Inflation and Central Bank Independence: Is Japan Really an Outlier?

Carl E. Walsh

The Bank of Japan has often been viewed as an outlier in combining low inflation with little formal central bank independence. This view has been based mainly on simple correlations between average inflation and measures of central bank independence. When additional factors that might account for cross-country variation in inflation rates are incorporated into the empirical analysis, Japan no longer appears to be a significant outlier. Since reputational considerations may have played a role in supporting a low-inflation environment in Japan, a simple model is used to show how increased political competition might affect equilibrium inflation.

Key words: Central banks; Monetary policy; Inflation

University of California, Santa Cruz

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I. Introduction

One of the most interesting recent developments in the field of monetary economics has been the recognition that institutional and political structures can matter for the conduct of monetary policy and for macroeconomic outcomes. A number of authors have studied how the design of policy-making institutions, and central banks specifically, can affect macroeconomic outcomes. Most of this work has been empirical in nature, examining the relationship between the legal and institutional structure of a nation's central bank and its success in maintaining a low-inflation environment. Using various indices of central bank independence, the existing literature has generally concluded that, at least for the developed economies, greater central bank independence from political control is negatively correlated with average inflation (see, for example, Bade and Parkin [1982]; Grilli, Masciandaro, and Tabellini [1991]; Banaian, Laney, and Willett [1983]; and Cukierman, Webb, and Neyapti [1992]). Independence also seems to be related to lower inflation variability, although here the findings are not quite as unanimous (see Table B-2 of Eijffinger and de Haan [1996]). Central bank independence shows no correlation with real variables such as average GDP growth or its variability (see Alesina and Summers [1993]; Cukierman et al. [1993]; and Eijffinger and de Haan [1996]). This entire literature has been critically surveyed by Eijffinger and de Haan (1996).

A high degree of central bank independence appears to have the potential to yield low average inflation with no deleterious effects on real activity. Faced with the evidence that central bank independence is a seemingly free lunch, countries around the world, from members of the European Community to Mexico and New Zealand, have moved, or are moving, to restructure their central banking laws to increase the political independence of the authorities charged with the conduct of monetary policy.

In the face of this growing consensus concerning the role of central bank independence, Japan is viewed as an outlier. The Bank of Japan is closely tied to the Ministry of Finance in ways that would normally appear to give the Bank little independence (Cargill, Hutchison, and Ito, [forthcoming]). In fact, one of the most commonly used measures of central bank independence, that of Cukierman, Webb, and Neyapti (1992), ranks only Norway below Japan among industrialized countries. Yet since 1980, Japan's inflation rate has averaged less than either Germany's or Switzerland's, two countries often viewed as having achieved among the most successful records against inflation. This has caused Cargill (1995a,b) to question the causal significance of the statistical correlations between measures of central bank independence based on descriptions of the legal structure of the bank. But the perception of Japan as an outlier arises from what are essentially simple correlations between inflation and central bank independence. Certainly central bank structure is not the only determinant of inflation, and other potential influences on inflation need to be accounted for before concluding that Japan is in any meaningful sense an outlier. Campillo and Miron (1996), for example, have shown that central bank independence has no explanatory power for cross-country variation in average inflation once other potential determinants of inflation are included in the analysis. They argue instead that the degree of openness is an important factor in explaining inflation, a factor that received earlier emphasis by Romer (1993).

Posen (1995) argues that low inflation and central bank independence are both products of a strong constituency for low inflation. This is a special case of the more general point that both inflation and central bank institutional structures are endogenous. De Haan and van't Hag (forthcoming) report that central bank independence is more likely in countries with historical experiences of high inflation and less likely in countries subject to political instability. So if independence is endogenous, simply changing laws to give more legal independence to the central bank may not by itself produce much effect on inflation. As Eijffinger and de Haan (1996) express it, "Current research leads us to conclude that every society gets the central bank it deserves."

