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Central bank independence: A paneldata approach

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Abstract. The present paper uses a paneldata estimation technique to combine the time series for individual countries (Australia, Canada, France, Germany, Italy, Japan, the Netherlands, Switzerland, the United Kingdom and the United States). We postulated the response of central banks in these countries to inflation, economic growth and current account surplus given the constraints to be the same among the sample countries. Differences between central bank independence come forward in a different structural pressure to lower or raise money market rates in these countries. The empirical results in this study coincide remarkably well with the legal indices of central bank independence.

1. Introduction

Recently, in many countries both political and monetary authorities have shown an increasing interest in the objective of monetary stability and the position of the central bank. According to Eijffinger (1994: 309) in Western Europe, there is a clear tendency to establish (more) independent central banks and to foster, thereby, monetary stability. According to the Maastricht Treaty, the independent European Central Bank is fully committed to the goal of price stability in the final stage of EMU by 1997 or later. Furthermore, in some Anglo-Saxon countries, e.g., Canada, New-Zealand and the United Kingdom, monetary authorities are trying to achieve monetary stability by an inflation target.[1] Finally, countries in Central and Eastern Europe, such as Hungary, Poland and the Czech republic, and in Latin America, Argentina, Chile and Mexico, are looking for a way to strengthen the position of their central bank in order to realize some degree of price stability.

The theoretical rationale for central bank independence finds its origin in the ongoing 'Rules versus Discretion' debate. Authors like Barro and Gordon (1983a, 1983b), Rogoff (1985) and Cukierman (1992) argue that governments and central banks are tempted to impart an inflationary bias to the economy, thereby sacrificing long-term welfare to short-run political gains. The associated time consistency problem can be overcome by legislative rules and by setting up politically independent central banks.

Unlike the well-developed theoretical literature,[2] there are only a few studies that compare actual monetary regimes between a large number of countries. The most comprehensive studies are Bade and Parkin (1988), Alesina (1988, 1989), Grilli, Masciandaro and Tabellini (1991), Cukierman (1992) and Alesina and Summers (1993). Focusing on more recent studies, it is striking that the conclusions of the latter are less clear-cut than the theoretical literature. For instance, contrary to Alesina and Summers, Bade and Parkin find no correlation between central bank independence and the variability of inflation. Next, unlike the prediction of the Rogoff framework,[3] both Alesina and Summers and Grilli, Masciandaro and Tabellini find no association between central bank independence and (the variability of) real output growth.

A recent study by the International Monetary Fund (Swinburne and Castello-Branco, 1991), questions the reliability of these empirical conclusions. This is because nearly all of them are stated in terms of correlations between indices of central bank independence and macro-variables (output, inflation).[4] Therefore, these results – e.g., the well-known inverse relationship between independence and the level of inflation found by Alesina (1988, 1989), Cukierman (1992), De Haan and Sturm (1992), Alesina and Summers (1993), Eijffinger and Schaling (1993b) – are particularly sensitive to the numerical values of indices.[5]

In this paper we view central bank independence from a different perspective. Following Koskela and Virén (1991), we estimate reaction functions for monetary policy for ten industrial countries (Australia, Canada, France, Germany, Italy, Japan, the Netherlands, Switzerland, the United Kingdom and the United States). The response of the money market rate with respect to inflation, economic growth and current account surplus is investigated. Next, we assume that the reaction of central banks to inflation, economic growth and current account not only depends on these variables, but also on an individual country-specific effect. We interpret this effect as *actual* (as opposed to *legal*) central bank independence. Using a panel data estimation technique (Hsiao, 1986), differences in central bank independence come forward in different structural pressure to lower or raise money market rates. Remarkably, the empirical results on central bank independence (the *empirical* indices) coincide very well with the legal indices as discussed in Eijffinger and Schaling (1993a).

The plan of this paper is as follows. In Section 2 we briefly discuss the indices of legal independence. Section 3 explains the paneldata estimation technique. The results for the so-called empirical index of central bank independence are given in Section 4. In Section 5 we investigate these results in more detail to see whether significant changes in empirical independence

Table 1. Indices of legal central bank independence

Country	ES	BP	AL	GMT Policy	GMT Political	GMT Economic
Australia	1	1	1	1	3	6
Canada	1	2	2	1	4	7
France	2	2	2	1	2	5
Germany	5	4	4	3	6	7
Italy	2	2	1.5	3	4	1
Japan	3	3	3	1	1	5
Netherlands	4	2	2	3	6	4
Switzerland	5	4	4	3	5	7
United Kingdom	2	2	2	2	1	5
United States	3	3	3	3	5	7
Sweden	2	2	2	NA	NA	NA

ES: Eijffinger-Schaling index; BP: Bade-Parkin index; AL: Alesina index; GMT: Grilli-Masciandaro-Tabellini index; NA: Not available.

can be detected between the first and second half of our sample period. Also, in this section the numerical values of empirical independence are confronted with the indices of legal independence. Finally, in Section 6 the relation between economic performance and the legal and empirical indices of central bank independence is analyzed.

2. Legal indices of central bank independence

In recent years some central bank indices have been developed. Basically, these indices are based on charters of central banks. Therefore, these indices constitute a measure of legal central bank independence. These are the indices of Bade and Parkin (1988), Alesina (1988, 1989), Grilli, Masciandaro, and Tabellini (1991) and Eijffinger and Schaling (1992, 1993a).

From now, these indices will be referred to by, respectively, the BP index, the AL index, the GMT index and the ES index.[6] The numerical values for all these indices and some variants are given in Table 1.

