Central Bank Independence and the Sacrifice Ratio: The Dark Side of the Force

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I. THE ISSUE

As a rule with few exceptions disinflations cause output losses. The new classical explanation for this is that disinflations typically lack credibility. As SARGENT (1983) has argued, a credible central bank (CB) may disinflate almost costlessly simply by announcing in a convincing fashion that it will engineer a reduction of inflation. After analyzing disinflations in a model that combines imperfect credibility and staggered price setting, BALL (1995) sides with SARGENT's view: «The central result is that low credibility worsens the output-inflation tradeoff: the expected sacrifice ratio rises with the hazard that the Fed reneges» (p. 18).

FISCHER (1984) and TAYLOR (1983) have expressed a quite different view. After injecting real world features like long term, staggered wage contracts and relative-wage considerations into his analysis, TAYLOR goes on to show that in order to keep disinflation costs at a minimum, the disinflation must start very slowly and only pick up as the bulk of wage contracts has been renegotiated after the disinflation plan has been announced. Real-world disinflations, no matter whether engineered by a dependent or an independent CB, appear to proceed much faster than the cost-minimizing pattern derived by TAYLOR calls for.

So BALL and SARGENT propose a *negative* relationship between the *credibility* of a disinflation and its output costs. Beyond some threshold FISCHER and TAYLOR postulate a *positive* relationship between the *speed* of a disinflation and its real costs. But then, with the assumption that more independent CBs disinflate more credibly and faster, the BALL/SARGENT and the FISCHER/TAYLOR views imply contrasting correlations between central bank independence and the sacrifice ratio. According to BALL and SARGENT more independence (meaning higher credibility) *reduces* the sacrifice ratio. In the view of FISCHER and TAYLOR more CB independence (meaning faster disinflations) may *raise* the sacrifice ratio.

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This paper takes an empirical look at the relationship between CB independence and real activity.[1] Section II starts with a bird's eye view and asks how CB independence affects the transmission ratio, defined as the ratio between the variability of real activity and the variability of inflation. Section III narrows the focus to clearly discernible disinflation episodes, drawing on a set of data generated by BALL (1993). Section IV tries to establish the robustness of the results. Section V places the question in a wider context, including a set of structural characteristics of the economy, of the labor market, and of the disinflation at hand. Sections VI and VII discuss the empirical results by looking at SARGENT's and TAYLOR's propositions and beyond. Section VIII looks at total output losses generated by disinflations since the move to flexible exchange rates in 1973. Section IX sums up.

II. CENTRAL BANK INDEPENDENCE AND THE TRANSMISSION RATIO

An entirely credible CB which controls expectations via announcements can move inflation up or down without concomitant output responses. If independence enhances credibility (and at the same time reduces the incentive to trigger output responses), a given variability of inflation should translate into a smaller variability of output if independence is high. Table 1 regresses this transmission ratio (defined as the variance of GNP growth over the variance of inflation) on four measures of CB independence.

The independence indexes employed here are those published in ALESINA and SUMMERS (1993), CUKIERMAN (1992), GRILLI, MASCIANDARO and TABELLINI (1991), and a modification of the latter proposed by DE HAAN and STURM (1992). This latter index drops those parts from the GRILLI index which are related to supervision of the banking system. The purpose of looking at different indexes is to see whether they yield consistent results. This would provide stronger support for any effect of CB independence we might find in the present context.[2]

The results are surprising. Uniformly, across all CB independence indexes, we obtain a significant positive coefficient estimate. This one variable explains between a quarter and half of the variance of transmission ratios across the 16 countries considered here. Thus more CB independence and credibility does not seem to cushion the real economy from changes in inflation, but appears to make it even more vulnerable.

1. The discussion of this relationship started with a series of, as it seems, independently written papers by DEBELLE and S. FISCHER (1995), GÄRTNER (1995a), WALSH (1995), A. FISCHER (1996), and GÄRTNER (1995b), of which the current paper is a revised version. A recent addition to this list is JORDAN (1997).

2. Evaluations of relative performance need to take into account that, due to availability, the GRILLI indexes explain a smaller sample of 14 countries only.

Table 1.— Transmission ratios and central bank independence
OLS and GLS estimates; 16 OECD countries; 1973–1987; endogenous variable: transmission ratio

eq. #	constant	central bank independence	R^2_{adj}	employed CBI index
(1)	-0.41 (1.69) [1.18]	0.37 (3.82) [2.30]	0.48	Alesina/ Summers
(2)	-0.19 (1.09) [0.84]	1.89 (4.07) [2.52]	0.51	Cukierman
(3)[a]	-0.31 (1.10) [1.04]	0.10 (2.91) [2.26]	0.36	Grilli
(4)[a]	-0.18 (0.64) [0.86]	0.09 (2.44) [2.33]	0.28	modified Grilli

Notes: [a]14 countries only. The transmission ratio is defined as the variance of GDP growth over the variance of inflation. Absolute *t*-ratios are given in parantheses underneath estimation coefficients. Brackets contain *t*-statistics calculated from the heteroskedasticity-consistent covariance matrix derived by White.

There are a number of caveats to such an interpretation, of course:

(1) The transmission ratio lumps together inflation increases and reductions in a nondiscriminating fashion. It may well be that trade-offs during disinflations and reinflations are affected in quite different ways by the independence of the CB. Disinflations engineered by an independent and credible CB may well generate little sacrifice. Rising inflation, on the other hand may create the hugest output gains under an independent CB, simply because the labor market refuses to adjust inflation expectations upward. The positive coefficient reported in table 1 may reflect this improved gain ratio rather than a rising sacrifice ratio.

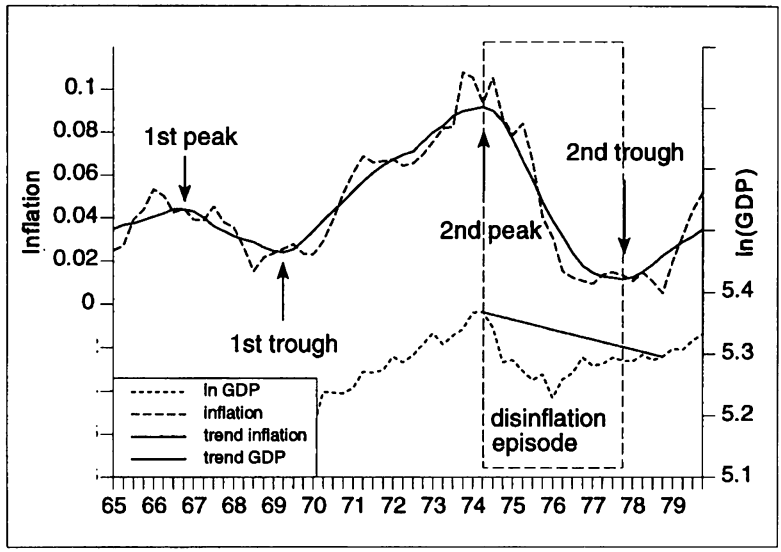
(2) The above interpretation postulates that causality runs from inflation to output. If causality runs the other way, the results would suggest that an independent CB makes sure that given output shocks translate into little inflation only.

