THE TRADE OFF BETWEEN CENTRAL BANK INDEPENDENCE AND CONSERVATIVENESS

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Abstract

This paper introduces a parameter for central bank independence in a monetary policy game with a conservative central banker. It tries to explain the optimal degree of central bank independence and conservativeness by four economic and political determinants, both theoretically and empirically. There appears to be a trade off between central bank independence and conservativeness. Then, by comparing the optimal degree of conservativeness and independence with the actual degree of independence, we want to identify the optimal degree of conservativeness for the countries participating in EMU.

1. Introduction

This paper deals with the following fundamental questions. First, it tries to explain the optimal degree of central bank *independence and conservativeness* by four economic and political determinants (the natural rate of unemployment, society's preferences for unemployment stabilization relative to inflation stabilization, the variance of productivity shocks and the benefits of unanticipated inflation) both theoretically and empirically. The empirical results are only given for the (twelve) member states of the European Union.[1] Second, we want to identify the optimal degree of *conservativeness* of the national central banks of countries constituting EMU.

The paper is organized as follows. Central bank independence is included in the model of a conservative central banker and the trade off between independence and conservativeness is discussed in Section 2. In this Section, also the relationship between (independence and) conservativeness of the central banks and the four economic and political determinants is investigated with an extension of the Rogoff (1985) model. Furthermore, we test this relationship empirically using a latent variables approach (LISREL) for nineteen industrial countries including the member states of the European Union in Section 3. Also, the optimal degree of conservativeness of the central banks is identified for countries participating in EMU. Finally, our conclusions are drawn in Section 4.

2. The Rogoff (1985) model

In the Rogoff (1985) model, society can make itself better off by appointing a conservative central banker who does not share the social objective function, but instead places "too large" a weight on inflation rate stabilization relative to output stabilization. In this simplified version, output is given by the Lucas supply function which is reformulated in terms of unemployment u_t:

$$u_t = \tilde{u} - \theta(\pi_t - \pi^e + \mu_t) \tag{1}$$

where $\theta > 0$ denotes the slope of the Phillips curve, π_t is inflation, π^e is expected inflation, $\tilde{u} > 0$ is the natural rate of unemployment and μ_t is a serially uncorrelated productivity shock with mean zero and variance σ_μ^2. The timing of events is as follows: first π^e is set (nominal wage contracts are signed), then the shock μ_t occurs and finally the central banker sets π_t.

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[1] On the contrary, Eijffinger and Schaling (1995a and b) focus on nineteen industrial countries, including also Australia, Canada, Japan, New Zealand, Norway, Switzerland and the United States. Eijffinger and Schaling (1995b) formulate and estimate an open economy version of the Eijffinger and Schaling (1995a) model.
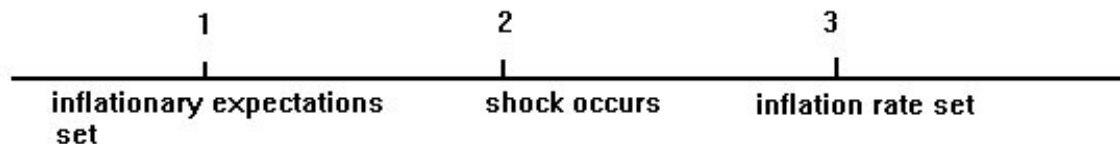
Figure 1: Timing of events in the Rogoff model

Society's loss function is given by:

$$L_t = \frac{1}{2}\pi_t^2 + \frac{\chi}{2}u_t^2$$

(2)

where the weight on output stabilization $\chi > 0$. The target level of inflation and the target level of unemployment are set to zero. Rogoff now shows that it is optimal for society to choose a conservative central banker who assigns "too large" a weight to inflation in his loss function:

$$I_t = \frac{1+\epsilon}{2}\pi_t^2 + \frac{\chi}{2}u_t^2$$

(3)

where ϵ, the additional weight on the inflation goal, lies between zero and infinity ($0 < \epsilon < \infty$).

Substituting (1) in (3), taking first order conditions with respect to π_t and solving for rational expectations, we obtain:

$$\pi_t = \frac{\chi\theta}{1+\epsilon}\tilde{u} - \frac{\chi\theta^2}{1+\epsilon+\chi\theta^2}\mu_t$$

(4)

$$\pi^e = \frac{\chi\theta}{1+\epsilon}\tilde{u}$$

(5)

$$u_t = \tilde{u} - \frac{\theta(1+\epsilon)}{1+\epsilon+\chi\theta^2}\mu_t$$

(6)

Policy rule (4) shows that the introduction of a conservative central banker ($\epsilon > 0$) leads to a lower inflationary bias ($\frac{\chi\theta}{1+\epsilon}\tilde{u}$) and a lower variance of inflation $\left(\frac{\chi\theta^2}{1+\epsilon+\chi\theta^2}\right)^2 \sigma_\mu^2$.

