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CENTRAL BANK INDEPENDENCE: A SENSITIVITY ANALYSIS

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ABSTRACT

In this paper we investigate the empirical relationship between four measures of central bank independence and macroeconomic performance. We look at both the mean and the variance of output and inflation for twenty industrial countries (Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom and the United States) for the period 1972-1992. The elasticity of inflation with respect to central bank independence is estimated and we calculate the fraction of the covariance between the mean and the variance of inflation that can be explained by their common association with central bank independence. We check the robustness of our results by looking at four indices of central bank independence, two subperiods and by including control variables.

We find that central bank independence lowers the mean and variance of inflation but has no effect on the mean and variance of output growth.

I INTRODUCTION[1]

In both economic research and policy making, the issue of central bank independence has been widely investigated and discussed during the last decade. To a large extent, this interest is motivated by the success of the Deutsche Bundesbank in keeping the rate of inflation stable at a low level for several decades. Economic theory as developed by Rogoff (1985), Neumann (1991) and Lohmann (1992) suggests that countries having an independent central bank can achieve low inflation rates because politicians cannot so easily influence monetary policy. This is good because politicians face a time-inconsistency problem when they try to implement their preferred policies and this leads to inferior outcomes. The time-inconsistency problem can be mitigated by delegating monetary policy to an independent central bank that is more conservative than the government in the sense that it cares more about inflation. However, the improved *credibility* that causes the lower rate of inflation comes at the cost of having less *flexibility*. Since the conservative central bank cares more about a low and stable rate of inflation, it will care less about stabilizing output shocks. In this paper we want to confront these theoretical results with the data for twenty industrial countries (Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, New Zealand, Sweden, Switzerland, the U.K. and the U.S.) for the post-Bretton Woods period (1972-1992). We also want to investigate how sensitive the empirical results are for the measure of central bank independence and the sample period that is chosen. Therefore, we do our regressions with four different measures for central bank independence and for both the whole sample period and two subperiods 1972-1982 and 1983-1992.

There are four important conclusions that follow from our paper. First, our estimation results show an inverse relationship between central bank independence and the level of inflation that is also found by Alesina (1988, 1989) and Cukierman, Webb and Neyapti (1992). Including openness as an additional explanatory variable as suggested by Romer (1993) doesn't change our results. Secondly, like Alesina and Summers (1993), we find some empirical evidence that the more independent the central bank is, the lower the variance of inflation. Thirdly, we do not find empirical support for the implication of the Rogoff (1985) model that more central bank independence leads to a higher variance of real output growth. Finally, after controlling for other factors that influence economic growth as described by Barro (1991), De Long and Summers (1992) and Levine and Renelt (1992), we find no empirical relationship between central bank independence and the level of real output growth.

The plan of this paper is as follows. In section 2, building on the Rogoff (1985) model we briefly analyze the theoretical relationships of central bank independence with the distributions of output and inflation. In section 3 we confront the propositions from the game-theoretic model with empirical evidence. We perform a sensitivity analysis that consists of using various indices of central bank independence, looking at two subperiods and adding control variables. Finally, section 4 concludes.

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[1] The authors are grateful for helpful comments by Alberto Alesina, Larry Summers, Stanley Fischer, Guy Debelle and two anonymous referees. Of course, the usual disclaimer applies.

II CREDIBILITY VS FLEXIBILITY

2.1 Recapitulation of the Monetary Policy Game

This section offers a short sketch of the theoretical background for the empirical work. It links the Rogoff model to the empirical work on indices of central bank independence (henceforth CBI).

There are two players, wage-setters and the central bank. Wage-setters unilaterally choose the nominal wage every period, and the central bank controls monetary policy. The labour market is characterized by one-period nominal wage contracts [Gray (1976), Fischer (1977a)]. Therefore, unemployment falls with unanticipated inflation. The behaviour of wage-setters is captured by a standard Phillips curve.

$$(2.1)\quad u_t = \tilde{u} - \frac{1}{1-\beta}(\Delta p_t - E_{t-1}\Delta p_t + v_t^{\mu}) \qquad 0 < \beta < 1$$

where u is unemployment, $\tilde{u}$ is the permanent or "natural" rate of unemployment, $(1 - \beta)^{-1}$ are the employment gains of unanticipated inflation (the slope of the Phillips curve) and v_t^{μ} is an aggregate supply shock with mean zero and finite variance σ_{μ}^2.