(3) Or there may be no causal link at all. Output variations may be unrelated (or weakly related) to the monetary sphere, say reflecting supply shocks, and similar across countries. Independent CBs may generate less inflation variability (as is well known), and our result may only be an artifact.

III. CENTRAL BANK INDEPENDENCE AND THE SACRIFICE RATIO

This section tries to deal with the valid reservations raised above by focusing on the relationship between output and inflation during periods with an obviously systematic downward trend of inflation and clear signs of inflation causing output. A sample of such periods, along with concomitant sacrifice ratios, is provided by BALL (1993). *Figure 1* illustrates his procedure, using Switzerland as an example.

Figure 1 – Disinflations and sacrifice ratios [Ball (1993)]. An illustration using Swiss data.



In order to identify disinflation episodes, BALL defines *trend inflation* as the centered moving average of actual inflation over nine quarters. Trend inflation is said to reach a *peak* when it is higher than in the preceding four quarters and in the following four quarters. It is said to reach a *trough* if it is in an analogously defined relative minimum. A peak and a trough mark the beginning and the end of a *disinflation episode* if trough inflation is no less than two percentage points below peak inflation.

Application of this procedure to Swiss data identifies two peaks and two troughs between 1965 and 1980. The first fall of trend inflation does not qualify as a disinflation, however, because the achieved reduction of trend inflation falls short of two percentage points. The second peak in the fourth quarter of 1973 does indeed start a disinflation which reduces trend inflation by some 7 percentage points by the fourth quarter of 1977.

The price paid for the achieved reduction of inflation is computed from the development of the log of real GDP plotted in the lower part of the graph. BALL assumes that output equals potential output at the beginning of the disinflation (i.e. in the peak quarter),

and is back to potential output one year after the disinflation ends. Connecting these two values gives a trend line for potential output. Adding up the vertical differences between trend output and actual output over the entire disinflation episode gives the incurred sacrifice. Division of this sacrifice by the engineered reduction of trend inflation gives the sacrifice ratio for this episode.

Reasonably accurate sacrifice ratios can only be computed if quarterly output data are available.[3] In BALL's sample this is possible for 9 countries and 28 episodes, 8 of which fall into the Bretton Woods era.[4]

Table 2 reports estimates of the influence of CB independence on the average sacrifice ratio per country. The sample comprises a homogenous set of major industrial countries, though it is almost embarrassingly small. All the more important is the high robustness of the results. No matter which index of CB independence is being used, or whether we employ average sacrifice ratios from the 1960–88 period or from the post-Bretton Woods era only, we always witness a significant rise of sacrifice ratios as CB independence increases. For the period since the introduction of flexible exchange rates in 1973, which is certainly the more appropriate one for the present purposes, since it finally gave CBs the opportunity to fill the discretionary space provided by CB laws, CB independence alone explains up to two thirds of the variation in sacrifice ratios across countries. The impact is quantitatively important. For the ALESINA/SUMMERS index, which ranks CB independence on a scale from 1 to 4, the countries with the most independent CBs are estimated to have sacrifice ratios of 2.32, which is 9 times as large as those to be expected for (hypothetical) countries with the most dependent CBs.[5]

The point made by equations (4') and (8') is that while a linear specification of the relationship is a reasonable first pass, the data do speak in favor of a strongly nonlinear specification. A comparison between equations (8) and (8') shows that raising the employed CB independence index to the power of 6 more than doubles the *t*-statistic and boosts the coefficient of determination from 0.66 to 0.91.

3. The low accuracy of sacrifice ratios computed from annual output data is due to the impossibility to determine output levels at the beginning and at the end of disinflations. Just how poor this makes the quality of those sacrifice ratios is illustrated by the fact that for the 28 disinflation episodes for which sacrifice ratios can be computed from both quarterly and annual output data, approximations computed from annual data only explain some 50 percent of the variation of sacrifice ratios computed from quarterly data.
4. The countries are Australia (no Bretton Woods disinflation episodes + 2 post Bretton Woods episodes), Canada (0 + 2), France (0 + 2), Germany (1 + 2), Italy (1 + 2), Japan (3 + 3), Switzerland (0 + 2), the United Kingdom (2 + 3), and the United States (1 + 2).
5. The sample does not include countries with an index value of 1, however. High-independence countries with an index value of 4, like Germany and Switzerland, are still estimated to possess sacrifice ratios about 2.5 times as large as countries with an index value of 2, as, e.g. the U.K.

Table 2 – Sacrifice ratios and central bank independence
OLS estimates; 9 countries; endogenous variable: sacrifice ratio per country

eq. #	constant	central bank independence	R^2_{adj}	employed CBI index
Reference period: 1960–1988				
(1)	-0.12 (-0.19)	0.60 (2.76)	0.45	Alesina and Summers
(2)	0.41 (0.84)	2.76 (2.52)	0.40	Cukierman
(3)	0.02 (0.04)	0.17 (2.58)	0.41	Grilli
(4)	-0.12 (0.23)	0.20 (3.05)	0.51	modified Grilli
(4')	0.04 (6.55) [5.57]	0.000000003 (5.37) [7.16]	0.78	modified Grilli[6]
Reference period: 1973–1988				
(5)	-0.44 (0.76)	0.69 (3.32)	0.56	Alesina and Summers
(6)	0.08 (0.20)	3.33 (3.39)	0.57	Cukierman
(7)	-0.44 (0.80)	0.21 (3.53)	0.59	Grilli
(8)	-0.49 (1.00)	0.24 (4.05)	0.66	modified Grilli
(8')	0.03 (8.29) [7.12]	0.00000003 (9.10) [13.65]*	0.91	modified Grilli[6]

Notes: Absolute *t*-ratios are given in parantheses underneath estimation coefficients. Brackets contain *t*-statistics calculated from the heteroskedasticity-consistent covariance matrix derived by White. Equations (4') and (8') use the modified Grilli index raised to the power of 6.

