effects of central bank independence and conservatism on real variables in such models. In fact, the change of unemployment induced by an increase in CBI has been found to be both positive and negative at any level of bargaining centralisation! The complete absence of a consensus with regard to the real costs of CBI might have to do with the rather heterogeneous econometric set-ups employed so far. While most authors engage in some kind of robustness check of their results, their approaches still differ significantly with regard to the models (cross-section *vs.* pooled time-series) and data (various CWB indices, different control variables) employed. Clearly, future research should aim at shedding light on the importance of these differences. For instance, following a practice in the standard CBI literature, results could be reported for a number of commonly used CWB indices.[33] Another issue is that most papers use indices of central bank independence to characterise monetary policy while the theoretical predictions focus on central bank conservatism.

Finally, we have discussed the reliability and usefulness of CBI indicators, the issue of causality as raised by Posen and the robustness of the outcomes of previous studies. We conclude that legal indicators are noisy, but useful indicators and that researchers should not base their analysis on just one indicator. Posen's view that inflation and CBI are both determined by the strength of the financial sector's opposition towards inflation is not supported by most empirical research. Especially the lack of a proper check on influential observations seems to be an interesting issue for further research.

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Table 1. Empirical studies on the consequences of central bank independence[a]

Study:	Measure used:[b]	Countries:	Estimation period:	Conclusions:
Posen (1995)	LVAU	32 countries	1950-1989	CBI (proxied by LVAU) does not affect inflation if measure of Effective Financial Opposition towards Inflation (FOI) is included
Banaian et al. (1995)	LVAU, GMT, TOR, own index	21 OECD countries	1971-1988	Independence dummy based on absence of government override is signifant in cross country model for inflation with various control variables; this dummy outperforms other CBI indicators.
Jonsson (1995)	LVAU	18 OECD countries	1961-1989 (cross country and pooled)	CBI has most important effect on inflation in period 1972-79, also if control variables are taken up; also in panel model is CBI significant for inflation; CBI has the largest effect on inflation under floating exchange rate regime; CBI is negatively associated with budget deficits, but not with the level or variance of unemployment
Froyen and Waud (1995)	Alesina-Summers; LVAU; Cukierman's inflation based index	16 OECD countries and 34 countries	1955-1989	Greater CBI is associated with an improvement in the terms of the output-inflation tradeoff for industrialised countries, while no such relationship is found for a sample of less developed countries.
Fujiki (1996)	LVAW	16 OECD countries	1960-1989 and subperiods (cross country and pooled)	Relationship between CBI and inflation depends upon sample period and becomes much weaker if panel data are used; in some regressions CBI affects economic growth

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Study	Index	Countries	Period	Results
Campillo and Miron (1997)	LVAW	62 countries	1973-1994	CBI does not affect inflation in contrast to openness, political instability and the debt-to-GDP ratio
Eijffinger et al. (1997)	AL, GMT, LVAU, ES	20 OECD countries	1972-82 and 1983-92	Inverse relationship between CBI and inflation is stronger in first period; results for inflation variability depend upon indicator
Walsh (1997)	LVAU, ES	19 (18) OECD countries	1960-1993 (1989) and subperiods (cross country and pooled)	In cross country model CBI is significant in explaining inflation (also if control variables are included), except in 1960-72. In pooled regression CBI is less important (but still significant) than in cross-country regressions. In fixed effects model CBI becomes insignificant once inflation dynamics and oil price effects are included.
Fuhrer (1997)	LVAU; Alesina-Summers	70 countries	1950-89 (cross country and panel data)	CBI does generally not affect inflation and once control variables are included the significance of the Alesina-Summers index vanishes; CBI is related to lower levels of growth and higher unemployment rate
De Haan and Kooi (1997)	decomposition of GMT and LVAU	21 countries	1972-79 and 1980-89	Instrument (economic) independence matters only for inflation performance.
Loungani and Sheets (1997)	own index	12 transition countries	1993	Highly negative relationship between CBI and inflation even if control variables are taken up; TOR is not significant if control variables are taken up.
Jordan (1997)	LVAU, ES, GMT	19 OECD countries	1960-92	CBI only matters during disinflation periods: sacrifice ratio and output loss are higher the more independent the central bank is.
Hayo (1998)	Bade-Parkin; Alesina-	9 EC member	1976-93	Public opinion about inflation is more strongly related to inflation than CBI.