All aforementioned legal indices of central bank independence have some features in common. Their values are dependent on (i) criteria used in the examination of central bank laws (statutes), (ii) the interpretation of the relevant statute as to whether a central bank meets this criterion, i.e., possesses a certain attribute, and (iii) the way these attributes are aggregated to a composite index of central bank independence. Of course, there is no non-arbitrary way of choosing criteria. Also the interpretation of the relevant statute is a

delicate matter because one has to make a distinction between purely formal or legal issues, and more substantive issues regarding the conduct of monetary policy. Again in making this distinction there is an unavoidable arbitrariness. For each economist when building an index of this kind is somewhat biased in favour of his/her own country, because the greater acquaintance with the case brings recognition of the greater freedom of behaviour acquired in current practice by the national central bank compared to the formal rule. Second, as pointed out by Grilli, Masciandaro, and Tabellini (1991: 31), there is no non-arbitrary way of aggregating these criteria or attributes to a composite index. Hence, there are unavoidable subjective elements in the construction of legal indices of central bank independence.

Third, as noted by Cukierman,[7] these legal indices only measure one aspect of actual central bank independence. Other aspects of central bank independence are, for instance, informal arrangements, tradition and culture of monetary stability, the quality of the bank's research department and personalities of important persons in the bank or political authorities that try to influence the monetary policy.[8]

3. The paneldata estimation technique

As Cukierman (1992: 369) notes *legal* independence is not the same as *actual* independence. Cukierman argues that there are at least two reasons for this divergence. Firstly, central bank laws are incomplete. It is impossible to specify the limits of the authority of the central bank and the political authorities in all situations. These limits are, among others, determined by informal arrangements, traditions and personalities of persons that are confronted with these unspecified situations. Secondly, even if the scope of authority, procedures, objectives, etc. are described explicitly in the law, actual practice may be different.[9]

Because actual independence is determined by many factors from which a lot are hardly or not quantifiable we will now assume that actual independence cannot be measured directly.[10] Therefore, in this paper we view central bank independence from a different perspective. Following Koskela and Virén (1991), we estimate reaction functions for monetary policy in ten industrial countries (Australia, Canada, France, Germany, Italy, Japan, the Netherlands, Switzerland, the United Kingdom and the United States). The response of the money market rate with respect to inflation, economic growth and current account surplus is investigated. Next, we assume that the reaction of central banks to inflation, economic growth and current account surplus not only depends on these variables, but also on an individual country-specific effect. We interpret this effect as *actual* (as opposed to *legal*) central bank indepen-

dence. Using a paneldata estimation technique (Hsiao, 1986) differences in central bank independence come forward in different structural pressures to lower or raise money market rates.

This means that the reaction function which was taken from Koskela and Virén (1991) takes the following form:[11]

$$\begin{aligned}\Delta MMR_{i,t} &= \beta_0 + \beta_1 P_{i,t} + \beta_2 P_{i,t-1} + \beta_3 Y_{i,t} + \beta_4 Y_{i,t-1} \\ &\quad + \beta_5 CA_{i,t} + \beta_6 CA_{i,t-1} + CBI_i + \eta_{i,t} \qquad (1)\end{aligned}$$

with $i = 1...N$, $t = 1...T$ and

$\Delta MMR_{i,t}$	=	change in money market rate of country i in period t;
$P_{i,t}$	=	inflation rate of country i in period t;
$Y_{i,t}$	=	real economic growth rate of country i in period t;
$CA_{i,t}$	=	current account surplus as a percentage of GDP of country i in period t;
CBI_i	=	actual central bank independence of country i;
$\eta_{i,t}$	=	the error term for country i in period t.[12]

The subscript i represents the countries in our sample and t is the time subscript.[13]

Because we would like to infer conclusions about a country-specific effect which cannot be observed directly we resort to the use of paneldata. Furthermore, we assume this central bank independence not to change a lot over the sample period in a particular country.[14] Therefore, the unobservable individual country-specific effect is fixed and this brings us to the *fixed-effects* models within the paneldata approach.

We will now describe the estimation technique for fixed-effects models using paneldata.[15] For convenience we introduce the following notation:

$$\begin{aligned}\beta &= (\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6)', \\ x_{i,t} &= (P_{i,t}, P_{i,t-1}, Y_{i,t}, Y_{i,t-1}, CA_{i,t}, CA_{i,t-1})', i = 1...N, t = 1...T, \\ EMP_i &= \beta_0 + CBI_i, i = 1...N.\end{aligned}$$

Now one is able to rewrite (1) as:

$$\Delta MMR_{i,t} = EMP_i + \beta' x_{i,t} + \eta_{i,t} \text{ with } i = 1...N, t = 1...T. \qquad (2)$$

Note that we have comprised the common intercept β_0 and the country-specific effect CBI_i together to EMP_i. The reason for this is that because both terms are fixed constants we cannot identify or estimate them separately.[16] We will refer to EMP_i as the generalized individual effect or the *empirical*

independence of central banks to distinguish it from the country-specific effect or the actual independence of central banks (CBI_i). To continue our exposure we also need the following notations:

$$\begin{aligned}\Delta MMR_i &= (\Delta MMR_{i,1}, ..., \Delta MMR_{i,T})', i = 1...N,\\ e &= (1, .., 1)',\\ X_i &= (x'_{i,1}, ..., x'_{i,T})', i = 1...N,\\ \eta_i &= (\eta_{i,1}, ..., \eta_{i,T})', i = 1...N.\end{aligned}$$