Next, we rerun the regressions of table 2 on sacrifice ratios for individual disinflation episodes, which provides larger samples. In principle, this should make estimates more efficient. On the other hand, the episodes are merely the data underlying the country averages used above. Since CB independence indexes cannot possibly explain intra-

country differences, however, the coefficients of determination must be lower in these estimates. The results are given in table 3.

Table 3 – Sacrifice ratios and central bank independence
OLS and GLS estimates; endogenous variable: sacrifice ratio per episode

eq. #	constant	central bank independence	R^2_{adj}	employed CBI index
data set: 28 episodes between 1960 and 1988				
(1)	-0.34 (0.68)	0.68 (3.71)	0.32	Alesina and Summers
(2)	0.36 (1.09)	2.98 (3.65)	0.31	Cukierman
(3)	-0.11 (0.26)	0.19 (3.83)	0.34	Grilli
(4)	-0.19 (0.45)	0.22 (4.17)	0.38	modified Grilli
(4')	0.99 (6.54)	0.0000007 (5.27)	0.50	modified Grilli[6]
data set: 20 episodes between 1973 and 1988				
(5)	-0.54 (1.05)	0.71 (3.84)	0.42	Alesina and Summers
(6)	0.06 (0.16)	3.35 (3.98)	0.44	Cukierman
(7)	-0.48 (1.05)	0.21 (4.17)	0.46	Grilli
(8)	-0.53 (1.22)	0.24 (4.50)	0.50	modified Grilli
(8')	0.81 (5.65)	0.0000008 (6.17)	0.66	modified Grilli[6]
data set: 8 episodes between 1960 and 1972				
(9)	0.12 (0.09) [0.08]	0.60 (1.23) [1.35]	0.07	Alesina and Summers
(10)	0.76 (1.08) [1.41]	2.98 (1.51) [2.78]	0.15	Cukierman
(11)	0.30 (0.32) [0.33]	0.19 (1.62) [2.23]	0.19	Grilli
(12)	0.28 (0.31) [0.35]	0.21 (1.69) [2.76]	0.21	modified Grilli

Notes: Absolute t-ratios are given in parantheses underneath estimation coefficients. Brackets contain t-statistics calculated from the heteroskedasticity-consistent covariance matrix derived by White.

The estimates underscore that CB independence is a much more useful explanation of disinflation costs during periods of floating exchange rates than under a rather rigid system as the one drafted in Bretton Woods. In a linear specification, for the three decades since 1960 the four indexes of CB independence explain between 32 and 38 percent of the variation in sacrifice ratios over time and across countries. All indexes are significant at the 1 percent level. Again, the nonlinear specification improves this, to 50 percent [equation (4')]. For the 20 disinflations since the abandonment of the Bretton Woods system an even higher share of the variation is explained. The coefficient of determination now varies between .42 and .50 in a linear setting and reaches .66 when CBI[6] is being used. Significance levels are slightly higher than in the larger sample.

The ability of CB independence to explain disinflation costs during the 8 episodes in 5 countries under fixed exchange rates is more limited. Coefficients of determination now only range from 0.07 to 0.21, and there is one index which, even after calculating White's heteroskedasticity-consistent coefficient matrix, is not significant. What is striking, on the other hand, is that all four CBI coefficients are very close to the coefficient estimates based on the independent 20 episodes that occurred after 1973: For the Alesina/Summers index the coefficients are .71 and .6, for the Cukierman index 3.35 and 2.98, for the Grilli index .21 and 0.19, and for the modified Grilli index 0.24 and 0.21.

IV. ROBUSTNESS CHECKS

This section provides checks of the robustness of the results encountered so far. The preceding section already started to do so by demonstrating that the encountered positive relationship between the sacrifice ratio and CB independence is rather insensitive to the kind of index being used and, within Ball's data set, pretty robust over time. The present section adds results based on sacrifice ratios derived from a larger set of annual data, results based on independently and differently computed sacrifice ratios given in SCHELDE-ANDERSON (1992), and results based on rank correlations only.

1. Sacrifice ratios from annual data

A disinflation rarely begins and ends with a calendar year. Sacrifice ratios computed from annual data, therefore, must be of inferior quality compared to those computed from data with higher frequency. The extent of this quality loss is illustrated by the fact that for the 20 post-1973 disinflation episodes for which quarterly output data are available, sacrifice ratios computed from annual data only explain 53 percent of the variation observed in sacrifice ratios computed from annual data.

On the other hand, sacrifice ratios computed from annual data provide us with a larger sample. While my position in the remaining part of this paper is that this does not outweigh the loss of precision, we consider a larger sample of annual sacrifice ratios in

this section. The sample includes the 20 post-1973 disinflation episodes identified in the quarterly data (with sacrifice ratios computed from annual data, however) plus the post-1973 episodes identified in those countries with annual output data only. Using the CUKIERMAN index of CB independence, which covers the largest set of countries, we end up with 44 observations (from 19 countries). The estimation equation is

$$\underset{\text{annual}}{\text{Sacrifice ratio}} = \underset{(0.06)}{0.001} + \underset{(2.36)}{0.09}\,\text{CBI}_{\text{Cukierman}} \tag{1}$$

OLS; 44 observations from disinflation episodes in 19 countries; $R^2_{adj} = 0.10$

or, with a non-linear specification

$$\underset{\text{annual}}{\text{Sacrifice ratio}} = \underset{(4.20)}{0.026} + \underset{(2.91)}{0.60}\,\text{CBI}^6_{\text{Cukierman}} \tag{1a}$$

OLS; 44 observations from disinflation episodes in 19 countries; $R^2_{adj} = 0.15$

The positive relationship between CB independence and the sacrifice ratio is maintained in this larger sample, though the *t*-statistics are smaller than in previous sections and the explained variation is lower. A closer look at the numbers reveals, however, that most of this deterioration is due to one Spanish disinflation from 1977 to 1987 which carries a huge sacrifice ratio. During this time Spain started and went through its transition from the Franco regime to democracy, along with enormous structural changes in its economy. To attribute the painful real effects of this transition primarily to the disinflation policies and the legal status of the Spanish CB would be like considering the breakdown of East Germany's economy after 1990 a direct consequence of the monetary policy stance of the Bundesbank.