The social loss function W penalizes both inflation and unemployment

$$(2.2)\quad W_t = \frac{1}{2}(\Delta p_t)^2 + \frac{\chi}{2}(u_t)^2 \qquad 0 < \chi < \infty$$

The parameter χ is the relative weight of unemployment stabilization relative to inflation stabilization in the preferences of society. It is well-known that the minimization of (2.2) subject to the Phillips curve (2.1) results in a counterproductive inflation bias [Kydland and Prescott (1977) and Barro and Gordon (1983)] with no gains in the form of systematic lower unemployment.

2.2 The Legislative Approach

In this paper we consider the *legislative* approach to monetary stability, namely to create by law a very independent central bank with an unequivocal mandate to focus on price stability. Academic contributions in this area are Rogoff (1985) and Lohmann (1992).

Rogoff proofs that society (the principal) can reduce the time-consistent inflation rate, at the expense of a less flexible response to output shocks, by delegating monetary policy to an agent who is known to place a greater weight on inflation stabilization than is embodied in the social loss function (2.1).

This agent minimizes

$$(2.3)\quad L_t = \frac{1+\varepsilon}{2}(\Delta p_t)^2 + \frac{\chi}{2}(u_t)^2 \qquad 0 < \varepsilon < \infty$$

When ε is strictly greater than zero, then this agent is more "conservative" than society.

In the empirical part of this paper several measures (indices) of central bank independence are used. According to these indices, central banks in which the only or main objective of monetary policy (as specified in the central bank law) is price stability are classified as being more independent than central bank laws with a number of objectives in addition to price stability, or central banks in whose law price stability is not mentioned as an objective at all.

Therefore, following most of the literature we proxy CBI as the strength of the

"conservative bias" of the central bank as embodied in the law[2].

2.3 Implications of the Credibility vs. Flexibility Model

The algorithm for deriving the time-consistent equilibrium under central bank independence (equation (2.3)) is standard. The resulting output and inflation rates are given by[3]

$$(2.4) \quad u_t - \tilde{u} = \frac{-(1-\beta)(1+\epsilon)}{(1-\beta)^2(1+\epsilon)+\chi} v^{\mu}_t$$

$$(2.5) \quad \Delta p_t = \frac{\chi}{(1-\beta)(1+\epsilon)} \tilde{u} - \frac{\chi}{(1-\beta)^2(1+\epsilon)+\chi} v^{\mu}_t$$

Following Cukierman (1992, pp. 353-355) in this section we investigate the effects of CBI on the implied distributions of output and inflation. As is suggested by the main intuition of the Rogoff model, there is an *inverse* relation between CBI and the mean inflation rate and a *positive* relation between CBI and the variance of output. The reason is simple, increasing the central bank's commitment to fighting inflation reduces society's *credibility* problem (and hence the mean and variance of inflation) at the expense of a distorted response to ouput shocks, - i.e. *flexibility* - increasing the variance of ouput. Finally, the mean output level is unaffected by CBI, as is to be expected in a natural rate model[4].
We now move on to confront the implications of the credibility vs. flexibility model with some empirical evidence.

III EMPIRICAL EVIDENCE ON CENTRAL BANK INDEPENDENCE

This section takes a hard look into the empirical evidence regarding the link between central bank independence and the level and variability of inflation and economic growth, respectively. Unfortunately, most existing research has focused on one measure of central bank independence only, so that it is not clear whether conclusions drawn are 'measure specific'. To overcome this difficulty, we use the measures of Alesina (1988, 1989), Grilli, Masciandaro and Tabellini (1991), Eijffinger and Schaling (1992, 1993a) and Cukierman (1992) as explanatory variables. We compare the outcomes of our empirical analysis on the relationship between central bank independence and the level and variability of inflation and economic growth with results reported in the literature.