The variance of output $\left(\frac{\theta(1+\epsilon)}{1+\epsilon+\chi\theta^2}\right)^2 \sigma_\mu^2$, however, is an increasing function of the conservativeness of the central banker. This is the trade off between credibility and flexibility that is already apparent in the Rogoff model. It can be shown that the optimal value for ϵ, in terms of social loss function (2), is positive but finite.[2] This implies that it

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[2]   Rogoff uses an envelope theorem to show this. In Eijffinger and Schaling (1995a and b) a graphical method is used to determine the optimal degree of conservativeness. Eijffinger, Hoeberichts and

is optimal for society to appoint a conservative central banker.

2.1 From Conservativeness to Independence

The independence of a central bank can be seen as the extent to which it determines monetary policy without interference of the government. In the Rogoff model, this can be incorporated in the loss function that determines monetary policy, M_t. This function is a *weighted* average of the central bank's loss function I_t and society's loss function L_t where the weight $0<\gamma<1$ is the degree of central bank independence:[3)]

$$M_t = \gamma I_t + (1-\gamma)L_t \qquad (7)$$

Substituting society's loss function (2) and central bank's loss function (3) into (7) gives:

$$M_t = \frac{1+\gamma\epsilon}{2}\pi_t^2 + \frac{\chi}{2}u_t^2 \qquad (8)$$

So, what matters for monetary policy is $\gamma\epsilon$: the *product* of independence and conservativeness of the central bank. There is an optimal degree of independence and conservativeness ($\gamma\epsilon^*$) which minimizes M_t. In practice, the degree of (legal) independence of a central bank is fixed as measured by the legal indices of independence which reflect the central bank laws in various countries. The level of conservativeness, however, can generally be chosen by the central bank. Hence, a lack of central bank independence can be compensated by choosing more conservative central bankers. On the basis of economic and political determinants, we determine the optimal degree of independence and conservativeness. Then, given the *actual* degree of independence for each country, we are able to identify its *optimal* degree of conservativeness ϵ^* (see Figure 2).

Schaling (1995) are able to derive a closed form solution.

[3)] This implies that central bank independence (γ) is defined as the degree in which the central bank determines effectively the monetary policy's loss function (M_t).

Figure 2: The Trade Off between Conservativeness and Independence
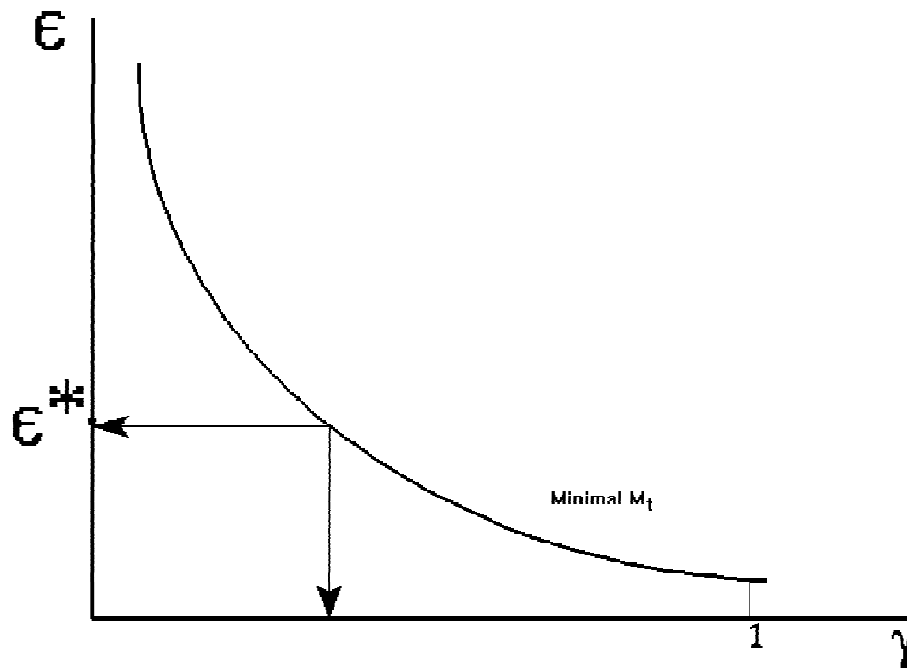
2.2 The Optimal Independence and Conservativeness of a Central Bank

This brings us to a key issue in the political economy of central banking: the relationship between institutional design and individual and collective preferences. Here the question to be dealt with is the *normative* issue of how conservative a central bank (CB) should be, i.e. the optimal degree of conservativeness of a CB.

An important study in this field is Cukierman (1994). Building on the seminal paper of Lohmann (1992), he wants to identify the economic and political factors that induce politicians to delegate more or less authority to the central bank. His theory predicts that central bank independence will be higher, the larger the employment-motivated inflationary bias, the higher political instability and the larger the government debt are.

These predictions were tested and, subsequently, rejected by De Haan and Van 't Hag (1995) using regression analysis (OLS method). In testing Cukierman's model, they employ measures of central bank independence that in - Rogoff's (1985) terminology - reflect the strength of the 'conservative bias' of the central bank as embodied in the law. In Cukierman's model, following Lohmann (1992), central bank independence is defined as the *cost of overriding* the central bank, rather than as the degree of *conservativeness*. Cukierman's (1994) theory also generates propositions about *optimal* regimes, whilst the legal measures describe *actual* monetary regimes.