Now equation (2) can be written as:[17]

$$\Delta MMR_i = EMP_i e + X_i\beta + \eta_i \quad (i = 1...N). \tag{3}$$

Define matrix Q as $Q = I_T - ee'/T$. I_T denotes the identity matrix with dimensions T by T. Pre-multiplying equation (3) with Q has the effect of transforming all observations into deviations of their individual means. Performing this transformation on equation (3) gives:

$$Q\Delta MMR_i = QX_i\beta + Q\eta_i \quad (i = 1...N). \tag{4}$$

Note that transforming a constant into a deviation of its individual mean gives zero. Therefore, the term $EMP_i e$ disappears in (4). Applying OLS to (4) gives the following within-group estimator.[18]

$$\hat{\beta}_{WG} = \left(\sum_{i=1}^{N} X_i'QX_i\right)^{-1}\left(\sum_{i=1}^{N} X_i'Q\Delta MMR_i\right). \tag{5}$$

Now we can estimate EMP_i by:

$$\begin{aligned}\hat{EMP}_{i,WG} &= \overline{\Delta MMR_i} - \overline{x_i'}\hat{\beta}_{WG} \text{ with}\\ \overline{\Delta MMR_i} &= \frac{1}{T}\sum_{t=1}^{T}\Delta MMR_{i,t}, \overline{x_i} = \frac{1}{T}\sum_{t=1}^{T}x_{i,t}.\end{aligned} \tag{6}$$

Furthermore, it is possible to derive that the covariance matrix of the within-group estimator and the variance of the estimator for EMP_i can be estimated by:

$$\hat{V}(\hat{\beta}_{WG}) = \hat{\sigma}_\eta^2\left(\sum_{i=1}^{N} X_i'QX_i\right)^{-1} \tag{7}$$

with

$$\begin{aligned}\hat{\sigma}_\eta^2 = \frac{1}{NT - (N + k)}\sum_{i=1}^{N}&(\Delta MMR_i - \hat{EMP}_{i,WG}e - X_i\hat{\beta}_{WG})'\\ &(\Delta MMR_i - \hat{EMP}_{i,WG}e - X_i\hat{\beta}_{WG})\end{aligned} \tag{8}$$

and

$$\hat{V}(\hat{EMP}_{i,WG}) = \overline{x_i'}\hat{V}(\hat{\beta}_{WG})\overline{x_i} + \frac{\hat{\sigma}_\eta^2}{T}. \quad (9)$$

The parameter k denotes the number of regressors. So, k = 6 in our case. In general, this analysis can be done for any fixed cross-sectional unit-specific effect. We assumed, however, that the individual country-specific effect can be contributed to the independence of central banks. Therefore, we labelled this country-specific effect CBI_i.

Basically, the just discussed approach implies that all countries have the same coefficients in front of the exogenous variables but that the intercepts are different among the several countries. Two remarks can be made here. Firstly, because of equation (2) this approach is also called a variable-intercept model. Secondly, we also could have estimated the model by introducing ten dummies – for each country one – that take over the role of the variable intercepts. The fixed-effects method – although being equivalent to the variable-intercept method – is discussed above because, in our opinion, the interpretation of the country-specific effects now comes forward in a more natural way.

Furthermore, we can see from this equivalence as well as from the fact that we can apply OLS to equation (4) that under the proper conditions for the error term the within-group estimator is BLUE (*Best Linear Unbiased Estimator*).

4. Empirical results

In the previous section we have seen that actual central bank independence can be estimated using paneldata. We only have to accept the identification of the country-specific effect with the degree of independence of central banks. Thus, central bank independence comes forward in different structural pressures to lower or raise money market rates. This definition of central bank independence implies that the same degree of independence should lead to the same response to data for inflation, economic growth and current account.[19] A central bank that is less independent will be tempted to lower the money market rate to stimulate economic growth and, thereby, employment. This implies that this sort of central bank will tend to have a relatively lower money market rate than more independent central banks. Relatively means here regarding the inflation, economic growth and current account data.[20] So, we expect less independent central banks to show a lower individual effect (CBI) and, consequently, a lower generalized individual effect (EMP) in reaction function (2).[21] Therefore, the degree of central bank independence may be identified with a country-specific effect in the determination of the money market rate. This was already stated in reaction function (1). When

we refer to empirical independence of central banks, we mean the estimated generalized country-specific effects (EMP). From former discussion it will be clear that this empirical independence will be used as a proxy for actual independence.

The estimation results of reaction function (2) using paneldata are given in Table 2 and the following equation:

$$\begin{aligned}\Delta MMR_{i,t} = {} & EMP_i + \underset{[1.666]}{0.118}P_{i,t} + \underset{[1.746]}{0.124}P_{i,t-1} + \underset{[6.646]}{0.378}Y_{i,t} + \underset{[1.869]}{0.107}Y_{i,t-1} \\ & - \underset{[4.773]}{0.681}CA_{i,t} + \underset{[3.230]}{0.460}CA_{i,t-1} + \eta_{i,t} \text{ and } \sigma_\eta^2 = 1.691. \end{aligned} \tag{10}$$

Absolute t-values for estimated coefficients are given between brackets. These results are conform our intuition. Judging the signs of the coefficients, we see that the common reaction to inflation and economic growth is a higher money market rate which is the result of a more restrictive monetary policy. On the other hand, the response to economic growth is stronger than the response to inflation which is not conform our expectations. If dependent central banks will fight inflation and if they have perfect control over the money market rate, we expect the response to inflation to be more pronounced than to economic growth.[22] The response to current (lagged) economic growth is significant on a 1% (5%) level, while the same response to both inflation variables is significant on a 10% level. Both coefficients of the current account to GDP ratio are strongly significant (on a 1% level). The coefficient of the current account surplus relative to GDP variable is negative while the coefficient of the lagged variable is positive. The coefficients of our prime interest are those which measure the differences between the countries. For ease of comparison, we have ranked the generalized individual effect – i.e., the empirical independence – in Table 2 from high to low.