3.1 The level of inflation
According to Alesina (1988, 1989), countries with an independent central bank will have lower rates of inflation than do countries with a dependent central bank. This well-known inverse

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[2] Eijffinger and Hoeberichts (1996) explicitly distinguish between conservativeness and independence.

[3] The supply function that is consistent with (2.1) is given by

$$y_t = \tilde{y} + \frac{\beta}{1-\beta}(\Delta p_t - E_{t-1}\Delta p_t + v^{\mu}_t)$$

[4] Formally this can be shown by taking the first derivative of both moments of output and inflation with respect to ϵ.

relationship between central bank independence and the level of inflation is also supported by empirical studies of De Haan and Sturm (1992), Alesina and Summers (1993) and Eijffinger and Schaling (1993b). It should, however, be noted that a negative correlation between central bank independence and inflation does not necessarily imply causation. The correlation between both variables could be explained by a third factor, e.g. the culture and tradition of monetary stability in a country, explaining both an independent central bank and low inflation.[5]

Still, the degree of central bank independence may be an important factor in explaining the level of inflation, because central bank independence reflects the ability and willingness to conduct an autonomous monetary policy directed at price stability. If not seriously hampered by wage increases, budget deficits and government debt, such policy will eventually lead to a low and sustainable level of inflation. The ultimate determinants of central bank independence are discussed more extensively in Eijffinger and De Haan (1995).

Using OLS regressions we investigate the link between the average level of inflation (annual percentage change of the Consumer Price Index) and the degree of central bank independence according to the measures of Alesina (AL), Grilli, Masciandaro and Tabellini (GMT), Eijffinger and Schaling (ES) and Cukierman (LVAU). The countries considered are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom and the United States. The relationship between average inflation in these countries and the four indices of central bank independence is analyzed for the post-Bretton-Woods period 1972-1992. 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 relationship between central bank independence and inflation is likely to be much less straightforward before 1972. Regression analysis by De Haan and Sturm (1992) supports this view. These authors found no significant relationship between both variables for the period 1961-1969.

In our analysis the post-Bretton-Woods period is divided into two subperiods (1972-1982 and 1983-1992) in order to distinguish between EMS countries (Belgium, Denmark, France, Germany, Ireland, Italy, the Netherlands and, partly, Austria, Portugal, Spain and the United Kingdom) on the one hand and non-EMS countries (Australia, Canada, Finland, Japan, New Zealand, Norway, Sweden, Switzerland and the United States) on the other. Although the Exchange Rate Mechanism of the EMS (ERM) was enacted in March 1979 after the 'snake arrangement', Ungerer (1990) characterizes the first phase of the EMS (1979-1982) as a period of 'initial orientation' full of frequent and, sometimes, large realignments of central rates. From 1982 onwards, the EMS enters a second phase of 'consolidation' (1982-1987), and - after the accord of Basle-Nyborg - moves into a third phase of 're-examination' (1987-present).[6] Consequently, the negative correlation between central bank independence and inflation is expected to be less clear cut during the second subperiod (1983-1992) than during the first subperiod (1972-1982), because of the priority EMS countries gave at that time to exchange rate stability. After 1982 monetary policy in these countries - except Germany as the anchor country - has become increasingly endogenous because exchange rate targets became

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[5] The standard example is the case of Germany, where the hyperinflation in the 1920s led to a culture and tradition of monetary stability.

[6] According to Ungerer (1990) the phase of consolidation was marked by "...a widespread consensus to follow stability-oriented policies, an increasing convergence in the development of costs, prices and monetary aggregates, and by long periods without realignments of central rates." (p. 338).

dominant.