In this paper we try to overcome these pitfalls. Building on the Rogoff (1985) model,

we distinguish between independence and conservativeness of a CB. Using a graphical method, we develop a new way of determining the optimal degree of independence and conservativeness.[4] As in Lohmann (1992), this degree depends on the balance between *credibility* and *flexibility*. However, unlike Rogoff and Lohmann, we are able to express the upper and lower bounds of the interval containing the optimal degree of independence and conservativeness in terms of the structural parameters of the model.

Furthermore, we derive a number of propositions concerning the relationship between economic and political factors and the optimal degree of independence and conservativeness. We show that optimal central bank independence and conservativeness is higher, the higher the natural rate of unemployment, the greater the benefits of unanticipated inflation (the slope of the Phillips curve), the less inflation-averse society and the smaller the variance of productivity shocks.

After we have found the optimal degree of independence and conservativeness for each country and knowing the actual degree of independence of its central bank, we can derive the optimal degree of conservativeness of the CB.

Using $\gamma\epsilon$ instead of ϵ in the expression for inflation (4) and the expression for unemployment (6), substituting these two expressions into the Central Bank's loss function (8) and taking expectations yields the following expected loss for society with a central banker with independence γ and conservativeness ϵ:

$$E_{t-1}L_t = \frac{\chi^2\theta^2\tilde{u}^2}{2(1+\gamma\epsilon)^2} + \frac{\theta^4\chi^2}{2(1+\gamma\epsilon+\theta^2\chi)^2}\sigma_\mu^2 + \frac{\chi\tilde{u}^2}{2} + \frac{\theta^2(1+\gamma\epsilon)^2\chi}{2(1+\gamma\epsilon+\theta^2\chi)^2}\sigma_\mu^2 \tag{9}$$

The first term in (9) is due to the inflationary bias and can be reduced by making the central bank more independent or conservative (a larger $\gamma\epsilon$). The second term measures how well the central bank manages to keep inflation constant. This variance can also be reduced by making the central bank more independent or conservative. The third term is a dead-weight loss due to the natural rate of unemployment. Obviously, this cannot be reduced through monetary policy. The last term is the variance of unemployment (or output). This term increases when the central bank becomes more independent or conservative. When we drop the dead-weight loss and take the two variances together, we get the following:

$$E_{t-1}L_t = \frac{\chi^2\theta^2\tilde{u}^2}{2(1+\gamma\epsilon)^2} + \frac{\chi\theta^2((1+\gamma\epsilon)^2+\theta^2\chi)}{2(1+\gamma\epsilon+\theta^2\chi)^2}\sigma_\mu^2 \tag{9'}$$

$$\underbrace{\qquad\qquad}_{credibility} \quad \underbrace{\qquad\qquad}_{flexibility}$$

The first term in (9') is related to the natural rate of unemployment and can be seen as the

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credibility component in the social loss; the second term is related to the variance of productivity shocks and represents the *flexibility* component in the social loss.

Minimizing the expected social loss with respect to $\gamma\epsilon$ yields the following first order condition:

$$\frac{dE_{t-1}L_t}{d(\gamma\epsilon)} = \underbrace{\frac{-\chi^2\theta^2\tilde{u}^2}{(1+\gamma\epsilon)^3}}_{negative} + \underbrace{\frac{\chi^2\theta^4\gamma\epsilon\sigma_\mu^2}{(1+\gamma\epsilon+\chi\theta^2)^3}}_{positive} = 0 \tag{10}$$

The first term in (10) is always *negative* and reflects the credibility effect of a more independent or conservative central bank: a higher $\gamma\epsilon$ reduces society's credibility problem. The second term is always *positive* and reflects the flexibility effect of more central bank independence or conservativeness: a higher $\gamma\epsilon$ means less stabilization.

Figure 3: The Optimal Degree of Conservativeness
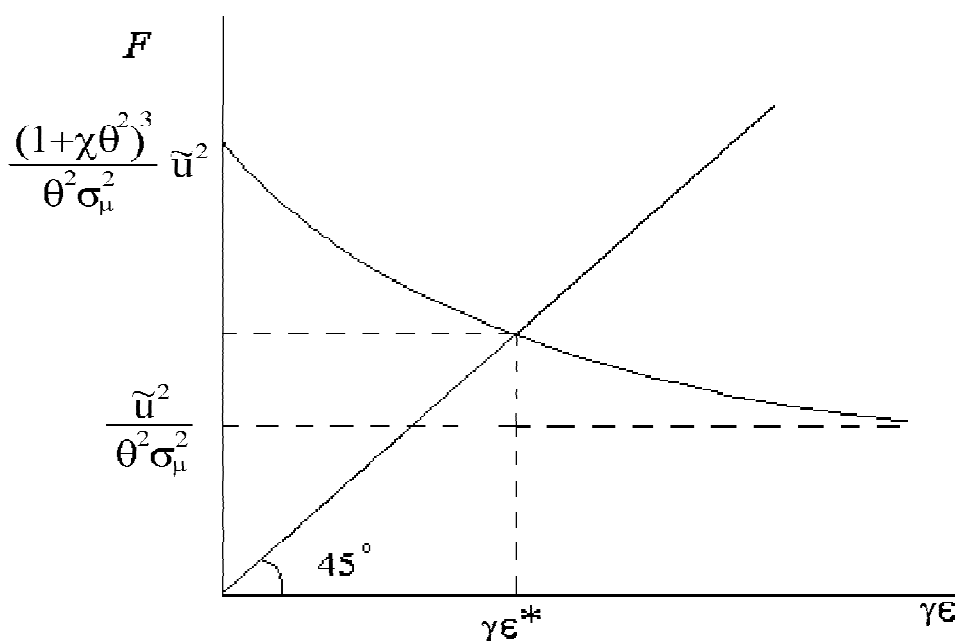
2.3 The Determinants of Optimal Independence and Conservativeness