These coefficients coincide remarkably well with our prior convictions. Among the ten countries is a first group of two countries (Germany and the Netherlands) which, obviously, have more independent central banks than the second group of countries. We will call these central banks *strongly independent* from now on. On the other hand, there are two countries (Italy and the United Kingdom) that have by far the least independent central bank. So, from now on we will classify these central banks as *dependent*. The other six countries have an *intermediate independent* central bank.[23] Furthermore, we see that all generalized individual coefficients (EMP) are significantly different from zero.[24] More important is, however, that the differences between the three groups of countries are obvious. These differences cannot be contributed to the common intercept term (β_0) but must be due to the actual independence of central banks (which we labelled CBI).

Table 2. Paneldata estimation results for empirical independence of central banks. Sample period: 1977 III – 1990 IV

Countries	Empirical independence[a] (EMP)	95%-confidence intervals
Germany	-0.117 [0.530]	(-0.550, +0.316)
Netherlands	-0.217 [1.139]	(-0.591, +0.157)
Canada	-0.539 [2.328]	(-0.992, -0.085)
Japan	-0.550 [2.616]	(-0.962, -0.138)
Switzerland	-0.597 [2.918]	(-0.997, -0.196)
United States	-0.755 [3.515]	(-1.176, -0.334)
France	-0.769 [3.427]	(-1.209, -0.329)
Australia	-0.784 [3.271]	(-1.254, -0.314)
Italy	-1.211 [4.540]	(-1.733, -0.688)
United Kingdom	-1.218 [4.049]	(-1.807, -0.628)

[a] Absolute t-values between brackets.

Though, the point estimations for the generalized individual effects give an obvious ranking, it is important to note that only a few countries have statistically significant different intercepts.[25] Within the class of strongly independent central banks each central bank has a significantly higher level of empirical independence than the Banca d'Italia and the Bank of England.[26]

Summarizing, we have found a clear ranking of central banks and, furthermore, for the most extreme cases (the group of strongly independent central banks versus the group of dependent central banks) these differences are statistically significant.

5. Further refining and interpretation

We made two important assumptions in Section 2. Firstly, that the country-specific effect could be attributed to the degree of actual independence of central banks and, secondly, that this effect was fixed over time. Because of this latter assumption we used the estimation technique for fixed-effects models. An alternative assumption could have been that the country-specific effect has a constant mean but that the actual country-specific effect will vary around this mean (so, it will equal its mean plus a stochastic error term). This could be due to, for instance, changing personalities in the policy board of the central bank and in political authorities that try to influence the central bank. Because, in general, persons come and go gradually over time[27] the actual value of the central bank independence will also change gradually

over time. This means that current values of actual independence are not independent of past values. Therefore, we can perform a simple test for this type of time-varying central bank independence.[28] We split up the sample in two sub-samples and we will judge whether the differences between the two sub-periods are significant or not. The results for the first and the second sub-period are given in Table 3 and the following two equations:[29]

$$\begin{aligned}\Delta MMR_{i,t} = {} & EMP_i + \underset{[1.103]}{0.128}P_{i,t} + \underset{[1.776]}{0.215}P_{i,t-1} + \underset{[5.350]}{0.444}Y_{i,t} + \underset{[1.158]}{0.096}Y_{i,t-1} \\ & \underset{[3.223]}{-0.575}CA_{i,t} + \underset{[1.712]}{0.389}CA_{i,t-1} + \eta_{i,t} \text{ and } \sigma_\eta^2 = 2.302, \end{aligned} \tag{11}$$

$$\begin{aligned}\Delta MMR_{i,t} = {} & EMP_i + \underset{[1.848]}{0.196}P_{i,t} + \underset{[0.595]}{0.061}P_{i,t-1} + \underset{[3.135]}{0.252}Y_{i,t} + \underset{[1.602]}{0.131}Y_{i,t-1} \\ & \underset{[4.141]}{-0.741}CA_{i,t} + \underset{[2.710]}{0.477}CA_{i,t-1} + \eta_{i,t} \text{ and } \sigma_\eta^2 = 0.974. \end{aligned} \tag{12}$$

Absolute t-values for estimated coefficients are given between brackets. The first equation is reaction function (2) again but now estimated for the first half of the sample period. The second equation is the equivalent of the first equation but now for the second half of the sample period. For both sub-periods the signs of the coefficients do not differ from the whole sample period. The overall contribution of the variables to the explanation of the variation in ΔMMR even appears to be insignificant on a 20% level. This may give rise to doubt the robustness of the regression results over time. In the first and second sub-period the joint contribution of the regressors in equation (2) is significant on a 1% level.[30] So, our model (equation (2)) does give a good fit for the data both in the first and second sub-period.

In Table 3 we have included the generalized invididual effects – i.e., the empirical independence of central banks – for the two sub-periods as well as for the whole sample period.[31] The generalized effects for the entire sample period are ranked, again, from high to low. For the whole sample period and sub-periods the rankings are given in parentheses. From this table it appears that the overall ranking does not change a lot. The classes of strongly independent, intermediate independent and dependent central banks are still the same. Furthermore, the ranking of intermediate independent and dependent central banks has slightly changed between the two sub-periods. This is not surprising, because the differences within these classes are small. Moreover, according to Table 3, there is no evidence of big changes in the ranking of central banks with respect to each other. Therefore, we conclude that there is

Table 3. Empirical central bank independence in the whole sample period and sub-periods