Table 3.1 Average inflation and the measures of CBI

Explanatory variables	1972-1992		1972-1982		1983-1992	
Constant	12.40	14.10	16.05	18.40	8.38	9.33
	(12.74)	(12.51)	(12.58)	(12.27)	(9.51)	(8.61)
Alesina (AL)	-2.24	-2.27	-2.78	-2.82	-1.65	-1.66
	(-5.33)**	(-6.14)**	(-5.04)**	(-5.84)**	(-4.34)**	(-4.50)**
Openness		-5.75		-8.01		-3.23
		(-2.23)*		(-2.35)*		(-1.43)
R^2 (adjusted)	0.63	0.72	0.60	0.70	0.52	0.56
Constant	15.27	15.85	19.46	20.03	7.85	8.89
	(9.53)	(7.46)	(11.05)	(8.42)	(7.41)	(6.79)
Grilli et al. (GMT)	-0.92	-0.93	-1.11	-1.12	-0.42	-0.43
	(-4.81)**	(-4.69)**	(-5.30)**	(-5.16)**	(-3.28)**	(-3.43)**
Openness		-1.74		-1.77		-3.01
		(-0.43)		(-0.38)		(-1.30)
R^2 (adjusted)	0.58	0.56	0.63	0.61	0.38	0.41
Constant	12.27	11.88	15.53	15.35	7.56	7.67
	(7.47)	(5.75)	(8.43)	(6.53)	(8.60)	(7.12)
Eijffinger-Schaling (ES)	-1.60	-1.65	-1.90	-1.93	-1.03	-1.01
	(-2.85)*	(-2.75)*	(-3.03)**	(-2.84)*	(-3.42)**	(-3.14)**
Openness		1.78		0.84		-0.53
		(0.32)		(0.13)		(-0.19)
R^2 (adjusted)	0.28	0.24	0.31	0.27	0.37	0.34
Constant	10.74	11.49	14.28	14.95	6.84	7.61
	(9.06)	(7.19)	(8.43)	(6.84)	(7.14)	(6.16)
Cukierman (LVAU)	-8.83	-8.78	-11.50	-11.50	-5.89	-5.79
	(-2.92)**	(-2.86)*	(-2.87)*	(-2.80)*	(-2.41)*	(2.36)*
Openness		-2.52		-2.25		-2.58
		(-0.72)		(-0.46)		(-0.99)
R^2 (adjusted)	0.29	0.27	0.29	0.25	0.21	0.21

Notes: t-values are in parentheses. One asterisk indicates that the coefficient is significantly different from zero at a 95% confidence level, two asterisks indicate that the coefficient is significant at a 99% confidence level.

Table 3.1 shows our estimation results for average inflation and the four measures of central bank independence during the whole period (1972-1992) and both subperiods (1972-1982 and 1983-1992). Following Romer (1993) we have also included the variable "openness" as measured by the percentage share of imports in GDP in the regression equation as an explanatory variable for the level of inflation. During the post-Bretton-Woods period and both subperiods, the inverse relationship between inflation and central bank independence appears to be significant for all measures. It should also be noted that including the variable openness doesn't change the results much, indicating that the estimated coefficients are robust.

The conclusion that follows from table 3.1 is that the more independent a central bank is,

the lower the rate of inflation in the long run will be. The table also confirms our intuition that the inflation reducing effect of a one unit increase in an index of CBI is larger in the first subperiod than in the second. This holds for all four indices of CBI.
Cukierman has elaborated his legal independence index (LVAU) for 68 countries - i.e. 21 developed industrial countries and 47 developing countries. Cukierman found no significant link between central bank independence and inflation for the group of developing countries. In his opinion, this is a consequence of the fact that these countries have "less regard for the law."[7]

Table 3.2 Elasticity of inflation with respect to the measures of CBI

Explanatory variables	1972-1992	1972-1982	1983-1992
Constant	2.44	2.70	2.04
	(25.58)	(28.34)	(12.80)
Alesina (AL)	-0.68	-0.63	-0.82
	(-5.67)**	(-5.29)**	(-4.08)**
R^2 (adjusted)	0.66	0.63	0.49
Constant	3.54	3.73	2.66
	(11.83)	(13.11)	(6.02)
Grilli et al. (GMT)	-0.78	-0.73	-0.62
	(-5.26)**	(-5.15)**	(-2.85)*
R^2 (adjusted)	0.62	0.61	0.31
Constant	2.42	2.66	1.98
	(15.35)	(18.17)	(11.02)
Eijffinger-Schaling (ES)	-0.48	-0.44	-0.57
	(-3.06)**	(-2.99)**	(-3.17)**
R^2 (adjusted)	0.32	0.31	0.34
Constant	1.54	1.84	1.07
	(8.11)	(9.95)	(4.00)
Cukierman (LVAU)	-0.38	-0.38	-0.35
	(-2.42)*	(-2.51)*	(-1.58)
R^2 (adjusted)	0.21	0.23	0.08

Notes: t-values are in parentheses. One asterisk indicates that the coefficient is significantly different from zero at a 95% confidence level, two asterisks indicate that the coefficient is significant at a 99% confidence level.