Excluding this Spanish disinflation episode for these reasons leaves a familiar strong influence of CB independence even on sacrifice ratios computed from annual data:

$$\underset{\text{annual}}{\text{Sacrifice ratio}} = \underset{(4.09)}{0.023} + \underset{(3.57)}{0.11}\,\text{CBI}^6_{\text{Cukierman}} \tag{2}$$

OLS; 43 observations from disinflation episodes in 18 countries; $R^2_{adj} = 0.22$

2. RANK CORRELATIONS

It could be argued that the employed indexes only *rank* CB independence, but do not *measure* it in a meaningful way. The correlations given in Table 4 do not advice that this

might be a serious problem. If all the cardinal information is taken out of the indexes, the correlation does weaken somewhat, but this deterioration is very small.

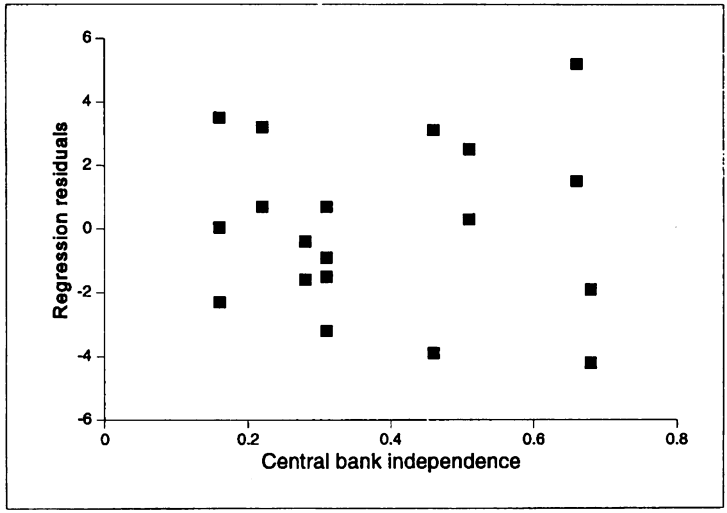
Table 4 – Comparison of correlations of sacrifice ratio with cardinal measure of central bank independence and with rank of central bank dependence

employed CBI index	correlation of sacrifice ratio with	
	cardinal value on CBI scale	rank position on CBI scale (inverted)
Alesina and Summers	.67	.53
Cukierman	.68	.60
Grilli	.70	.61
modified Grilli	.73	.66

20 disinflation episodes since 1973; sacrifice ratios computed from quarterly data;

Figure 2 plots the residuals from a regression of the sacrifice ratio on the Cukierman index [equation (6), Table 3] against this index. There is no evident pattern that may cause concerns.

Figure 2 – Plot of regression residuals from equation (6), Table 3, against eplanatory variable.



3. *An independent set of sacrifice ratios*

In a study of OECD disinflation experiences SCHELDE-ANDERSEN (1992) provides his own sacrifice ratios for 16 countries.[6] Rather than defining and identifying disinflation episodes by means of some clearly specified criterion in the spirit of BALL (1993), SCHELDE-ANDERSEN proceeds from the general observation that the entire community of industrialized countries experienced a more or less steady reduction of inflation in the 1980s. Sacrifice ratios are computed by dividing the accumulated output losses for a selected time span, which is the same for all 16 countries, by the achieved disinflation. The drawback of this procedure for our present purposes is that it does not take into account when the disinflation really began, when it ended, and whether it was interrupted in between.

With these reservations, using the sacrifice ratios obtained from output losses between 1979 and 1988, we obtain

$$\underset{}{\text{Sacrifice ratio}_{\text{Schelde}}} = \underset{(0.93)}{-0.27} + \underset{(2.47)}{1.88}\,\text{CBI}_{\text{Cukierman}} \tag{3}$$

OLS; 16 sacrifice ratios from 16 countries; $R^2_{\text{adj}} = 0.25$

with a linear specification and

$$\underset{}{\text{Sacrifice ratio}_{\text{Schelde}}} = \underset{(1.96)}{0.22} + \underset{(3.49)}{16.49}\,\text{CBI}^6_{\text{Cukierman}} \tag{3a}$$

OLS; 16 sacrifice ratios from 16 countries; $R^2_{\text{adj}} = 0.43$

when a nonlinear influence of CB independence is postulated. So the lesson to be learned from this section is that the qualitative relationship between the sacrifice ratio and CB independence is impressively robust: It not only survives the use of different CB independence indexes, as has been shown previously, but also the expansion of the sample size (at the cost of switching to less precise sacrifice ratios), and the use of an independently computed set of new sacrifice ratios for a different set of countries.

V. OTHER DETERMINANTS OF THE SACRIFICE RATIO

We now look for multivariate explanations of the sacrifice ratio. This provides additional information on the robustness of the impact of CB independence detected above, but

6. The countries are Australia, Austria, Belgium, Canada, Denmark, France, Germany, Ireland, Japan, the Netherlands, New Zealand, Norway, Sweden, the United Kingdom and the United States of America.

also should render information on its relative importance as compared to other, structural determinants of the sacrifice ratio. A set of such structural determinants has been analyzed by BALL (1993), and some of them where found to determine the sacrifice ratio. This section checks how these perform relative to CB independence.

The structural variables considered here fall into three groups:

(i) *characteristics of the disinflation process.* These characteristics are initial inflation at the peak, the size of the disinflation between peak and trough, and the length of the disinflation. An alternative to looking at size and length separately is to define their relative value as speed.
(ii) *labor market characteristics.* These characteristics are contract duration and wage responsiveness.
(iii) *macroeconomic structure.* The one characteristic considered in this category is the openness index employed by ROMER (1993) in his empirical analysis of international inflation levels.

Table 5 reports a representative sample of the efforts to obtain a multivariate explanation of sacrifice ratios. Equations (1)–(8) are of an explorative nature, pairing the other structural variables with CB independence, first individually, and then as a group.[7] The basic insight from these regressions is that the other structural variables perform rather poorly if combined with CB independence. The only such variable that turned out to provide a significant contribution to the explanation of sacrifice ratios alongside CB independence was the length of the disinflation episode.