	Summers; GMT	countries		
Clark et al. (1998)	LVAU	18 OECD countries	1970s-1990s	Countries with more CBI show less election induced cycles in output and unemployment.
Sikken and De Haan (1998)	LVAW, TOR, VUL	30 LDCs	1950-94	TOR and VUL (but not LVAW) are significantly related to central bank credit to government; CBI is not related to budget deficits.
Fry (1998)	Own measure based on whether CB neutralises government credit requirements; LVAU; TOR	70 LDCs	1972-95	Measures of CBI do not provide information how independent CB actually behaves; the estimated policy reaction functions show that higher deficits and greater reliance on the inflation tax and financial repression are associated with less neutralisation.
Jordan (1998)	LVAU, GMT	17 OECD countries	1971-80; 1981-90	CBI does not affect output growth rates and during the 1980s CBI had a negative effect on the total quantity of output available.
Bannian et al. (1998)	LVAU	27 countries	1980-1989	Index and pricipal components thereof are generally not significant in inflation model.
Posen (1998)	LVAU	17 OECD countries	1950-1989	CBI is positively related to disinflation costs; CBI not related to nominal wage rigidity, seignorage or manipulation of monetary policy for electoral gain.
Cornwall and Cornwall (1998)	LVAU, GMT, Alesina-Summers	18 OECD countries	1960-89 (4 period averages)	Unemployment is significantly higher due to CBI.
Akhand (1998)	LVAW, TOR	62 countries	1960-1989	Fragile relationship between all measures of CBI and economic growth

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	VUL, NOR			(Levine-Renelt method)
Iversen (1998a,b)	Index based on BP, GMT, LVAU and measure of a "hard currency index" that is 1 for relative appreciating countries and 0 else.	15 OECD countries	1973-1993; pooled cross-country time series, 5 time periods (4 years, last period 5 years)	Inflation strictly decreases as monetary regimes become more "conservative". Increases in "conservatism" lower unemployment at intermediate levels of CWB and increase it at higher levels of CWB.
Hall and Franzese (1998)	Average of LVAU, QVAU, two components of GMT, BP	18 OECD countries	1955-1990; cross-country, decade and annual frequency data	Inflation decreases both in CBI and CWB. Positive unemployment costs of CBI depend negatively on CWB.
Franzese (1999b)	Ibid	Ibid	1972-1990, annual	CBI affects inflation, also after controlling for financial-sector strength. CBI has strongest impact on inflation when government is left, union denity is high, economy is not open, inflation aboraod is high, financial secto is small and wage-bargaining co-ordination is low
Franzese (1999c)	Ibid	21 OECD countries	1974-1990, annual	CBI, CWB and sectoral structure interact in determination of inflation and unemployment; impact of CBI on inflation is less if CWB increases
Iversen (1999)	GMT, LVAU, AL composite index	13-16 OECD countries	1973-1989(95)	Inflation reducing impact of CBI is largest when centralisation of wage bargaining is intermediate level.
Oatley (1999)	8 indicators, incl. AL,	21 OECD	Pooled time series,	CBI affects inflation even if control variables (incl. labour market centralisation and partisan effects) are

	GMT, LVAW, TOR	(10) countries	1970-1990	included, but results depend on selection of CBI indicator as only three indices yield significant relationship.
Cukierman and Lippi (1999)	LVAU	19 OECD countries	1980, 1990, 1994	Inflation reducing impact of CBI is largest when centralisation of wage bargaining is intermediate level.
Moser (1999)	LVAU, LVAW, GMT	16-22 OECD countries	Cross section, 1973-89	The negative relation between inflation and legal bank independence, is stronger in countries with forms of checks and balances in their legislative system than in those without any checks and balances.
Kilponen (1999a)	components of LVAU	17 OECD countries	Pooled time series	Objectives of CB (proxy for conservativeness) not related to inflation, but to wage growth; instrument independence related to inflation. More co-operation in wage bargaining leads to less inflation and unemployment.
De Haan and Kooi (1999)	TOR	97 developing countries	Cross-section	CBI is robustly related to inflation but not to economic growth
Sturm and De Haan (1999)	Ibid	Ibid	Ibid	Effect of CBI (proxied by TOR) disappears if high-inflation observations are excluded, but legal indicator for CBI becomes significant if outliers are excluded. This conclusion holds if various controls are included.