Because the four indices of CBI that we used in our analysis all are defined on a different scale, the size of the parameters is difficult to interpret. Therefore, we also calculated the elasticities of inflation with respect to the different measures of CBI. We did this by estimating a regression equation in which the log of inflation is explained by the log of CBI and a constant. The results are presented in table 3.2.

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[7] This is only valid for the legal measure of Cukierman for central bank independence. If the 'turnover rate' of central bank governors is used as a measure of actual independence, Cukierman (1992) finds a significant negative relationship for developing countries.

From table 3.2 we conclude that for the whole sample period and for the first subperiod a one percent increase in CBI as measured by the GMT index yields the highest reduction in the rate of inflation. For the second subperiod, the elasticity of inflation with respect to the Alesina index is the highest. Interestingly, a comparison between the first and the second subperiod doesn't give a clearcut result in table 3.2, as it did in table 3.1.
Finally, it is interesting to note that Debelle and Fischer (1995) have shown that if the GMT measure is split into various components (lack of goal independence, political independence and economic independence) the two variables that most closely tied to inflation performance are lack of goal independence (i.e. the bank has a statutory requirement to pursue price stability) and economic independence (i.e. instrument independence); the variables relating to appointment procedures are not significantly related to inflation.

3.2 The variability of inflation

What is the empirical relationship between central bank independence and the *variability of inflation*? Chowdhury (1991) has investigated the relation between the level and variability of inflation in 66 countries for the period from 1955 to 1985. He concludes that during this period there exists a significant, positive correlation between both variables. De Haan and Sturm (1992) have also examined this relation in eighteen industrial countries for the period 1961-1987. They found a clear, positive correlation between both variables for the post-Bretton-Woods subperiods 1970-1978 and 1979-1987, but no for the subperiod 1961-1969.

We expect that greater independence should lead to less variability of inflation. We assume the various measures of central bank independence (AL, GMT, ES and LVAU) to be the explanatory variables of the variance of inflation (CPI) for the sample. Again, the relationship between the four indices and the variance of inflation is examined for the complete post-Bretton-Woods period (1972-1992) and our two subperiods (1972-1982 and 1983-1992). During the second subperiod, the negative correlation between central bank independence and inflation variability is also expected to be less clear cut than during the first subperiod as a consequence of growing exchange rate stability between EMS countries.

Table 3.3 shows the results for the variance of inflation and the four measures of central bank independence using data from the sample. The inverse relationship between inflation variability and independence is significant for the index of Grilli et al. (all periods), for the Cukierman index (whole period and first subperiod) and for the Alesina index (second subperiod). For the other indices and periods, we find a negative but insignificant relation for both the whole period, and its two subperiods. From this table, it may be concluded that there is some evidence that greater independence of a central bank guarantees a more stable inflation.[8] Hence there is some empirical evidence that the more independent the central bank, the lower the variance of the inflation rate.

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[8] De Haan and Sturm (1992) find a significant negative relationship for the modified measure of Grilli et al. and for the Alesina and ES indices during the period 1961-1987. Alesina and Summers (1993) report similar results for an average of the Alesina and GMT index.