Country	Whole sample period	First sub-period	Second sub-period
Germany	-0.12 (1)	-0.28 (1)	+0.17 (1)
Netherlands	-0.22 (2)	-0.46 (2)	-0.04 (2)
Canada	-0.54 (3)	-0.76 (3)	-0.42 (4)
Japan	-0.55 (4)	-0.80 (4)	-0.30 (3)
Switzerland	-0.60 (5)	-0.94 (5)	-0.51 (5)
United States	-0.76 (6)	-0.98 (7)	-0.82 (7)
France	-0.77 (7)	-1.23 (8)	-0.63 (6)
Australia	-0.78 (8)	-0.94 (6)	-0.85 (8)
Italy	-1.21 (0)	-1.98 (10)	-0.96 (9)
United Kingdom	-1.22 (10)	-1.57 (9)	-1.51 (10)

Whole sample period: 1977 III – 1990 IV; First sub-period: 1977 III – 1984 I; Second sub-period: 1984 II – 1990 IV. Rankings in the different periods are given in parentheses.

no evidence of significant changes over time in the country-specific effects (CBI).[32]

We now have proxies for actual independence of central banks which, approximately, appear to be constant over time. In Section 2 we also discussed some indices of legal independence. It is interesting to confront these measures with each other. In Table 4 we compare our measure of actual central bank independence with the legal indices of central bank independence, and we order the countries – according to our measure of actual independence – from the country with the most independent central bank to the country with the least independent central bank.[33]

From Table 4 we see that most measures of legal independence coincide rather well with actual independence.[34] The correlation between our measure of actual independence and the indices of legal independence is given in Table 5. We also tested whether these Pearson correlation coefficients are significantly positive.[35] The values for this Pearson correlation statistic are also given in Table 5.[36]

From Table 5 appears that our judgement is confirmed by the correlations. All indices show a positive relationship with actual independence. The ES index has the highest coefficient of correlation with the measure of actual independence. Moreover, the ES index is the only index that shows a significantly positive relation with actual independence on a level of 1%. So, the ES index of legal independence is the best proxy for the measure of actual inde-

Table 4. Empirical and legal indices of central bank independence

Country	EMP	ES	BP	AL	GMT Polity	GMT Political	GMT Economic
Germany	-0.12	5	4	4	3	6	7
Netherlands	-0.22	4	2	2	3	6	4
Canada	-0.54	1	2	2	1	4	7
Japan	-0.55	3	3	3	1	1	5
Switzerland	-0.60	5	4	4	3	5	7
United States	-0.76	3	3	3	3	5	7
France	-0.77	2	2	2	1	2	5
Australia	-0.78	1	1	1	1	3	6
Italy	-1.21	2	2	1.5	3	4	1
United Kingdom	-1.22	2	2	2	2	1	5

EMP: Empirical independence; ES: Eijffinger-Schaling index; BP: Bade-Parkin index; AL: Alesina index; GMT: Grilli-Masciandaro-Tabellini index.

Table 5. Pearson correlation test for positive correlation between empirical and legal central bank independence

Correlation of empirical independence with the	Pearson correlationcoefficient	Pearson test statistic t_ρ
ES index	0.595**	2.091
BP index	0.453*	1.438
AL index	0.517*	1.706
GMT Policy index	0.130	0.372
GMT Political index	0.584**	2.034
GMT Economic index	0.481*	1.553

*Significant for $\alpha = 0.10$; **Significant for $\alpha = 0.05$.

pendence that we estimated.[37] The BP, AL and GMT Economic index show a positive relation on a level of 5%. So, these legal indices are also relatively good indicators for actual independence.[38] Finally, for the GMT Policy index and the GMT Political index we did not find a significant positive correlation.

6. Central bank independence and economic performance

Our hypothesis in this section is that the empirical index is a better approximation of actual central bank independence than any of the other indices that measure legal independence of central banks. Therefore, using our measure of actual independence will give, we expect, more pronounced results.

Furthermore, it is interesting to test whether central bank independence has any effect on the mean and variance of the money market rate. Especially, the relation between the empirical index and the average money market rate is interesting in light of the meaning of this empirical index. The empirical index actually measures the tendency of keeping the money market rate high (relative to the inflation, economic growth and current account data). This upward pressure on the money market rate does not mean that it is higher in absolute value. So, it is not clear a priori which countries will show the highest money market rates. Those with independent central banks or those with more dependent central banks. From a theoretical point of view there are two possible visions on whether a more independent central bank will lead to higher or lower interest rates. Nominal interest rates may be lower because of less inflation uncertainty and a lower expected rate of inflation or higher to keep the inflation rate low. This question is important because of the relation between the level of interest rates and the level of investments (and consumption).[39] Therefore, we investigate whether higher central bank independence will lead to higher or lower money market rates.[40]

We tested the relation between the mean and the variability of the inflation rate, the rate of economic growth, the current account to output ratio and the money market rate, on the one hand, and all indices (legal and actual) from Table 4, on the other hand.[41] The results are given below in Table 6.

Table 6 contains correlation coefficients between the several indices of central bank independence and economic performance. Because the causality of some relations is not evident these relations were not tested with regressions but we report the Pearson correlation coefficient without imposing a causal relation. Broadly speaking, Table 6 shows that there is a significant *negative* relationship between central bank independence and the average inflation rate, the variance of the inflation rate, and the average money market rate and a significant *positive* relationship with the average current account surplus relative to GDP. These correlations are significantly different from zero for the empirical index of independence. It appears that the GMT indices show hardly any significant correlation at all.[43] For all other indices high central bank independence, low average inflation rates and low average money market rates appear together. These correlation coefficients are strongly significant. This implies that countries with low inflation rates do not necessarily have high money market rates. Also, there is no relation between the mean (or variance) of output growth and central bank independence. The same applies to the variance of the current account to GDP ratio. The variance of the inflation rate and the average current account to GDP ratio show only for the empirical index significant relations. These relations, though, are significant on a level of 1%. The AL index and the ES index show a weak significant negative relation

Table 6. Economic performance and the indices of independence: 1977–1990[42]