In Eijffinger and Schaling (1995a) it is shown that a unique solution for the optimal $\gamma\epsilon$ exists. Furthermore, the comparative static properties of this equilibrium are derived by means of a graphical method as is illustrated in Figure 3. First, the first-order condition (10) is rewritten as:

$$\gamma\epsilon = \frac{\tilde{u}^2(1+\gamma\epsilon+\chi\theta^2)^3}{\sigma_\mu^2\theta^2(1+\gamma\epsilon)^3} \equiv F(\gamma\epsilon) \tag{11}$$

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The function F on the right-hand side of equation (11) is monotonically decreasing in $\gamma\varepsilon$. The left-hand side is a 45° line through the origin and the intersection point gives the optimal degree of independence and conservativeness $\gamma\varepsilon^*$. The comparative static properties of the optimal degree of independence and conservativeness can be derived from the partial derivatives of the function F. If F shifts upward, the intersection point shifts to the right.[5]

It turns out that the higher the *natural rate of unemployment* (the higher ũ), the higher the optimal degree of conservativeness and independence of the CB. The intuition behind this result is the following. A higher natural rate of unemployment implies a higher time-consistent rate of inflation (See equation (4)) and, consequently, a higher credibility component of the social loss function. This means that society's credibility problem increases. Hence, with an unaltered relative weight placed on inflation versus unemployment stabilization the monetary authorities' commitment to fight inflation is now too low.

The higher *society's preferences for unemployment stabilization relative to inflation stabilization* (the higher χ) in a country, the higher the optimal degree of conservativeness and independence of the CB. The underlying intuition is that, if citizens become more concerned with unemployment and more lax about inflation, the time-consistent inflation rate goes up (See equation (4)). Therefore, society's credibility problem becomes more pressing. With an unchanged relative weight placed on inflation stabilization, the balance between credibility and flexibility needs to be adjusted in favor of increased commitment of fighting inflation.

The higher the *variance of productivity shocks* (the higher σ_μ^2) in a country, the lower the optimal degree of conservativeness and independence of a CB. This result may be explained as follows. If the variance of productivity shocks increases, ceteris paribus, the economy becomes more unstable. Thus, the need for active stabilization policy increases (the flexibility component of the social loss function goes up). With an unaltered relative weight placed on inflation stabilization the balance between credibility and flexibility needs to be shifted towards more monetary accommodation.

If society is relatively unconcerned with inflation $\left(\chi > \dfrac{(1+\gamma\varepsilon)}{2\theta^2}\right)$ the greater the *benefits of*

unanticipated inflation (the higher θ) in a country, the higher the optimal degree of conservativeness and independence of a CB. The intuition behind this proposition is that, if the benefits of unanticipated inflation rise (See equation (1)), it becomes more tempting to inflate the economy. Therefore, society's credibility problem gains in importance. With the same emphasis on inflation stabilization, the balance between credibility and flexibility

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[5] For a formal derivation of the properties of the function F in the first-order condition, see Appendix B in Eijffinger and Schaling (1995a).

needs to be shifted towards increased commitment to price stability.[6]

3. Empirical Evidence on the Optimal Conservativeness

In this Section, the economic and political determinants of the optimal degree of central bank conservativeness and independence ($\gamma \varepsilon^*$) discussed before are empirically investigated. We will use, for that purpose, a latent variables approach (LISREL) to make a distinction between the *optimal* and *actual* degree of conservativeness and independence.[7] The reasons for this distinction are two-fold. First, the propositions derived in the former Section are related to the optimal degree of conservativeness and independence and *not* to the actual degree. These propositions formulate the relationship between the optimal degree and four economic and political factors in a country:

- the natural rate of unemployment ($\tilde{u}$);
- society's preferences for unemployment stabilization relative to inflation stabilization (χ);
- the variance of productivity shocks (σ_μ^2); and
- the slope of the Phillips curve (θ).

These determinants, reflecting the economic and political structure of a country, explain theoretically the optimal degree of conservativeness and independence in that country.[8] Second, there is also an identification and measurement problem. Whereas the determinants will change *frequently* during the sample period, i.e. the period 1960-1993, the actual degree may change much less in the same period. The stickiness may, for example, result from the fact that central bank laws are *very occasionally* adjusted in the industrial countries during the post-war period.