Table 3.3 Variance of inflation and the measures of CBI

Explanatory variables	1972-1992	1972-1982	1983-1992
Constant	25.34	11.85	12.02
	(4.61)	(2.23)	(4.06)
Alesina (AL)	-4.61	-0.72	-3.31
	(-2.02)	(-0.31)	(-2.59)*
R^2 (adjusted)	0.16	-0.06	0.26
Constant	45.51	30.93	25.25
	(8.15)	(5.77)	(4.28)
Grilli et al. (GMT)	-3.40	-2.35	-2.31
	(-5.09)**	(-3.41)**	(-3.27)**
R^2 (adjusted)	0.61	0.40	0.38
Constant	26.38	17.70	11.59
	(4.13)	(2.99)	(1.93)
Eijffinger-Schaling (ES)	-3.63	-2.31	-1.79
	(-1.66)	(-1.15)	(-0.87)
R^2 (adjusted)	0.09	0.02	-0.01
Constant	27.04	18.60	8.60
	(5.09)	(4.59)	(3.08)
Cukierman (LVAU)	-30.41	-23.10	-10.60
	(-2.24)*	(-2.24)*	(-1.49)
R^2 (adjusted)	0.18	0.18	0.06

Notes: t-values are in parentheses. One asterisk indicates that the coefficient is significantly different from zero at a 95% confidence level, two asterisks indicate that the coefficient is significant at a 99% confidence level.

We have also calculated, for each measure of CBI, how much of the strong positive association between the mean and the variance of inflation is due to their common association with CBI. This analysis is performed along the lines of Cukierman (1992) and Cukierman and Webb (1995). We predicted the mean and the variance of inflation, using only CBI as an explanatory variable. The ratio between the covariance of the predictions and the covariance of the actual mean and variance of inflation are a measure for the extent to which the positive association between variance and mean can be attributed to CBI. We find the following ratios as presented in table 3.4.[9] Cukierman (1992) reports a value of 0.19 for developed countries for the period 1950-1989. This comes close to our value of 0.21 for the LVAU index for our sample period. The most striking result that we find in table 3.4 is that between 86 and 100% of the positive covariance between the mean and the variance of inflation can be explained by cross country variations of the GMT index.

[9] The fact that for the GMT index the ratio is larger than one must be due to negative correlation between the residuals of the two regressions.

Tabel 3.4 CBI and the association between mean and variance of inflation

Index	1972-1992	1972-1982	1983-1992
AL	0.24	0.06	0.50
GMT	0.86	0.89	1.02
ES	0.25	0.23	0.30
LVAU	0.21	0.26	0.19

Note: The figures in the table represent the fraction of the covariance between the mean and the variance of inflation that is due to their common association with the index of CBI for the different periods.

3.3 Economic growth

Central bank independence may stimulate economic growth in the longer run because with a low and stable rate of inflation the functioning of the price mechanism will be better. Empirical research by Grimes (1991) and Fischer (1993) shows that inflation reduces economic growth.[10] This may be explained by the positive corelation between the level and variability of inflation. Greater variation in the rate of inflation can imply increasing uncertainty about inflation and may, thereby, lead to lower economic growth. This relationship between inflation variability and economic growth is, however, not supported by most studies.

Various studies have examined directly whether central bank independence affects economic growth. Grilli, Masciandaro and Tabellini (1991), De Haan and Sturm (1992), Eijffinger and Schaling (1993b) and Alesina and Summers (1993) all conclude that central bank independence has no effect on economic growth.

This conclusion is supported by results reported in table 3.5 which presents estimates for the average annual growth rate of per capita real Gross Domestic Product, and the four measures of central bank independence. The literature on long-run economic growth identifies various factors that determine the growth rate of a country. Based on Barro (1991), De Long and Summers (1992) and Levine and Renelt (1992) we have chosen two additional variables to be included in the regression: Initial GDP per capita (Y60) and the share of investment in GDP (I/Y). The relationship between real economic growth and central bank independence appears to be insignificant except for the GMT index during the second subperiod (1983-1992) where central bank independence has a positive effect on growth. The coefficients for the other indices and periods have mixed signs and are insignificant. Despite the fact that a high degree of central bank independence is associated with lower inflation in the long run, it follows from table 3.5 that a policy of disinflation is apparently not associated with high costs or great benefits in terms of long-run economic growth. Hence, in general, empirical evidence shows that there is no relationship between central bank independence and average real output growth.[11]

We also note that a one unit increase in an index for CBI leads to more expected output

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[10] This conclusion of Grimes (1991) and Fischer (1993) is contradicted in a study by Karras (1993).