7. Speed is omitted from equation (8) since by construction it combines the effects of size and length.

TABLE 5 – Structural determinants of the sacrifice ratio
OLS and GLS estimates; endogenous variable: sacrifice ratios from 20 disinflation episodes since 1973

		disinflation characteristics				labor market characteristics				R^2_{adj}
eq.#	constant	speed	size	length	initial inflation	contract duration	wage responsiveness	openness	central bank independence	F
(1)	-0.01	-0.74	–	–	–	–	–	–	0.22	0.51
	(0.01)	(1.06)							(3.96)	10.79
(2)	-0.67	–	0.02	–	–	–	–	–	0.25	0.48
	(1.13)		(0.36)						(4.34)	9.72
(3)	-1.12	–	–	0.05	–	–	–	–	0.23	0.58
	(2.28)			(2.09)					(4.72)	14.22
(4)	-0.29	–	–	–	-0.01	–	–	–	0.23	0.48
	(0.41)				(0.45)				(3.91)	9.80
(5)	-0.42	–	–	–	–	-0.07	–	–	0.24	0.48
	(0.79)					(0.42)			(4.26)	9.77
(6)	-0.50	–	–	–	–	–	-0.01	–	0.24	0.47
	(0.76)						(0.06)		(3.98)	9.59
(7)	-0.07	–	–	–	–	–	–	-0.94	0.22	0.51
	(0.12)							(1.04)	(3.91)	10.74
(8)	0.11	–	-0.08	0.07	-0.03	-0.31	0.10	-0.97	0.17	0.56
	(0.11)		(0.82)	(1.94)	(0.45)	(1.03)	(0.65)	(1.03)	(2.61)	4.50
(9)	1.70	–	-0.17	0.10	–	–	–	-2.06	–	0.41
	(2.76)		(2.99)	(2.97)				(2.08)		5.38
	[2.99]		[3.78]	[2.99]				[2.12]		
(10)	-0.53	–	–	–	–	–	–	–	0.24	0.50
	(1.22)								(4.50)	20.29
	[1.26]								[4.34]	
(11)	-0.18	–	-0.09	0.08	–	–	–	-0.92	0.18	0.61
	(0.23)		(1.78)	(2.60)				(1.05)	(3.09)	8.58
	[0.31]		[2.65]	[2.87]				[1.01]	[4.18]	
(11')*	1.05	–	-0.06	0.04	–	–	–	-0.99	0.0000006	0.66
	(2.10)		(1.03)	(1.30)				(1.23)	(3.63)	10.38
	[2.76]		[1.37]	[1.48]				[1.23]	[4.42]	

Notes: Absolute t-ratios are given in parantheses underneath estimation coefficients. Brackets contain t-statistics calculated from the heteroskedasticity-consistent covariance matrix derived by White.

* Here the nonlinear specification CBI6 is employed.

Equation (9) gives the «best» explanation of sacrifice ratios that can be obtained without CB independence. It proposes that the smaller a disinflation is and the longer it lasts, the larger is the sacrifice ratio. Also, more open economies seem to enjoy smaller sacrifice ratios. However, while these three variables together explain 41 percent of the variation in sacrifice ratios, CB independence alone explains 50 percent, as shown in equation (10). The dominating influence of CB independence is retained in equation (11), which merges equations (9) and (10). CB independence outperforms the other variables in terms of t-value, the coefficient of determination peaks at 0.61, and openness turns insignificant. When a nonlinear influence of CB independence on the sacrifice ratio is permitted in equation (11') the other variables are sidelined altogether. The achieved coefficient of determination is .66, the same as in Table 3, equation (8'), when CBI[6] was used alone.

VI. DISCUSSION OF EMPIRICAL RESULTS

Central bank independence explains a large part of the variation of sacrifice ratios across countries and across episodes. Surprisingly, the estimated impact is positive: More independence raises the sacrifice ratio. The underlying sample of sacrifice ratios from 28 disinflation episodes is small. But the correlation is too robust to be dismissed as spurious: It shows up for each of the four CB independence indexes employed here, it is there during the Bretton Woods era of fixed exchange rates as well as during the post-1973 era of floating rates, and also performs in a dominating fashion alongside other structural indicators of the country or the disinflation at hand.

It may still be argued that we got causality wrong. Countries with institutional features that give rise to low disinflation costs may simply be more inclined to entertain the luxury of a CB controlled by the government, because it cannot do much harm anyway. This would imply, however, that countries anticipated today's sacrifice ratios when CB laws were implemented several generations ago. Also, this perspective would have to explain why a series of countries, including Canada, France, and New Zealand, quite recently rewrote their CB laws. Was this in anticipation of higher future sacrifice ratios in those countries?

The labor market characteristics exert a rather erratic influence on the sacrifice ratio. During the floating episode alone, absolute t-statistics usually remain below one, and the sign of wage responsiveness fluctuates. The sign of contract duration is the opposite of what we would expect. For all 28 episodes wage responsiveness occasionally turns out significant, but with the wrong sign. More responsive wages would appear to make sacrifice ratios larger.

Openness consistently shows up with a negative coefficient, but significant ones are rare. This lends some support to the arguments advanced by ROMER (1993), but its quantitative relevance in the present context appears marginal.

The obtained estimates seem to support the view advocated by TAYLOR (1983) that, beyond some threshold, faster disinflation raises the sacrifice ratio. But this reading may

be premature. If independent CBs only raise sacrifice ratios because they are less patient to remedy excessive inflation, we should observe a positive correlation between CB independence and *speed,* and a negative one between CB independence and length. There is no evidence of this.[8] What is more, CB independence retains its dominating influence even after we control for *speed* and related variables such as *length* and *size.*

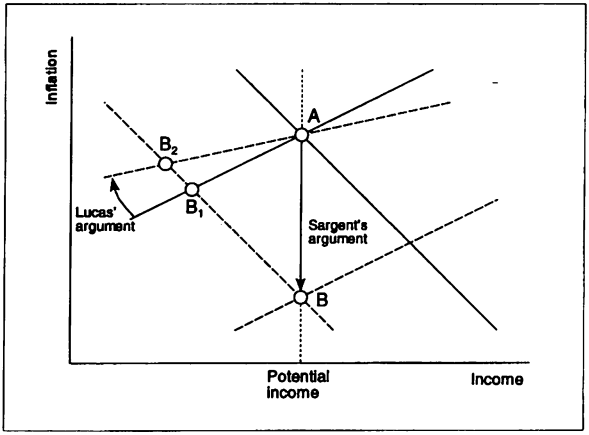
On the other hand, the result does not go well at all with the new classical prediction that credible disinflation carries little cost, at least as long as we want to stick with the standard assumption that independence establishes credibility. In order to save the new classical prediction, we would have to resort to the assumption of independence impairing credibility, which would turn much of last decade's discussion of this topic on its head.

VII. TENTATIVE EXPLANATIONS

The concept of sacrifice ratios rests on the assumption of a vertical aggregate supply (AS) curve over potential output, from which actual income may deviate temporarily along a positively sloped short-run or surprise AS curve. To help structure the interpretation of the obtained results, Figure 3 sketches this scenario.