Given the nature of the existing empirical evidence, it is not surprising that a number of authors have contested the conclusion that central bank independence is responsible for low inflation. The typical approach in the empirical literature has been to employ cross-country comparisons of average inflation and measures of central bank independence, but such comparisons are problematic for two reasons. First, if the legal status of central banks has changed little, then it will be impossible to separate the effects of central bank structure on inflation from the effects of other country-specific factors. Cross-country correlations cannot control for country-specific fixed effects that may be related both to central bank structure and to economic outcomes such as average inflation. Yet this separation is critical if one is to draw policy conclusions about the desirability of central banking reforms aimed at increasing independence.

Second, a focus on average inflation cannot shed light on whether central bank independence affects the manner in which policy responds to economic disturbances or whether other aspects of economic behavior might be related to central bank structure. Debelle and Fischer (1994), Walsh (1995b), Fischer (1996), and Froyen and Waud (1995) have suggested that low average inflation may not be the only effect of central bank independence. These authors show that the real output losses associated with reductions in the rate of inflation are positively correlated with central bank independence. Debelle and Fischer note that Grilli, Masciandaro, and Tabellini's index of central bank independence is positively related to Ball's (1996) estimates of the sacrifice ratio. Using three alternative measures of central bank independence, Walsh (1995b) estimates the effect of central bank independence on the short-run inflation-output trade-off for the 12 member states of the European Community and finds that increasing independence is associated with greater real output effects of changes in nominal income growth.

These results have been given a variety of interpretations. One is that independent central banks derive no credibility bonus from their insulation from political pressures during disinflationary periods. Another is that variations in sacrifice ratios could indicate that economic structures—in this case, the slope of the short-run inflation/output relationship—may be systematically correlated with central bank independence, either because both are caused by common factors or because the policy behavior of the central bank influences directly the Phillips Curve slope. This latter possibility is explored in Walsh (1995b), who shows how the central bank's response to economic disturbances might affect the short-run inflation/output trade-off.

This work suggests there is value in pursuing two lines of research. First, there is a need to control for other potential determinants of inflation in attempting to estimate the contribution of central bank structure to inflation. And second, there is a need to examine how differences in the degree of central bank independence might be related to the manner in which policy responds to economic disturbances. A focus on cross-country responses to economic shocks may also provide a means of minimizing the difficulty of isolating the effects of central bank independence from other country-specific effects. Further empirical evidence on these issues will serve to provide new insights into the case of Japan by examining whether Japan remains an outlier once we have controlled for other potential determinants of inflation.

The main contribution of this paper is to focus on the relationship between central bank structure and the response to economic shocks and on panel data approaches that utilize both cross-country and time-series variation in inflation to explore the determinants of inflation. By exploiting evidence from before and after an economic shock, it is possible to control partially for country-specific fixed effects. In this regard, the oil price shocks of the 1970s provide a natural experiment; since country-specific factors are the same before and after the shocks, the oil price shocks allow one to examine whether inflation responses varied systematically with the degree of central bank independence. Not surprisingly, the rise in average inflation associated with the first oil price shock was negatively related to the degree of central bank independence. This provides some (weak) evidence that central banking structures play a role in affecting the way each country responds to external disturbances.

While a comparison of how policy responded in the face of discrete disturbances is informative, such an approach ignores the information contained in the annual variations in inflation that may also reflect policy differences. That is, both cross-country and time-series variation in inflation may serve to provide evidence on the way in which central bank structure affects macroeconomic outcomes. So a panel data approach is also utilized in this paper.

The empirical findings in this paper help to cast light on the Japanese experience. Japan has successfully combined low average inflation with a legally quite dependent central bank. Cargill, Hutchison, and Ito (forthcoming) argue that Japan is best thought of as having achieved a (potentially fragile) reputational equilibrium. However, the empirical evidence from the panel estimates suggest that, in an important sense, Japan is not an outlier. While Japan's inflation rate is surprisingly low when only central bank independence is used to predict inflation, the prediction error is significantly reduced once other important determinants of inflation are taken into consideration. A reputational model of delegation is developed to explore why the Bank of Japan may have been able to achieve low inflation without formal independence. The model implies that increased political competition in Japan is likely to strengthen the case for policy delegation.