[11] Cukierman (1993, p. 284) reports that when similar experiments are repeated for LDCs, again, no association is found between *legal* independence and growth. Using several behavioral measures of central bank independence, like the turnover rate of central bank governors, and controlling for other determinants of growth Cukierman, Kalaitzidakis, Summers and Webb (1993) find a *ceteris paribus* positive association between growth and central bank independence.

growth in the second subperiod than in the first one.

Table 3.5 Average economic growth and the measures of CBI

Explanatory variables	1972-1992	1972-1982	1983-1992
Constant	3.50	1.73	4.44
	(3.64)	(1.26)	(3.80)
Alesina (AL)	0.20	0.04	0.38
	(1.52)	(0.20)	(2.03)
I/Y	-0.00	0.06	-0.05
	(-0.00)	(1.65)	(-1.24)
Y60	-0.31	-0.25	-0.33
	(-4.62)**	(-2.49)*	(-3.81)**
R^2 (adjusted)	0.62	0.52	0.43
Constant	3.89	3.19	4.40
	(5.85)	(2.78)	(6.18)
Grilli et al. (GMT)	0.07	0.04	0.11
	(2.06)	(0.75)	(2.24)*
I/Y	-0.01	0.01	-0.03
	(-0.34)	(0.34)	(-0.95)
Y60	-0.37	-0.32	-0.41
	(-7.42)**	(-3.99)**	(-6.27)**
R^2 (adjusted)	0.81	0.62	0.72
Constant	3.61	1.81	4.70
	(4.49)	(1.69)	(4.67)
Eijffinger-Schaling (ES)	-0.03	-0.11	0.04
	(-0.33)	(-0.97)	(0.32)
I/Y	0.01	0.07	-0.03
	(0.42)	(2.19)*	(-0.95)
Y60	-0.29	-0.23	-0.32
	(-5.41)**	(-3.14)**	(-4.13)**
R^2 (adjusted)	0.66	0.59	0.46
Constant	3.45	1.95	4.26
	(3.82)	(1.58)	(3.95)
Cukierman (LVAU)	0.26	-0.47	1.17
	(0.36)	(-0.51)	(1.17)
I/Y	0.01	0.06	-0.02
	(0.47)	(1.85)	(-0.70)
Y60	-0.30	-0.24	-0.33
	(-4.65)**	(-2.70)*	(-3.86)**
R^2 (adjusted)	0.62	0.57	0.41

Notes: t-values are in parentheses. One asterisk indicates that the coefficient is significantly different from zero at a 95% confidence level, two asterisks indicate that the coefficient is significant at a 99% confidence level.

3.4 The Variability of Output Growth

A new question is whether there exists a relationship between central bank independence and the *variation of economic growth*. Theory predicts different outcomes. According to Rogoff (1985), independent central banks purchase a lower level of inflation at the price of a higher variability of real economic growth. In contrast, Alesina and Summers (1993) argue that an autonomous central bank will be less inclined to conduct a 'stop-go' policy which may limit fluctuations in economic growth. Alesina and Gatti (1995) formalize this point.

Table 3.6 Variance of economic growth and the measures of CBI

Explanatory variables	1972-1992	1972-1982	1983-1992
Constant	7.95	7.96	7.33
	(3.59)	(4.06)	(2.25)
Alesina (AL)	-0.65	-0.14	-1.11
	(-0.68)	(-0.17)	(-0.79)
R^2 (adjusted)	-0.03	-0.06	-0.03
Constant	11.63	12.31	10.48
	(4.36)	(5.12)	(2.98)
Grilli et al. (GMT)	-0.60	-0.50	-0.69
	(-1.88)	(-1.74)	(-1.63)
R^2 (adjusted)	0.14	0.11	0.09
Constant	9.06	8.40	9.30
	(3.32)	(3.73)	(2.55)
Eijffinger-Schaling (ES)	-0.71	-0.10	-1.34
	(-0.77)	(-0.14)	(-1.08)
R^2 (adjusted)	-0.02	-0.06	0.01
Constant	6.97	6.64	6.75
	(3.69)	(4.01)	(2.39)
Cukierman (LVAU)	-1.51	2.11	-4.84
	(-0.31)	(0.50)	(-0.67)
R^2 (adjusted)	-0.05	-0.04	-0.03

Notes: t-values are in parentheses. One asterisk indicates that the coefficient is significantly different from zero at a 95% confidence level, two asterisks indicate that the coefficient is significant at a 99% confidence level.