This table includes studies which are not included in tables B1-B3 of Eijffinger and De Haan (1996).

BP is the index of Bade-Parkin; AL is Alesina's (1988; 1989) index; GMT is the index of Grilli et al. (1991); ES is the Eijffinger-Schaling (1993) index; TOR is the turnover rate of central bank governors; LVAW (LVAU) is ukierman's (un)weighted legal independence index; QVAW is Cukierman's index based on a survey, while VUL refers to the political vulnerability index of Cukierman and Webb (1995). NOR is the non-political turnover rate 'Cukierman and Webb (1995).

Notes

[1] The natural rate of output is normalised to zero and the slope is set at one.

[2] In a similar vein, Herrendorf (1998) argues that a legislated delegation can restrict the discretionary influence of government and make monetary policy more transparent, which effects the equilibrium because it makes reputation more effective. In other words, institutional solutions complement reputation.

[3] A related argument is found in Hefeker (1998), who assumes that unions rather than the state determine labour market regulation. For a survey of the impact of EMU on employment see Calmfors (1998a). A discussion of the interaction of EMU and (European) wage bargaining is found in Grüner and Hefeker (1998) and Kilponen (1999b).

[4] Saint-Paul (1996) and Berger (1998) provide empirical evidence that points towards strong partisan influences in regulatory politics. The latter paper also finds that regulatory activity is higher, the tighter the fiscal budget constraint is.

[5] Piga (1998) argues that unions can lobby for stabilisation of output and employment after observing productivity shocks. Under this assumption, there will be a trade-off between less union power (yielding a lower inflationary bias) and output volatility if workers in the no-union case do not share the unions' preference for real stabilisation.

[6] Driffill (1985) showed that, even without an extra inflation target, one might end up with a comparable interaction between government policy and union behaviour if the government is prone to smooth employment. Such behaviour will induce a monopolistic union to exploit this implicit employment guarantee and raise the real wage. For a similar contribution looking at the interaction between a government pursuing a discretionary exchange rate policy and a monopoly union see Horn and Persson (1988). Bleany (1996) discusses a model with multiple unions that are not inflation-averse.

[7] An argument less prone to such critique could be drawn from the earlier literature on wage indexation. For instance, Agell and Ysander (1993) show that, if a union cares about net-income and income taxes are progressive but not indexed, the union takes fully into account the inflationary consequences of its wage demands. In this case the extension to the case of many unions seems less problematic. A survey of recent contributions to the debate on wage indexation is Heinemann (1998). On unions targeting net-income see already Hersoug (1984).

[8] The exposition, while abstracting from the multiple union case, broadly follows the Cukierman and Lippi (1999) and Guzzo and Velasco (1999) models. See also Grüner and Hefeker (1998).

[9] If output were produced with a Cobb-Douglas production function $Y = AK^{1-\alpha}L^{\alpha}$, with K capital, L labour, $A > 0$ a productivity parameter and $0 < \alpha < 1$, labour demand would be $L^D = \left(\dfrac{\alpha A K^{1-\alpha}}{W/P} \right)^{\frac{1}{1-\alpha}}$.

Substituting for L in the production function, output (in logs) becomes $y = \tilde{y} + \theta(p - w)$, with

$\theta = \dfrac{\alpha}{1 - \alpha}$ and $\tilde{y} = \ln K + \theta\left(\ln\alpha + \dfrac{\ln A}{\alpha}\right)$. Note that eq. (4.3) is quite similar to a standard Lucas

supply curve like eq. (2.2) in which p^e has been replaced by w.

[10] Compare the discussion in Guzzo and Velasco (1999: Result 3) and Cukierman and Lippi (1999: Proposition 6).

[11] In related work, Forteza (1998) shows the inflationary bias to depend negatively on the extent of sustainable co-operation between unions.

[12] Calmfors (1993) provides a comprehensive survey of both the theoretical and empirical findings of the earlier literature.