Figure 3 – The LUCAS and SARGENT arguments applied to the effect of CB independence on disinflation costs.

A disinflation starting in A and ending in B proceeds along a path that is crucially



8. CB independence explains 0 percent of length and, with the wrong sign, 5 percent of speed (post-1973 episodes).

dependent on the credibility of the exercise. If it lacks credibility, the beginning stages of the disinflation will be characterized by a movement along the surprise AS curve into a point like B_1 or B_2. In this case the slope of the AS curve obviously matters for the size of the sacrifice. If the disinflation is announced and fully credible, the economy moves vertically down from A straight into B, with no income sacrifice at all. In this case the slope of the surprise AS curve does not matter.

Our regressions were unable to detect any significant influence of variables believed to affect the slope of the AS curve, not even by the lowest statistical standards. This is what we would expect when disinflations are fully credible. But then the sacrifice ratios should be zero, which is not the case at all. The conclusion advocated by FISCHER (1996) and JORDAN (1997) in this context, that independent CBs face a flatter short-run AS curve and, hence, higher sacrifice ratios, remains unconvincing. If this was the proper explanation, the direct determinants of the slope of the AS curve such as labor market flexibility or openness should perform much better statistically than the indirect measure of CB independence. Or, alternatively, say if labor market flexibility measures are considered unreliable and AS curves are believed to be flatter at the lower inflation rates where independent central banks operate, then the initial inflation rate at the start of the disinflation would be the appropriate measure and it should certainly outperform the substitute measure of CB independence. There is no evidence of this whatsoever. The statistical performance of the initial inflation rate is erratic, and in no case performs even remotely as well as CB independence.

But if there is no evidence that it is the slope of the AS curve that makes independent CBs face higher sacrifice ratios, may be the curve moves down more slowly?

1. Endogenous inflation expectations formation

A first pass at rationalizing the obtained result could proceed from the insight that inflation expectations may be more reluctant to downward adjustment under an independent CB.[9] Some evidence for this is provided by VANDERHOFF (1988). Building on work by CUKIERMAN and WACHTEL (1979), his analysis of Livingston inflation forecast data yields evidence of *endogenous expectations formation:* the more variable the inflation rate is, the more people are prepared to replace usual adaptive expectations formation processes by structural, rational equations that feature expectations of money growth and other variables. Since it is well established that government-dependent CBs not only generate higher inflation, but also more variable inflation [ALESINA and SUMMERS (1993)], individuals are being kept more on their toes. Therefore, inflation expectations during a disinflation may indeed fall faster than under an independent CB. So while independent CBs may provide real benefits by allowing individuals to settle

9. A simple illustrative model along these lines is given in appendix A.

for simpler, less expensive adaptive expectations processes, the bill arrives when a disinflation does have to be engineered.

Equation (1) in Table 6 provide some support for this explanation: disinflations engineered after periods of high inflation variability seem to cause smaller output losses than disinflations which start after periods of low inflation variability. Here again, however, as was the case with the Taylor story, a second look raises questions as to the validity of this explanation. If the variance of inflation is considered alongside CB independence, as equations (2) – (5) do, it looses most of its explanatory potential. So while endogenous expectations formation may partly explain the obtained empirical results, there must be other, additional channels through which CB independence bears on sacrifice ratios.

Table 6 – Sacrifice ratios and inflation variability
OLS estimates; endogenous variable: Sacrifice ratio per episode

eq.#	constant	standard deviation of inflation per episode[a]	central bank independence	R^2_{adj}	CBI index
(1)	2.03 (6.07)	-0.35 (2.44)	_	0.21	_
(2)	0.07 (0.09)	-0.15 (1.06)	0.59 (2.78)	0.42	Alesina/ Summers
(3)	0.59 (1.07)	-0.16 (1.24)	2.82 (3.03)	0.45	Cukierman
(4)	0.03 (0.05)	-0.13 (0.96)	0.18 (3.08)	0.46	Grilli
(5)	0.06 (0.09)	-0.17 (1.38)	0.21 (3.63)	0.53	modified Grilli
(5')	1.13 (4.11)	-0.13 (1.36)	0.0000007 (5.21)	0.68	modified Grilli[6]

Notes: Absolute *t*-ratios are given in parantheses underneath estimation coefficients.
[a] Standard deviation of inflation during last 24 months prior to respective disinflation episode.

2. *The LUCAS (1973) argument*

The endogenous-expectations-formation argument laid out above may be difficult to distinguish observationally from the argument advanced and tested by LUCAS (1973). He argued that in an economy with a stable overall price level, firms interpret changes in the prices of their own products to be changes in the relative prices of these products. Hence, small price changes lead to large changes in output, making the aggregate supply schedule rather flat. In an economy with a great deal of variability in the general price level, the opposite will hold: a decrease of the aggregate price level would cause a small reduction of aggregate output only, as firms would tend to believe that their own relative prices have been unaffected, rendering the aggregate supply curve very steep. Using data for 18 countries LUCAS found some evidence in support of the hypothesis that countries with higher inflation variability face steeper aggregate supply curves. Equation (1) in table 5 can be interpreted as another piece of evidence in support of LUCAS' hypothesis. Adding the insight offered by ALESINA and SUMMERS (1993) that CB independence reduces inflation variability, independent CBs would face flatter AS curves and thus incur larger sacrifices (Figure 3). Again, however, the question remains why direct measures of inflation variability are so clearly outperformed by CB independence.

VIII. DO INDEPENDENT CENTRAL BANKS CREATE HIGHER INCOME LOSSES?

What has been demonstrated so far is that independent CBs appear to pay a higher price for a reduction of trend inflation by one percentage point. This may be shrugged off with the argument that countries with independent CBs may not have to pay this price very often because first, disinflations need to be engineered less frequently, and, second, they are typically much smaller than those conducted by more government-dependent CBs.

Drawing on different samples or sources of data, both FISCHER (1996) and JORDAN (1997) address this issue, with opposite results. While JORDAN concludes that «CBI also increases the output loss during disinflations» (p. 3), FISCHER states that «there was no statistical link between output loss and independence» (p. 17). While these conflicting conclusions may be attributed to differences in the construction of sacrifice ratios and the countries included, it should be noted that the employed specifications do not fully address the issue we are dealing with here. First, both studies look at total income loss per episode. This goes only half way towards answering the question raised above, since the possibility remains that there are fewer disinflation episodes in countries with very independent CBs.[10] Second, Jordan finds an influence of CB independence on income loss per episode only in a multiple regression setting with the (squared) size of the disinflation among the regressors. Since he also finds that disinflation size is lower when

10. FISCHER (1996) provides some evidence later on that this is not the case in his sample.

CB independence is high, the overall effect of CB independence on income loss remains open.