Table 3.6 shows results of our regression analysis where the four measures of central bank independence try to explain the variance of annual economic growth rates. For none of the four measures, the coefficient appears to be significantly different from zero. On top of that, we also find most coefficients to be negative, indicating that more central bank independence is associated with lower variance of output growth. Consequently, we may conclude that a higher degree of central bank independence is not associated with greater variation of real economic growth rates. Alesina and Gatti (1995) provide a possible theoretical explanation for this empirical finding. They suggest that variance of output growth consists of two components. Apart from productivity shocks that are also present in Rogoff (1985), Alesina and Gatti (1995) have politically induced output shocks in their model. They show that the effect of

these shocks can be reduced by making the central bank more independent. So there are two opposite effects, which may explain these empirical findings. Comparing the two subperiods shows us that an increase in CBI leads to a larger expected reduction of the variance of output growth in the second subperiod than in the first one.

IV CONCLUSION

The main conclusions of this theoretical and empirical analysis of central bank independence with respect to the level and variability of inflation and economic growth are the following.

First of all, both our model and estimation results, give further support to the well-known inverse relationship between the degree of central bank independence and the level of inflation found by Alesina (1988, 1989) and Cukierman, Webb and Neyapti (1992). Secondly, we find some empirical evidence - especially for the Cukierman and GMT indices - supporting our proposition that the more independent the central bank is, the lower the variability of inflation.

Thirdly, according to our proposition that the level of economic growth does not depend on the prevailing monetary regime, no relationship can be found between central bank independence and the level of real output growth in the long run. Our interpretation of this outcome is that the attainment and maintenance of low inflation by an independent central bank is not accompanied by large costs or benefits in terms of sustainable economic growth.

Fourthly and finally, our estimation results reject clearly the proposition of a positive relation between independence and the variability of real output growth. An independent central bank does not lead to more variable economic growth in the short run. In other words, inflation-averse central banks do not bear the costs of triggering recessions nor do politically sensitive central banks reap the benefits of avoiding recessions. The absence of a long-run trade off between CBI and the mean and variance of economic growth implies that the establishment of central bank independence in countries, which did not use to have this, is a *"free lunch"* (Grilli, Masciandaro and Tabellini, 1991).

When looking at the differences between the subperiods that we distinguish, there are three observations with respect to the point estimates of CBI that can be made for all four indices. First, the inflation reducing effect of a one unit increase of CBI, according to all indices, was larger in the first subperiod than in the second. Interestingly, this doesn't hold in terms of elasticities. Secondly, after controlling for initial GDP and the share of investment, a one unit increase of CBI leads to more output growth in the second subperiod than in the first. Thirdly, a one unit increase of CBI leads to a larger reduction of the variance of output growth in the second subperiod than in the first.

THE DATA

- The mean and variance of inflation have been calculated from Consumer Prices- All Items, Non-adjusted, OECD Main Economic Indicators;
- The mean and variance of per capita output growth, intial (1960) per capita real GDP and the share of investment over GDP are calculated from Penn World Tables;
- Openness as measured by the share of imports in GDP is calculated from the National Accounts of OECD Countries, 1960-1977, 1977-1989, 1978-1992. (Imports of goods and services/GDP), in current prices. OECD Paris, 1979, 1991, 1994.
- The indices for CBI can be found in Eijffinger and De Haan (1996). Some observations are not available for the sample of 20 countries. For AL, Austria, Ireland and Portugal are not available, for GMT, Finland, Norway and Sweden, for ES, Ireland and for LVAU Portugal are lacking.

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