[13] This could be due to size or a certain logic in the centralisation process. Assume with Calmfors and Driffill (1988) that wage bargaining is centralised along sectors or branches. Within a certain industry or sector, the demand elasticity of substitution will be high. This effectively constrains wage increases at the firm level. As a consequence, CWB within this branch will produce rather strong wage effects. These effects become (indefinitely) smaller with higher degrees of centralisation, however, because CWB encompasses more and more distant sectors.

[14] On a more formal note, Velasco and Guzzo (1999) show the relation to be u-shaped if the elasticity of substitution is larger than some threshold that is a positive function of the economies of scale imbedded in the production function. Increasing economies of scale in a particular type of labour might actually invert the competition effect altogether.

[15] The political science literature rarely provides formal models to support this notion.

[16] Franzese (1999a) provides a more extensive discussion of the following and related arguments.

[17] Table 1 extends table B1 in Eijffinger and De Haan (1996). Not all studies are discussed in the main text.

[18] This applies to the following criteria: is the governor not appointed by government; are all the board members not appointed by government; is the governor appointed for more than 5 years; is the direct credit facility at market interest rates; is it automatic; is it temporary; central bank does not participate in primary government debt market.

[19] Forder is absolutely right that the correlation between inflation can never be the proper criterion to determine whether an indicator is a good proxy for CBI or not. Unfortunately, quite a few authors fall in the trap that they equate CBI with low inflation (see e.g. Neumann, 1996).

[20] Of course, there can be other constraints (like the exchange rate regime; see below for a further discussion), but these should be included as control variables in an empirical model.

[21] Forder (1999) argues that the correlation between LVAW and GMT drops from 0.37 to 0.16 if Germany and Switzerland are excluded. But why should one leave these countries out of consideration? And why not exclude Greece, say? Doing so would increase the correlation.

[22] In a similar vein, Fry (1998) argues that his measure for CBI (i.e. whether the central bank offsets government's demand for credit) is not related to legal measures of CBI. One may, however, question Fry's reasoning. Why would the central bank's neutralisation policy be the proper aspect to focus on?

[23] When Campillo and Miron (1997) add Posen's measure of financial opposition towards inflation in their model it enters insignificantly. They conclude that Posen's results derives from the data for the 1960s.

[24] Also in economic growth regressions there is some evidence for sample sensitivity. Fujiki (1996) reports that CBI indicators are significant in his regression for OECD countries (with various control variables included) for the entire period 1960-89, but not for the subperiods.

[25] Indeed, one could argue that if no evidence of a relationship between central bank independence and inflation performance is found in the Bretton Woods period, while there exists such a link for the post-Bretton Woods era, this would strengthen the argument that central bank independence is a primary determinant of a country's inflation performance.

[26] CBI is not an issue in the Giavazzi-Pagano analysis. This might be reasonable if exchange rates are entirely fixed. However, exchange rate regimes like the EMS have had various realignments. It could be argued that the likelihood of such realignments is a function of how independent the central bank is (Jonsson, 1995). Indeed, De Haan (1998) finds an inverse relationship between CBI and the cumulative devaluations of the various currencies from the start of the EMS.

[27] For older studies that also included control variables, see Eijffinger and De Haan (1996).

[28] Apart from the criticisms raised further on, it should also be pointed out that one of the variables that Fuhrer takes up in his control set is the short-term interest rate determined by central banks. It is likely that this variable is highly correlated with CBI. Furthermore, Fuhrer does not properly differentiate between various periods, while it is well-known that the results on the relationship between CBI and inflation differ somewhat across periods (as is also to be expected on theoretical grounds).

[29] In his analysis Cukierman (1998) does not take output stabilisation or inflation-averse labour unions into account.

[30] Cukierman and Lippi (1999) base their index on data reported in OECD (1997). They do not, however, follow OECD (1997) in constructing a composite index that takes into account information on both centralisation and co-ordination of wage bargaining.

[31] While Hall and Franzese (1998) report that at the highest level of CWB an increase in CBI seems to decrease unemployment, the estimated coefficients are far from significant.

[32] Specific tests for a possible hump-shaped relation between CBI or central bank conservatism and inflation seem to be missing from the literature so far.

[33] Calmfors (1993), OECD (1997) and Franzese (1999a) provide a more detailed discussion of the existing approaches to code CWB.