II. Independence and the Response to Oil Price Shocks

The standard approach in empirical studies of central bank independence and inflation has been to focus on cross-country data and the correlation between measures of central bank independence and average inflation. Differences in average inflation rates are attributed to differences in central banking structure. But it is not only average inflation rates that might differ systematically across countries in ways related to central bank structure. Consider, for example, the basic one-period model typically used to study time-inconsistency issues in monetary policy (see, for example, Rogoff [1985] or Persson and Tabellini [1990]). The central bank is assumed to have preferences over output and inflation fluctuations given by

$$-\frac{1}{2}(y - y^* - k)^2 - \frac{1}{2}\beta\pi^2.$$

The policy-maker's utility is decreasing in squared deviations of output from $y^* + k > y^*$, where y^* is the economy's equilibrium value of output, and squared deviations of inflation from zero. This type of objective function is standard. Output deviations from y^* are a positive function of inflation surprises:

$$y = y^* + \alpha(\pi - \pi^e) + e \qquad (1)$$

where π^e is the public's expectation of inflation formed prior to observing the shock e; in contrast, the central bank can set policy after observing e. Under discretion, equilibrium inflation is given by[1]

$$\pi = \frac{\alpha k}{\beta} - \frac{\alpha}{\alpha^2 + \beta} e + v \qquad (2)$$

where v represents control errors that arise because the central bank does not directly set the inflation rate.

It is quite common to interpret the parameter β, the weight the central bank places on inflation objectives, as measuring central bank independence. Monetary authorities with greater political independence are assumed to place greater weight on inflation control. This means that greater independence is associated with lower average inflation ($\alpha k/\beta$), the result that has formed the focus of most of the empirical literature in this area. But equation (2) also shows that the policy response to the shock e will be a function of β. If greater independence is reflected in a larger β, then it should also be reflected in a smaller (in absolute value) inflation response to aggregate supply disturbances.

1. See Walsh (1995a).

This implication has been tested by looking not at the relationship between the variance of inflation and economic disturbances, but by looking at output variance and central bank independence. Substituting equation (2) into equation (1) shows that

$$y = y^* + \frac{\beta}{\alpha^2 + \beta} e + \alpha v.$$

Thus, the impact of e on output, and therefore the variance of output, is increasing in β. As Alesina and Summers (1993) showed, this implication is not supported by the data.

As noted in Section I, central bank independence seems to be related to lower inflation variability, although the evidence is not uniform (de Haan and Eijffinger [1996]). One reason the evidence is not clear-cut may be that the variance of inflation is affected not just by the type of aggregate supply disturbances highlighted in equation (1) but also by aggregate demand shocks represented in v, since such shocks affect the transmission from policy instruments to actual inflation. This may serve to mask the relationship between central bank independence and inflation (and output) volatility.

In addition, the role played by central bank independence might be more apparent in affecting an economy's response to the type of discrete supply disturbance associated with the oil price shocks of the 1970s. For example, Ball (1995) develops a model in which just such discrete shocks lead to persistent movements in inflation. An examination of how the industrialized economies adjusted to the oil shocks provides an alternative to looking at sample variances as a means of assessing whether central bank independence matters for economic stabilization.

Section II.A. begins by reporting inflation-central bank independence correlations based on a sample of 19 industrialized economies. This serves to review the standard finding that the level of inflation is related to measures of independence. Next, some preliminary evidence on the correlation between central bank independence and changes in average inflation before and after the major oil price shocks of the 1970s is presented. The oil price shocks provide natural experiments for isolating the effects of monetary policy structure under the assumption that other country-specific fixed effects affect only the average inflation rate. The results are suggestive and are explored further in the following section using a panel data set.

A. Data Description

Attention is restricted to a sample of 19 industrialized economies, in part because attempts to link measures of central bank independence based on their legal structures to economic outcomes have been less successful for the developing economies (Cukierman [1992]). The countries included in the sample are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Spain, Sweden, Switzerland, the United Kingdom, and the United States.