Economic variables and indices	Average inflation rate	Variance inflation rate	Average output growth rate	Variance output growth rate	Average current account output ratio	Variance current account output ratio	Average money market rate	Variance money market rate
BP	-0.67**	-0.33	-0.07	-0.28	0.17	-0.15	-0.83***	-0.54
	[2.58]	[0.99]	[0.19]	[0.83]	[0.48]	[0.42]	[4.18]	[1.80]
AL	-0.74**	-0.41	-0.08	-0.24	0.18	-0.13	-0.86***	-0.59*
	[3.13]	[1.28]	[0.21]	[0.70]	[0.51]	[0.37]	[4.84]	[2.09]
GMT	-0.19	0.07	-0.56*	0.29	-0.13	0.07	-0.40	-0.09
Policy	[0.54]	[0.19]	[1.93]	[0.85]	[0.37]	[0.19]	[1.22]	[0.26]
GMT	-0.34	-0.50	-0.52	0.46	0.42	-0.40	-0.39	0.05
Political	[1.01]	[1.62]	[1.73]	[1.46]	[1.31]	[1.24]	[1.18]	[0.14]
GMT	-0.49	-0.65**	-0.11	-0.09	0.20	-0.13	-0.41	-0.22
Economic	[1.61]	[2.44]	[0.32]	[0.25]	[0.58]	[0.36]	[1.27]	[0.65]
ES	-0.77***	-0.40	-0.28	0.14	0.18	-0.09	-0.90***	-0.61*
	[3.42]	[1.24]	[0.84]	[0.41]	[0.51]	[0.24]	[5.69]	[2.15]
EMP	-0.84***	-0.88***	-0.02	0.43	0.78***	-0.44	-0.68**	-0.49
	[4.42]	[5.19]	[0.05]	[1.36]	[3.52]	[1.39]	[2.60]	[1.61]

Absolute t-values between brackets. *Significant for $\alpha = 10\%$; **Significant for $\alpha = 5\%$; ***Significant for $\alpha = 1\%$.

with the variance of the money market rate. Thus, we can conclude that high central bank independence, low money market rates, low inflation rates and current account surpluses (instead of deficits) appear together, without the average economic growth rates being significantly lower. Moreover, even the variability of inflation rates and money market rates seems to be, sometimes, lower.

The fact that the empirical index gives the most or one of the most strong relationships when the literature indicates there exists a relationship is reason for us to conclude that the legal indices do attempt to measure independence but that actual independence is best approximated by our measure of empirical independence. Summarizing, an independent central bank will contribute to lower inflation rates, lower money markets rates and current account surpluses without effects on the economic growth rate. So, the statement of Grilli, Masciandaro, and Tabellini (1991) that having an independent central bank is like having a free lunch is confirmed.

Notes

1. For a recent discussion about the independence of the Bank of England and the associated inflation targeting framework see Roll et al. (1993).
2. For a survey of the 'state of the art' see Cukierman (1992) and Eijffinger and De Haan (1995).
3. This framework is summarized in Alesina and Grilli (1992).
4. Exceptions are Bade and Parkin (1988: 21–23).
5. Since the 1980s the establishment of the EMS made central banks more dependent on external constraints, for this period one would expect this relationship to be affected. We leave this as an item for further research.
6. In fact, the ES index is more than a purely legal index of central bank independence. The central bank laws are examined against the background of monetary policymaking. See Eijffinger and Schaling (1993a: 51). This implies that the ES index tries to grab some of the actual independence. This is in contrast with the other – purely legal – indices of central bank independence.
7. See Cukierman (1992: 369 and Section 19.7: 393–395).
8. This may be criticized if one conceives central bank independence structurally. Grilli, Masciandaro, and Tabellini (1991: 366), for example, acknowledge that "the independence of the Bundesbank is the result of specific central bank laws but also of its reputation and a tradition of monetary discipline. Hence, by neglecting behaviourial indicators we miss an important dimension of monetary regimes." Nevertheless, they confine themselves to a purely legal– structural – index of central bank independence because "behaviourial indicators have often varied over time (e.g., with personalities in charge of monetary policy) whereas monetary institutions have generally been more invariant and, to the extent that there have been institutional reforms, they are more clearly identifiable." See also Eijffinger (1993).
9. In this respect it is interesting that Cukierman (1992: 421) finds results indicating that the divergence between the law and actual practice in developing countries is substantially higher than in developed countries.
10. This does not mean, though, that legal independence (and perhaps other factors) can not be used as a proxy for actual independence. Later in this section we will try to find empirical measures of actual independence, and, using this measure of actual independence we will test whether actual independence can be approximated by legal independence.
11. We have also tried to deduce different degrees of independence from differences in the parameters in front of the regressors. Therefore, the reaction function is also estimated for the ten countries separately using only time series analysis. There appeared to be no systematic relation between these varying coefficients and central bank independence in the these countries.
12. We assume the error term $\eta_{i,t}$ to be an independently, identically distributed random variable with mean zero and variance σ_η^2. Furthermore, we assume that the error term is independent of the regressors. Moreover, when we use F-statistics or t-statistics we, implicitly, make the assumption that the error term is normally distributed.
13. We will consider the following ten countries (N = 10): Australia, Canada, France, Germany, Italy, Japan, the Netherlands, Switzerland, the United Kingdom and the United States. This means – in comparison to our previous analyses – that we excluded Sweden. This is because of the fact that we were faced with a trade-off between the number of countries to include and the number of observations per country that could be included. Because we are using paneldata we need data for all countries for the whole sample period. This means that the countries with little observations determine the length of the sample period. By excluding Sweden, our sample period ranges from the third quarter of 1977 (t = 1) to the last quarter of 1990 (t = T = 54).