This section looks at how CB independence affects total GDP loss added up over all disinflations between 1973 and 1988. While this goes at the cost of sample size, GDP loss per country appears to be the only proper measure of the total price of CB independence in terms of output losses during disinflations.

$$\begin{array}{rcll} \text{GDP loss} = & 5.29 & + & 1.73\ \text{CBI} \\ & (0.69) & & (1.90) \end{array} \qquad (4)$$

OLS; 9 sacrifice ratios from 9 countries; $R^2_{adj} = 0.25$

The estimates say that more independent CBs have subjected their countries to higher output losses during the 1973-88 period in the course of their efforts to fight inflation. Their higher sacrifice ratios are obviously not entirely counterbalanced by less frequent or smaller disinflations. While the significance level in equation (4) is only 10 percent, it improves to 1 percent if we permit the same nonlinear influence postulated in the study of sacrifice-ratio equations above. This yields the estimation equation

$$\begin{array}{rcll} \text{GDP loss} = & 14.63 & + & 0.000006\ \text{CBI}^6 \\ & (5.61) & & (2.76) \\ & [4.64] & & [3.87] \end{array} \qquad (4a)$$

OLS; 9 sacrifice ratios from 9 countries; $R^2_{adj} = 0.45$

which explains almost half of the differences in total output losses.

It is quite likely that these regressions understate the statistical relationship between total GDP loss and CB independence. Consider Figure 4(a), which plots total GDP loss against each country's average sacrifice ratio. While, generally, there appears to be a rather close relationship, Italy seems to be somewhat of an outlier. It is distinctly off the line one would draw for the other countries, and seems to have experienced output losses much higher than it should have according to its sacrifice ratio.

Figure 4(b) looks at this a bit more closely by plotting GDP loss during each disinflation episode against CB independence. It turns out that Italy's outlier status in Figure 4(a) is the result of a single disinflation episode that does not fit the usual picture.

Figure 4(a)

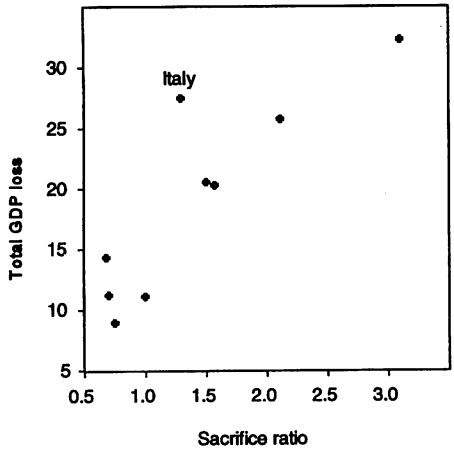
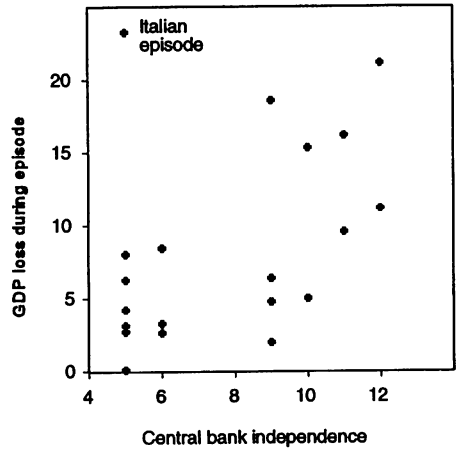


Figure 4(b)



IX. SUMMARY AND CONCLUSIONS

In its core, this paper took an empirical look at disinflation costs in the world's largest economies. The most challenging result to evolve from these efforts is that the role of CB independence is opposed to widely held beliefs: The more independence a CB enjoys from government interference, the larger are the recessionary side effects of disinflations.

This core result appears reasonably robust: it is insensitive to the use of CB independence indexes, shows up strongly alongside other explanatory variables, and even renders those entirely insignificant if a nonlinear relationship is permitted; it can be found in larger samples of (presumably less accurate) sacrifice ratios computed from annual output data, and in independently computed sacrifice ratios from other sources as well.

This result poses quite a challenge. It clearly speaks against the new classical view of how CB independence, reputation and credibility fit into the macroeconomy, which has almost monopolized discussions of policy and institutional design for more than a decade. It also does not confirm the implications of the imperfect-credibility-cum-staggered-price-setting model analyzed by BALL (1995). But on the other hand, while reduced-form results are well in line with TAYLOR'S (1983) view, upon closer scrutiny we hit upon a lot of questions regarding the underlying transmission mechanism. Thus the verdict is still out, and it may well turn out that neither approach can properly explain the results advanced here.

I have suggested one avenue to go when attempting to rationalize the counterintuitive role of CB independence during disinflations. By providing less inflation variability on average, an independent CB may sort of lure individuals into settling for very simple, low-cost adaptive inflation expectations formation. As a consequence, they are ill-prepared for their part even in a credibly engineered disinflation. Expectations only gradually adjust downwards and need to be driven by a sizable recession.

In a way, this interpretation would also take the edge out of the result, suggesting that while countries with more independent CBs may indeed face higher disinflation costs, this seems to be offset by inflation variability being lower in general, which evidently puts individuals in a position to make do with more economical forecasting procedures.

Another interpretation of this paper's findings is that they directly derive from LUCAS' (1973) hypothesis and empirical results on the relationship between output-inflation tradeoffs and inflation variability. The problem with both these explanations is that the explanatory variables they propose perform worse than the substitute measure of CB independence.

This paper has not arrived at final answers as to why sacrifice ratios and total incomé losses are so high under independent CBs. Institutional factors and relative wage considerations, as suggested by TAYLOR (1983), and endogenous inflation expectations formation may provide partial answers, but no coherent picture has emerged yet. On the other hand, a comprehensive set of empirical approaches applied in this paper and by a handful of other authors all come to the same conclusion that since the 1960s CB independence has raised sacrifice ratios. The nonlinear specification introduced here

makes this point more forcefully than any other study, and we even found that total income losses due to disinflation exercises also increase with CB independence. Augmenting this with JORDAN's (1997) finding that income gains during times of accelerating inflation do not increase with central bank independence, the total income loss added by CB independence amounts to a net price paid by society for having an independent CB and lower inflation. This adds to the familiar ROGOFF (1985) argument that high CB independence is not the same as optimal CB independence in the presence of occasional supply shocks. And even though we do not fully understand the underlying mechanism, the empirical phenomenon poses a challenge for discussions of monetary policy and institutions, and a caveat to today's euphoria for central bank independence.