The basic index of central bank independence employed is that of Cukierman, Webb, and Neyapti (1992) and reported in Table 19.4 of Cukierman (1992). Measures of central bank independence are designed to reflect the institutional framework within which central banks operate and depend on various legal aspects of the central banking structure in each country. Cukierman, Webb, and Neyapti have assembled an extensive database on legal characteristics of central banks for a large sample of developed and developing countries. The data categories range from information on who appoints the central bank's CEO and the provisions for the CEO's dismissal to information on the terms of government borrowing from the central bank. Cukierman, Webb, and Neyapti use these data to construct their measure of legal independence. This measure, denoted here by *LVAU*, is also used by Cukierman (1992, see in particular Chapter 19) and Cukierman et al. (1993). The index is available for the 19 industrialized economies for which data were also available on real and nominal GDP (or GNP) from the International Monetary Fund's *International Financial Statistics*. The sample period covers 1960 to 1993 and includes periods of significant inflation variation.

While the Cukierman, Webb, and Neyapti index has been used extensively, it has also been subject to criticism. Eijffinger and de Haan (1996) provide a discussion of several alternative measures of central bank independence. Among the more commonly used are those of Alesina (1988); Grilli, Masciandaro, and Tabellini (1991); and Eijffinger and Schaling (1993). Eijffinger and Schaling provide a detailed discussion of these last three. All incorporate subjective judgments in their construction, and unfortunately, the rankings implied by the different measures can vary. As noted by Eijffinger and de Haan, the rank correlations between the alternative measures are often quite low.[2]

In Walsh (1995b), several measures of central bank independence were employed as a check on the empirical results. And while the *LVAU* index will be the primary measure used in this paper, results are also reported using the measure developed by Eijffinger and Schaling (1993). In addition, all the regressions were re-estimated using the central bank independence index of Alesina (1988), both the index of political independence of Grill, Masciandaro, and Tabellini (1991) and the sum of their political and economic independence indexes, and an index used by de Haan and van't Hag (forthcoming) based on legal aspects of central banks reported by Cukierman (1992).[3] The general conclusions of this paper were robust across these various measures of independence.

B. Average Inflation and Central Bank Independence

The oil price shocks of the early 1970s provide a natural experiment for determining whether a country's central banking structure affected the manner in which domestic

2. For example, the Fendall rank correlation between *LVAU* and the Eijffinger and Schaling measure, *ES*, is only 0.20 for the industrialized nations. See also Walsh (1993).
3. All these measures, with the exception of the de Haan and van't Hag measure, are reported in Table 2, page 23, of Eijffinger and de Haan (1996). De Haan and van't Hag's index is reported as column 2 of their Table 1, page 12. Note that not all measures are available for all 19 countries.

inflation was allowed to respond in the face of a macroeconomic disturbance. From 1960 to 1972, inflation across the economies in the sample averaged 4.8 percent; from 1973 to 1979, it averaged 9.6 percent. Not all countries experienced the same rise in inflation, and in this section we investigate whether the cross-country differences in inflationary experiences were related to central bank independence.

Figure 1 plots average inflation from 1973 to 1979 against the Cukierman, Webb, and Neyapti index *LVAU* for each of the 19 countries. The negative slope easily stands out in the figure, reflecting the common finding that central bank independence is negatively correlated with average inflation rates. Table 1 presents the same information in the form of a regression of average inflation on central bank independence. The results for the 1973–79 period are reported, using both *LVAU* and *ES* under the columns headed (1.3) and (1.4). The scatter of points in Figure 1 suggests that the assumption of homoscedastic errors may be inappropriate, so the standard