The actual degree of central bank independence is approximated by the *legal* degree, according to the four main indices of central bank independence in the literature. The index of Alesina (AL) is a narrow measure of independence and based on Alesina (1988, 1989). The total index of political and economic independence of Grilli, Masciandaro and Tabellini (GMT) is a broad measure based on Grilli, Masciandaro and Tabellini (1991). The index of policy independence of Eijffinger and Schaling (ES) is, however, a narrow measure based on Eijffinger and Schaling (1992, 1993a) and extended by Eijffinger and Van Keulen (1995). The unweighted legal index of Cukierman (LVAU) is a very broad measure of independence and derived from Cukierman (1992). These four legal indices

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[6] Eijffinger and Schaling (1995b) provide an open economy version and find that the optimal degree of conservativeness is higher when the real exchange rate variability and the openness of the economy is smaller.

[7] A clear overview of the latent variables approach is given by Aigner, Hsiao, Kapteyn and Wansbeek (1984). For an application of this approach to the determinants of central bank independence only, see Eijffinger and Schaling (1995a and b) and Appendix A.

[8] The proxies for these economic and political variables and the sources of the data are given in Appendix C.

have been *lognormalized (AL, GMT, ES* and *LVAU)* so that the natural logarithms of their values range from zero to one.

For our cross-country analysis, initially, a set of nineteen industrial (OECD) countries - Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, New Zealand, the Netherlands, Norway, Spain, Sweden, Switzerland, the United Kingdom and the United States - is taken which are ranked by the above-mentioned indices.[9] The sample period that we have chosen covers more than thirty years, namely the period 1960-1993 (for ũ: 1960-1988). The argument to choose such a long period is that it contains many political and business cycles.

The idea behind the model is the following. The optimal degree of conservativeness and independence is a function of the determinants, $\gamma\varepsilon^* = f(X)$, where f is a function and X are the determinants. Taking logs, we rewrite the equation as $\log(\gamma) = g(X) - \log(\varepsilon^*)$, where g is a function. Now, we use the log of the legal indices as proxies for $\log(\gamma)$ which we interpret as actual independence. The residual ($-\log(\varepsilon^*)$), which we calculate by the difference between the average of the (log) legal indices and g(X), can be interpreted as a measure for optimal conservativeness. Using this approach has several implications. First, by interpreting the residual as optimal conservativeness, we implicitly assume that optimal conservativeness is uncorrelated with the determinants. Put differently, the part of independence that cannot be explained by the determinants, will be compensated by conservativeness. Furthermore, it means that every CB has the optimal degree of independence as long as the right level of conservativeness is chosen.

3.1 Estimation Results

Table 1 shows the estimation results for the optimal degree of conservativeness and independence ($\gamma\varepsilon^*$) using a latent variables approach (LISREL).[10] For convenience the restriction that the disturbance terms in the model are uncorrelated is imposed.[11] From Table 1, it can be seen that only one explanatory variable (θ) is significant at a 5% significance level. Apparently, the benefits from unanticipated inflation do play an important role. The other explanatory variables have relatively low t-values which could, probably, be attributed to the many restrictions still imposed on the model. Nevertheless, the model as such is not rejected according to a Likelihood Ratio-test for the model to be

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[9]   By including not only the twelve member states of the European Union but also seven non-member states, we have sufficient data to estimate the LISREL model. For two member states - Greece and Portugal - no data on the natural rate of unemployment (ũ, proxied by NAIRU) were available, whereas Luxembourg has a monetary union with Belgium.

[10] The idea behind LISREL (Linear Structural Relations) is to compare a sample covariance matrix with the parametric structure imposed on it by the hypothesized model. Under normality, LISREL delivers Full Information Maximum Likelihood (FIML) estimates of the model parameters. For more details, see Appendix A. See also Aigner et al. (1984).

[11] Two of these restrictions, however, have to be rejected according to a univariate Lagrange Multiplier-test and are, thereby, lifted. For the relaxation of the restrictions, see Appendix B.

of the specified structure (see the Appendix).

Therefore, we have calculated the *optimal* degree of conservativeness and independence (henceforth OCI) on the basis of the economic and political determinants for each country. Given the *actual* independence being the unweighted average of the legal indices of central bank independence (CBI), we are able to determine the optimal conservativeness (OC) for the twelve member states of the European Union. Here we use an average of broad and narrow indices. As the indices are highly correlated (see Eijffinger and De Haan (1995)) splitting the broad an narrow indices up wouldn't yield much different results.

3.2 The Optimal Conservativeness

Rogoff (1985) has shown that society can make itself better off by appointing a "conservative" central banker who places an *additional* weight on inflation stabilization (price stability) than society. From Section 2 it is evident that central bank independence and conservativeness are (close) *substitutes* of each other. An independent central bank can afford to be less conservative than a dependent central bank. Therefore, the optimal conservativeness may be interpreted as the degree of *discretion* (flexibility) in monetary policy which can be afforded by the central bank: the lower the optimal conservativeness of the central bank, the higher the degree of discretion it can afford in monetary policy making.[12]

Furthermore, the average long-term interest rates (period 1990:1 - 1995:8) of the twelve member states of the European Union[13] - excluded are Greece, Luxembourg and Portugal - can be seen as the *likelihood* according to the financial markets that these countries will enter the third stage of EMU. These long-term interest rates are a reflection of the chances of the respective countries to comply with the convergence criteria set out in the Maastricht Treaty.