14. We expect legal independence to constitute the normal (mean) level of central bank independence developing over time due to gradual changes in the tradition and culture of monetary stability and because of different personalities in policy boards of central banks and in institutions that try to influence the actions of the central banks. However, for the time being, we assume these changes to be marginal and neglect them.
    Concerning the importance of different persons in the policy board on a central bank it is illustrative to quote Friedman (1962: 234). He states that a "defect of the conduct of monetary policy through an independent central bank that has a good deal of leeway and power is the extent to which policy is thereby made highly dependent on personalities." Referring to Friedman's article Bade and Parkin (1988: 21) state that there is a "large potential for individual Governor/Director preferences and for personal strengths and weakness to influence policy in a genuinely independent central bank".
15. The fixed-effects model approach is described in Hsiao (1986: 29–32).
16. Unless, we have additional restrictions. If we, for example, introduce the restriction that the sum of all CBI_i's must be zero then it is possible to identify both β_0 as well as CBI_i's. The individual effects then can be interpreted as the deviation of the individual country from the common mean β_0. See Hsiao (1986: 32).
17. The conditions for $\eta_{i,t}$ mentioned in footnote 12 imply for η_i:

$$\begin{array}{lll} \text{(i)} & E(\eta_i) = 0 & \text{for } i = 1...N \\ \text{(ii)} & E(\eta_i \eta_i') = \sigma_\eta^2 I_T & \text{for } i = 1...N \\ \text{(iii)} & E(\eta_i \eta_j') = 0 & \text{for } i,j = 1...N \wedge i \neq j \end{array}$$

    with I_T denoting the T by T identity matrix.
18. This estimator is called this way because only the variation within each group (country) is used. Other names which sometimes are used for this estimator are covariance estimator or least-squares dummy-variable (LSDV) estimator. The first name stems from the fact that models like equation (4.2) are also called analysis-of-covariance models. The name LSDV estimator finds its origin in the fact that we also can estimate this model using dummies, as we will see later on.
19. Though, the response also depends on the way the economy is organized. A different structure of the economy implies somewhat different reactions to actions of central banks and, therefore, somewhat different constraints on the behaviour of central banks.
20. In general, countries with an independent central bank will have lower mean inflation rates than countries with more dependent central banks. See, for instance, Eijffinger and Schaling (1993b) or Cukierman (1992: Chs. 18 and 20), for theory and empirical evidence confirming this statement. This implies that, notwithstanding the fact that the money market rate in latter countries will be relatively lower, they actually may have a higher money market rate. According to theory and empirical evidence the degree of independence does not influence the mean level of economic growth. See Eijffinger and Schaling (1993b). These relations between central bank independence and the mean (and variance) of the inflation rate, the rate of economic growth, the current account surplus and the money market rate are investigated in Section 6.
21. Note that $EMP_i = \beta_0 + CBI_i$. Because β_0 is equal for all central banks and because the individual effect CBI_i is expected to be lower for more dependent central banks the composite coefficient EMP_i is also expected to be lower for more dependent central banks.
22. At second thought this may be not so remarkable. We are investigating the common behaviour towards economic growth and inflation of ten countries among which some have independent central banks and some have more dependent ones. So, it is well possible that the common reaction is dominated by economic growth data. After all, the different inflation-aversion between the countries comes forward in the proxy for actual independence.
23. In Table 2 the three types of central banks (strongly independent, intermediate independent and dependent) are separated by space.

24. For the Netherlands this is only true for a 10% significance level. For Switzerland and Germany this is true on a 5% level. In the other seven countries the intercept is even significant on a 1% level.
25. Of course, it would be too much to expect the generalized individual effect (EMP) for each country to differ significantly from all other countries. Ten countries imply ten confidence intervals and these are likely to show – at least – some overlap.
26. These comparisons have been made using a 1% significance level. Using a 5% significance level there are more significant differences. The class of strongly independent central banks are significantly more independent than the central banks from Australia, France and the United States. Furthermore, there are significant differences between the Banca d'Italia and the central banks in Canada, Switzerland and Japan. Also the Bank of Japan is significantly more independent than the Bank of England.
27. In the United States, for instance, the Board of Governors consists of seven members which all are appointed for fourteen years by the President. Every two years one Governor is replaced. It should be noted, though, that this is the most extreme case of gradually replacing members of the policy board of a central bank. See Bade and Parkin (1988: 10–15).
28. A way to model the alternative behaviour could be:

$$CBI_{i,t} = \mu_i + \nu_{i,t} \text{ with } \nu_{i,t} = \rho\nu_{i,t-1} + \lambda_{i,t}$$

and

$$\lambda_{i,t} \text{ i.i.d. } N(0, \sigma^2_{\lambda_i}), 0 < \rho < 1.$$

Here i.i.d. denotes independently, identically distributed. A test whether the individual effects are fixed (H_0) are not against this alternative would amount to testing:

$$H_0 : \sigma^2_{\nu_i} = 0 \text{ versus } H_1 : \sigma^2_{\nu_i} > 0.$$

Note that we did not test our null hypothesis with respect to this particular alternative. It is mentioned here to get insight in the actual process by looking at an attempt to formalize this process. Note further that Cukierman (1992: 165) also uses the same specification for his parameter A – i.e., the relative emphasis on employment versus price stability – when he is modelling shifts in this relative concern as well as the persistence in these shifts. In Eijffinger and Schaling (1993b: 6) the parameter 1/A is identified with the degree of central bank independence.
29. The first sub-period ranges from 1977 III – 1984 I and the second from 1984 II – 1990 IV.
30. Also for the whole sample period the overall contribution of the regression to the explanation of the variation in ΔMMR is significant on a 1% level.
31. In Table 3 the three types of central banks are again separated by space.
32. This is confirmed by applying the Chow (1960) stability test. Computing this test statistic for the paneldata estimations – i.e., equations (10), (11) and (12) – gives 0.598 which does not exceed 1.70 which is the 5% significance level of the F-distribution with 14 degrees of freedom in the numerator and 512 in the denominator.
33. Of course, we will not include Sweden in this table because we also excluded Sweden when determining the empirical independence of central banks. Note further than the three groups of central banks (strongly independent, intermediate independent and dependent) are separated in Table 4 by space.
34. This is consistent with the observation of Cukierman (1992: 419) that legal independence is a good measure for actual independence in developed countries. He found evidence, however, that legal independence and actual independence are two different things in less developed countries. He suggests the turnover of central bank governors as a measure of actual independence of central banks in this latter group of countries.
35. Notice that this is a one-sided test. The null hypothesis is no – or negative – correlation and the alternative hypothesis is positive correlation.

36. The Pearson correlation test statistic is defined by:

$$t_\rho = \frac{\sqrt{n-2}}{\sqrt{1-\rho^2}}\rho, \text{ with}$$
$$\rho = \text{Pearson correlation coefficient,}$$
$$n = \text{number of observations.}$$

We have 10 countries in our sample. So, n = 10. Under the assumption that the numerical values for empirical independence and the legal index of central bank independence are drawn from a bivariate normal distribution the Pearson correlation test statistic follows a t-distribution with n – 2 degrees of freedom. In our case the critical values for the Pearson test statistics are 1.397 on a 10% level and 1.860 on a 5% level. This corresponds to critical levels for the correlation coefficient of respectively 0.443 and 0.549.

37. This is not remarkable in the light of the fact that the ES-index is the only index that tries to grab some of the actual implementation of central bank laws. Also our empirical index is based on actual behaviour of central banks. So, apparently, Eijffinger and Schaling succeeded in creating an index that comprises legal independence as well as the actual implementation of the law. It should be noted, however, that legal indices only change when central bank laws are changing and that these changes are easily to identify. The ES-index, though, is somewhat more difficult to construct and is likely to change more frequently while these changes are more difficult to identify.
38. At first sight, it may look strange that the AL index performs better as a proxy for actual independence than, for instance, the BP index. Is this a contradiction of the fact that the AL index is internally inconsistent? This is not the case. The AL index is internally inconsistent because Italy is downgraded for the wrong reasons. The fact that Italy is downgraded was expected to correspond more to reality. This is confirmed by the results.
39. It should be noted, though, that it is not clear what determines investments. It is likely that the real interest rate is more important in determine investments than the nominal interest rate. This implies that if central bank independence leads to lower inflation and concomitant inflationary expectations as well as to a lower nominal money market rate the total effect of central bank independence on the real interest rate still is undetermined.
40. At the same time we also analyze whether central bank independence has any effect on the variability of the money market rate. This is investigated because a lower variability in the money market rate contributes to more financial stability.
41. In the Appendix the data that were used for the mean and variance of the inflation rate, the economic growth rate, the current account surplus and the money market rate are given. Also is described how these averages and variances have been computed.
42. Notice that contrary to the previous Pearson correlation test this one is two-sided. For each combination of index and performance measure the null hypothesis is no correlation. So, $H_0 : \rho = 0$ is tested against the alternative hypothesis $H_1 : \rho \neq 0$. Again $n = 10$ and the Pearson correlation test statistic follows at t-distribution with 8 degrees of freedom. In this case the critical values for the Pearson test statistic are 1.860 on a 10% level, 2.306 on a 5% level and 3.355 on a 1% level. This corresponds to critical levels for the correlation coefficient of respectively 0.549, 0.632 and 0.765.
43. Two exceptions are the negative relations between the GMT Economic index and the variance of inflation and between the GMT Policy index and average output growth.

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Appendix 1. Measures of economic performance (1977–1990)

Country	Average inflation rate	Variance inflation rate	Average output growth rate	Variance output growth rate	Average current account output ratio	Variance current account output ratio	Average money market rate	Variance money market rate
Australia	8.0689	0.5157	2.9653	1.2521	0.01061	0.15101	12.5022	9.1473
Canada	6.5291	0.5765	2.8036	0.9433	0.52320	0.10672	11.1037	8.3870
France	7.1328	1.0494	2.3522	0.3171	–0.28829	0.07889	10.5000	7.0110
Germany	2.8855	0.3855	2.4330	1.2700	1.22677	0.38894	6.5783	6.3981
Italy	10.5334	1.8515	2.7807	0.5747	–0.65425	0.27867	12.7391	9.5540
Japan	2.7192	0.7046	4.2737	0.4015	0.44479	0.15568	6.3876	3.1252
Netherlands	2.9712	0.4911	2.0183	2.8862	0.25657	0.55574	6.9587	4.9255
Switzerland	3.3057	0.4844	2.1238	0.2212	–1.06766	0.26058	4.2826	5.8134
United Kingdom	7.7945	1.9347	2.2037	1.1139	–2.65500	2.99585	11.3017	6.8556
United States	5.9584	0.8551	2.3577	0.9309	–0.60158	0.05391	8.6637	6.1349

The data for economic performance which have been used for the regressions reported in Table 6 are given above. These averages and variances are calculated from quarterly data reaching from the third quarter of 1977 till the last quarter of 1990. So, they are based on 54 observations. This particular period has been chosen because it coincides with the sample period used in the paneldata estimations. This is because of the conviction that the interpretations in Section 6 are most meaningful when the analyses of the behaviour of central banks – given by reaction function (10) and Table 2 – are as comparable as possible with the data for economic performance. Consequently, the rate of inflation, the rate of economic growth and the current account to GDP ratio are calculated from quarter to quarter.