Appendix

A. *A simple illustration*

Let individuals form expectations according to

$$E\pi_t = \alpha Em_t + (1-\alpha)\pi_{t-1}$$

where E is the expectations operator, π is inflation, and m is money growth. Here π_{t-1} is a parsimonious stand-in for a possibly more sophisticated *adaptive* part of expectations formation. Similarly, let Em_t represent *rational* expectations formation, which also will usually take a much more elaborate form. In combination with an aggregate supply function of the *Lucas*-surprise or of the modified *Phillips*-curve mold, (A1) gives rise to lower sacrifice ratios as α increases.

Rational expectations have the advantage of being more precise. Adaptive expectations are cheaper. So let the cost C of computing inflation forecasts increase with α,

$$C = C(\alpha) \qquad C' > 0$$

and assume that benefits B derived from an inflation forecast increase with α and with the variance of inflation.

$$B = B[\alpha, \mathrm{var}(\pi)] \qquad B_1, B_2 > 0, B_{12} > 0$$

$B_{12} > 0$ notes that the benefits from forming expectations more rationally are higher if inflation is volatile. Individuals choose α so as to maximize net benefits. Assume for now that this does not result in a corner solution, which obtains if the B and C functions are well-behaved, $B_1[0, \mathrm{var}(\pi)] > C'(0)$ and $B_1[1, \mathrm{var}(\pi)] < C'(1)$. Then, under the conditions spelled out by the implicit function theorem,

$$\frac{d(B-C)}{d\alpha} = B_1[\alpha^*, \text{var}(\pi)] - C'(\alpha^*) = 0$$

implies a function

$$\alpha^* = f[\text{var}(\pi)]$$

for which the implicit function rule gives

$$\frac{d\alpha^*}{d\,\text{var}(\pi)} = -\frac{\partial\{B_1[\alpha^*, \text{var}(\pi)]/\partial\,\text{var}(\pi)\}}{\partial^2 B/\partial\alpha^2 - \partial^2 C/\partial\alpha^2} > 0$$

The indicated sign applies because the numerator (which had been named B_{12} above) is positive and the denominator must be negative if we assume the optimum to be interior ($0 < \alpha^* < 1$).

In the light of this model, because independent CBs reduce inflation variability, which makes individuals rely on simpler, adaptive inflation expectations formation, they disinflate with higher sacrifice ratios.

B. Data sources

Sacrifice ratios are taken directly or computed from BALL (1993).
Inflation variances are from ALESINA and SUMMERS (1993).
Transmission ratios are computed from the variances of GDP growth and of inflation reported in ALESINA and SUMMERS (1993).
Central bank independence indexes are from ALESINA and SUMMERS (1993), CUKIERMAN (1993), GRILLI, MASCIANDARO and TABELLINI (1991) and DE HAAN and STURM (1992).
Disinflation characteristics and *labor market features* are from BALL (1993).
Openness is from ROMER (1993).
Inflation rates are from IMF data tapes.

C. *Correlations*

Table 7 – Correlation matrix for 1973–88 sample with 20 episodes

$CBI_{MGRILLI}$	Initial inflation	Speed	Size	Length	Contract duration	Wage responsiveness	Openness
1.00	-0.37	-0.31	-0.25	0.08	-0.17	-0.40	-0.33
-0.37	1.00	0.75	0.72	0.18	-0.15	0.24	-0.18
-0.31	0.75	1.00	0.56	-0.17	-0.12	0.18	-0.00
-0.25	0.72	0.56	1.00	0.65	-0.07	0.09	-0.31
0.08	0.18	-0.17	0.65	1.00	0.02	0.02	-0.32
-0.17	-0.15	-0.12	-0.07	0.02	1.00	0.76	0.07
-0.40	0.24	0.18	0.09	0.02	0.76	1.00	0.07
-0.33	-0.18	-0.00	-0.31	-0.32	0.07	0.07	1.00

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SUMMARY

The paper looks at the empirical relationship between central bank independence (CBI) and income losses caused by restrictive monetary policy. It finds that higher CBI goes along with higher sacrifice ratios. This relationship is strongly nonlinear (differences at high CBI levels matter much more), robust and dominant (no other variables discussed in the literature exert a significant influence alongside CBI). Also between 1973 and 1988 total income losses added up over all disinflation episodes are highest in countries with the most independent central banks. No evidence is found that higher sacrifice ratios are due to flatter Philips curves.

ZUSAMMENFASSUNG

Die Arbeit untersucht den empirischen Zusammenhang zwischen Zentralbankunabhängigkeit und den bei restriktiver Geldpolitik entstehenden Einkommensverlusten. Es

zeigt sich, dass bei höherer Zentralbankunabhängigkeit höhere Sacrifice Ratios entstehen. Dieser Zusammenhang ist ausgeprägt nichtlinear (Änderungen bei bereits grosser Unabhängigkeit wirken sich viel stärker aus), robust und dominant (keine andere in der Literatur diskutierte Variable übt bei gleichzeitig berücksichtigter Zentralbankunabhängigkeit einen signifikanten Einfluss aus). Weiter erlitten Länder mit unabhängigeren Zentralbankunabhängigkeiten zwischen 1973 und 1988 höhere aufsummierte Einkommensverluste im Verlaufe aller Desinflationen. Schliesslich findet sich keine Evidenz dafür, dass für die höheren Sacrifice Ratios unter unabhängigen Zentralbanken flachere Phillipskurven verantwortlich sind.

RESUME

Cet article explore la relation empirique entre l'indépendance d'une banque centrale (IBC) et les pertes de revenu national provoquées par une politique monétaire restrictive. Nous démontrons qu'une forte indépendance d'une banque central provoque des 'sacrifice ratios' plus prononcées. Cette relation est fortement non-linéaire (les différences aux niveaux d'IBC plus élevés sont plus importantes), robuste et dominante (en combination avec l'IBC aucune autre variable considérée dans la littérature n'exerce une influence significante). En plus, entre 1973 et 1988 les pertes de revenu national sommées à travers toutes les périodes de désinflation sont plus prononcées dans les pays ou les banques centrales sont les plus indépendantes. Nous ne trouvons pas d'évidence que des sacrifices ratios plus hautes sont causées par des courbes de Phillips plus plates.