If we compare the optimal conservativeness (OC) and the long-term interest rates in the twelve member states as in Figure 4, there appears to be a significant, positive relationship between both variables[14], although the level of long-term interest rates is, of course, also influenced by other factors than monetary policy such as the evolution of the government deficit. Apparently, countries with a relatively high degree of optimal conservativeness are not considered to be likely candidates for the third stage of EMU according to the financial markets.

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[12]   See also the comparison between German and Italian monetary policy by Fratianni and Huang (1995). They conclude that the Bundesbank could afford during the period 1984-1994 more deviations from their monetary targets than the Banca d'Italia by its higher reputation.

[13]   The long-term interest rates are taken from OECD Main Economic Indicators, 1995.

[14]   The coefficient for OC (see Figure 4) is significant at a 5% significancelevel.

Table 1: The Optimal Conservativeness

$$\gamma\varepsilon^* = -0.019 * \tilde{u} + 0.171 * \chi + 0.015 * \sigma^2_\mu + 0.706 * \theta \quad R^2 = 0.37 \quad DF = 15$$
$$\quad\quad (-0.822) \quad\quad (0.800) \quad\quad (0.696) \quad\quad\quad (2.501)$$

Country	Indices				Log Normalized Indices					Optimal Conservativeness	
	AL	*GMT*	*ES*	*LVAU*	*AL*	*GMT*	*ES*	*LVAU*	*CBI*	*OCI*	*OC*
Austria		9	3	0.58		0.71	0.62	0.90	0.74	0.55	-0.19
Belgium	2	7	3	0.19	0.45	0.52	0.62	0.15	0.44	0.47	0.03
Denmark	2	8	4	0.47	0.45	0.62	0.83	0.74	0.66	0.57	-0.09
Finland	2		3	0.27	0.45		0.62	0.36	0.48	0.60	0.12
France	2	7	2	0.28	0.45	0.52	0.36	0.38	0.43	0.37	-0.06
Germany	4	13	5	0.66	1.00	1.00	1.00	1.00	1.00	0.56	-0.44
Ireland		7		0.39		0.52		0.60	0.56	0.38	-0.18
Italy	1.5	5	2	0.22	0.25	0.30	0.36	0.23	0.28	0.34	0.06
Netherlands	2	10	4	0.42	0.45	0.79	0.83	0.66	0.68	0.54	-0.14
Spain	1	5	1	0.21	0.00	0.30	0.00	0.21	0.13	0.26	0.13
Sweden	2		2	0.27	0.45		0.36	0.36	0.39	0.86	0.47
United Kingdom	2	6	2	0.31	0.45	0.42	0.36	0.45	0.42	0.70	0.28

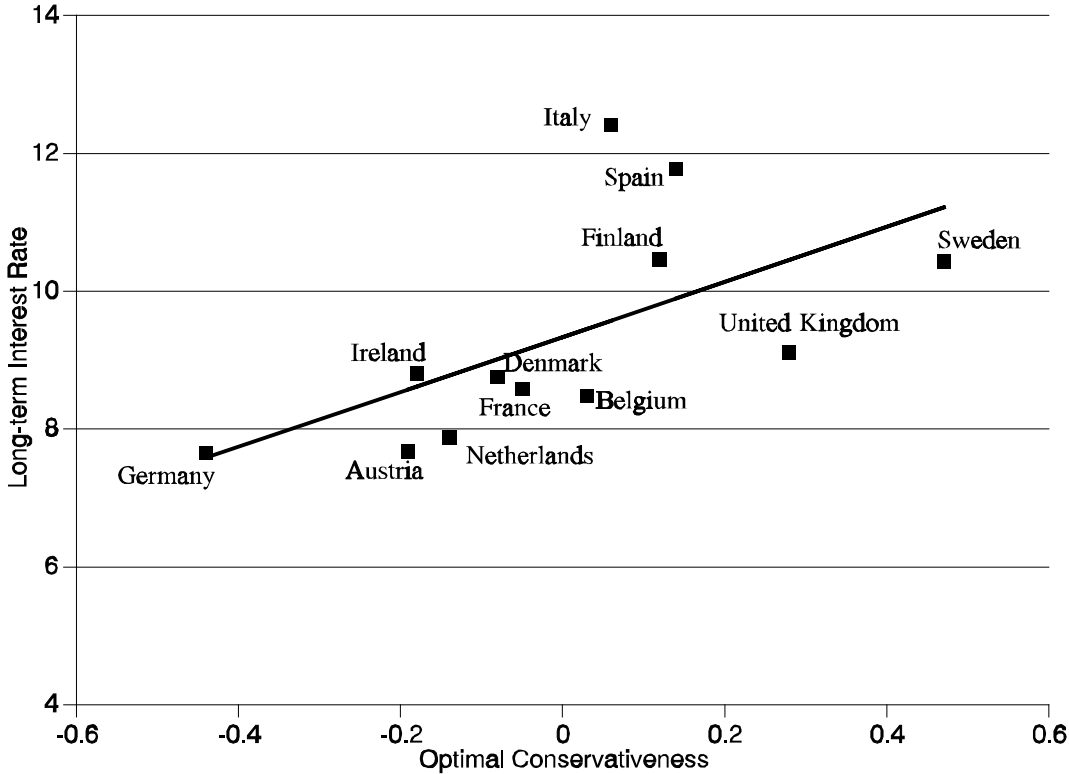Notes:

t-statistics in parentheses:

Italics refer to lognormalized indices of central bank independence;

Actual central bank independence: *CBI = (AL + GMT + ES + LVAU)/4*

Optimal central bank conservativenss and independence: *OCI* ($\gamma\varepsilon^*$);

Optimal conservativeness: *OC = OCI - CBI.*

Figure 4: The Optimal Conservativeness (OC) and Long-Term Interest Rates

Long-term interest rate =   9.34 + 4.00 * OC $R^2 = 0.37$ DF = 10
                              (24.483)   (2.404)

4. Conclusions

What are the main conclusions from the theoretical and empirical analysis on the optimal degree of conservativeness? The optimal degree of central bank independence and conservativeness depends positively on the natural rate of unemployment, society's preferences for unemployment stabilization relative to inflation stabilization and the benefits of unanticipated inflation and negatively on the variance of productivity shocks. Using a LISREL-model we estimated the relationship between four proxies of legal central bank independence and the four economic and political determinants. Then, we determine the optimal degree of independence and conservativeness for each country based on the determinants. Given the actual degree of independence we calculate the optimal degree of conservativeness. The empirical evidence suggests a positive relationship between the optimal conservativeness and the long-term interest rates in the twelve member states of the European Union. Apparently, countries with a relatively high optimal conservativeness are not considered to be likely candidates for the third stage of EMU. From a normative point of view, countries with a high optimal degree of conservativeness should either grant

more independence to their central bank or change the determinants so that they are more in line with the current level of independence.

Appendix

A. The Estimated Model

Let γ be the latent *dependent* variable, i.e. the latent degree of central bank independence, and x be the observed *explanatory* variables, in our case the four ultimate determinants of central bank independence, satisfying a system of linear structural relations

$$\gamma = B \cdot x - \varepsilon, \tag{A.1}$$

with B being the vector of coefficients and ε the disturbances. It is assumed that γ, x and ε have *zero* expectations, and that x and ε are *uncorrelated*. Instead of the latent variable γ, the vector of proxies y is *observed*, such that

$$y = \Lambda \gamma + \delta \tag{A.2}$$

with δ the vector of measurement errors, *uncorrelated* with γ and ε, but possibly correlated among themselves and Λ=[1 1 1 1]'. The observed vectors x and y are measured as deviations form their means, thus, having *zero* expectations and a covariance equal to E[x y]. Also, γ and δ have zero expectations.

Therefore, y is a vector of *observed* legal indices of central bank independence (AL, GMT, ES and LVAU), lognormalized so that the natural logarithm of their values range from 0 to 1 and measured in deviation from their means,

$$y = \begin{bmatrix} AL\_NM \\ GMT\_NM \\ ES\_NM \\ LVAU\_M \end{bmatrix} \tag{A.3}$$

and x is a vector of *observed* explanatory variables, being the non-accelerating inflation rate of unemployment (NAIRU), the percentage of years of a left-wing government (WLEFT), the variance of output growth (VPROD) and the compensation of employees as share of GDP (SLOPE) measured in deviation from their means

$$x = \begin{bmatrix} NAIRU\_M \\ WLEFT\_M \\ VPROD\_M \\ SLOPE\_M \end{bmatrix} \tag{A.4}$$

So, equation (A.2) becomes

$$\begin{bmatrix} AL\_NM \\ GMT\_NM \\ ES\_NM \\ LVAU\_M \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \\ 1 \\ 1 \end{bmatrix} \cdot \gamma + \begin{bmatrix} \delta_1 \\ \delta_2 \\ \delta_3 \\ \delta_4 \end{bmatrix} \tag{A.2'}$$

14

Furthermore, Φ and Ψ are defined as the covariance matrix of x and the variance of ε, respectively, and Θ_δ as the true variance-covariance matrix of δ. Then it follows from the above assumptions that the variance-covariance matrix Σ of [y', x']' is

$$\Sigma = \left[\begin{array}{c|c} \Lambda [B\Phi B' + \Psi] \Lambda' + \Theta_\delta & \Lambda B \Phi \\ \hline \Phi B' \Lambda' & \Phi \end{array} \right] \tag{A.5}$$

where $\Lambda = [1\ 1\ 1\ 1]'$ and Θ_γ is diagonal, which implies that the correlation between the observed legal indices of central bank independence (y) is *only* caused by the latent optimal degree (η).

The parameters occurring in Σ (B, Φ, Ψ, Θ_δ) are estimated on the basis of the matrix S of second sample moments of x and y. Given the structure that matrix (A.5) imposes on the sample covariance matrix, LISREL computes FIML estimates of the parameters when [y', x'] is normally distributed, i.e. when the following criterion is minimized

$$\ln |\Sigma| + \text{tr} [S\Sigma^{-1}] \tag{A.6}$$

On the basis of the restrictions given in the former section, LISREL computes *Full Information Maximum Likelihood* estimates of the parameters of the model, explaining the relationship between the degree of central bank independence (γ) and the explanatory variables (NAIRU, WLEFT, VPROD and SLOPE). Then, using the parameters we have estimated, we predict the optimal degree of central bank independence and conservativeness for each country (OCI). The comparison between the *optimal* degree of independence and conservativeness and the *legal* indices of central bank independence (AL, GMT, ES and LVAU) can be made. The difference between the optimal degree of independence and conservativeness on one hand and the average of the lognormalized legal indices of central bank independence (CBI) on the other hand, is interpreted as optimal conservativeness (OC).

If the predicted optimal degree of independence and conservativeness (OCI) exceeds the average of legal indices (CBI), then the optimal degree of conservativeness (OC) is positive, indicating that the central bank should be more conservative than the average central bank. Of course, the optimal degree of conservativeness is negative if the optimal degree of conservativeness and independence is smaller than CBI.

15

B. The Relaxation of Restrictions

In the first model, we imposed the restriction that the disturbance terms in the model are uncorrelated. The statistics of this model show a Likelihood Ratio-test for the null hypothesis that the predicted covariance matrix is of the specified structure against the alternative that the covariance matrix is unconstrained. For the first model, the null hypothesis is rejected implying that the specified structure was not correct. Apparently, too many restrictions were imposed. Testing structural models, a univariate Lagrange Multiplier-test is carried out for most elements in the model matrices that are constrained to equal constants. When the test statistic, having a χ^2_1-distribution, has a value larger than 3.84 the restriction is rejected at a significance level of 5%.

In the first regression, with all restrictions imposed, the constraint that the disturbances of the GMT-index and the variance of productivity shocks (σ_μ^2) are uncorrelated is rejected. The test statistic has a value of 10.00 which is the highest of all restrictions. Therefore, we have lifted this restriction and tested the modified model. Now the restriction on the covariance of the GMT-index and the ES-index is rejected with the highest test statistic. So we lifted this restriction. The modified model gives no restriction with a test statistic higher than 3.84 and the Likelihood Ratio-test for the model to be of the specified structure gives a test-statistic of 14.86 which is well below the critical value of 22.31 for a χ^2_{15}-distribution at a significance level of 10%.

Table 2: Table based on Estimation with Cumulative Relaxation of Restrictions

Lifted Restriction	Estimated Equation	R² and DF
No Lifted Restriction	$\gamma\varepsilon^*$=-0.028 * ũ + 0.037 * χ - 0.009 * σ_μ^2 + 0.565 * θ (-1.283) (0.189) (-0.452) (2.070)	R²=0.43 DF=17
GMT, σ_μ^2	$\gamma\varepsilon^*$=-0.019 * ũ+0.121 * χ + 0.012 * σ_μ^2 + 0.700 * θ (-0.867) (0.591) (0.647) (2.669)	R²=0.41 DF=16
GMT, ES	$\gamma\varepsilon^*$=-0.019 * ũ+0.171 * χ + 0.015 * σ_μ^2 + 0.706 * θ (-0.822) (0.800) (0.696) (2.501)	R²=0.37 DF=15

Note: t-values in parentheses.

C. The Data

As proxies for the ultimate determinants of the optimal degree of central bank conservativeness and independence, we have chosen the following economic and political variables. For $\tilde{u}$, the *non-accelerating inflation rate of unemployment* (NAIRU) is taken from Layard, Nickell and Jackman (1991). They estimated the NAIRU for nineteen industrial countries in the period 1960-1988. The proxy for society's preferences for unemployment stabilization relative to inflation stabilization (χ) is the number of years that a *left-wing (socialist) party* has been in government as a share of the *total* number of years. For, a left-wing government has a higher preference for unemployment stabilization and, thereby, the optimal degree of central bank conservativeness and independence increases under a left-wing government. The variance of productivity shocks (σ_μ^2) is proxied by the *variance of output growth* (GDP) on an annual basis. We compute the slope of the Phillips curve (θ), using labour's income share in GDP. Because data for labour's income share are not available for all countries in our sample, we have taken the ratio between the *compensation of employees* paid by resident producers to resident households and GDP.

$\tilde{u}$: R. Layard, S. Nickell and R. Jackman,
    Unemployment, Macroeconomic Performance and the Labour Market, Oxford, Oxford University Press, 1991.
    Estimates for NAIRU 1960-1988, Table 14, Chapter 9.

χ: *Winkler Prins Encyclopedie*, 1990.
    A.J. Day (ed.), *Political Parties of the World*, London, Longman, 1988.
    (# years that a left-wing party has been in the government, either alone or in a coalition)/(total # years), 1960-1993.

σ_μ^2: OECD, *Main Economic Indicators,* various issues.
    Growth rate of GDP in US$ in 1985 prices and exchange rates, 1960-1993.

θ: OECD, *National Accounts of OECD Countries*, 1960-1977, 1977-1989, 1978-1992.
    1/[1 - (Compensation of employees paid by resident producers/GDP)], in current prices.
    OECD, Paris, 1979, 1991, 1994.

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