Figure 1 Average Inflation: 1973–79 and 1980–93

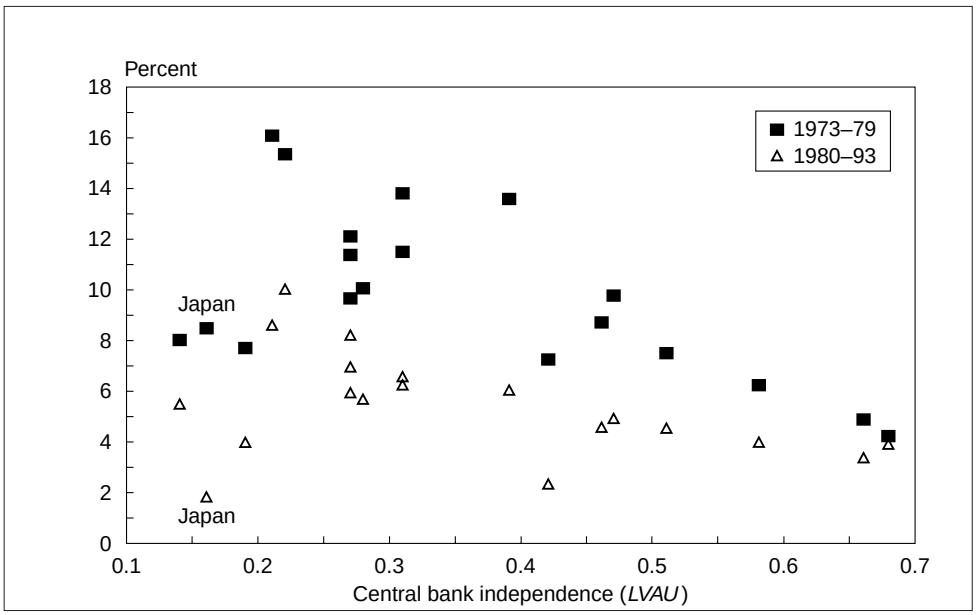


Table 1 Average Inflation

	1960–72		1973–79		1980–93	
	(1.1)	(1.2)	(1.3)	(1.4)	(1.5)	(1.6)
Constant	0.053**	0.040**	0.141**	0.138**	0.074**	0.077**
LVAU	–0.015		–0.122**		–0.054*	
ES		0.003		–0.015**		–0.008**
S.E.	0.010	0.010	0.028	0.029	0.020	0.020
$\overline{R^2}$	0.006	0.043	0.320	0.221	0.132	0.145

Note: ***, **, and * indicate statistical significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

errors reported in Table 1 are White-consistent standard errors. The coefficients on both *LVAU* and *ES* are negative and highly statistically significant.

Since we will want to focus on the effects of the oil price shock on the inflationary experiences of the countries in the sample, Table 1 also reports, under columns (1.1) and (1.2), the results for the pre-oil price shock period, 1960–72. For this earlier period, the coefficients on the measures of central bank independence are only one-fifth to one-tenth their value for the 1973–79 period and are not statistically significant. The insignificance of central bank independence during the 1960–72 period is perhaps not surprising, since the Bretton Woods era of fixed exchange rates limited the ability of central banks to conduct discretionary monetary policy. However, this period is far from characterized by a shared common world inflation rate. In the sample used here, average inflation ranged from a high of almost 7 percent to a low of just above 3 percent; if central bank independence were important, it is surprising that this inflation variation was not related to either *LVAU* or *ES*.

Figure 1 also shows the average inflation rates experienced by the industrialized economies during the 1980–93 period. Reflecting the general disinflation that occurred during the early 1980s, these points lie below those for the earlier period, but a negative relationship with *LVAU* is still apparent. Columns (1.5) and (1.6) of Table 1 show that the coefficients on both *LVAU* and *ES* remain statistically significant for this more recent sample period, although the point estimates are roughly half that for the 1973–79 period.

The measure of *LVAU* for Japan is 0.16, and Japan can be identified in Figure 1 as being an outlier from the general relationship that seems to exist between inflation and central bank independence. It is interesting to note, however, that the three countries with the lowest rankings according to the *LVAU* index (Japan, Norway, and Belgium) all seem to have experienced lower inflation than would be predicted solely on the basis of the degree of independence enjoyed by their central banks.

C. Differences in Differences

The results in Table 1 reflect the conventional wisdom; greater legal independence on the part of the central bank is associated with lower average inflation. One of the problems with the standard findings of the type reported in Table 1, however, is that they fail to control for country-specific factors. In other words, has Germany had low average inflation because the Bundesbank is independent, or are there other factors that account for Germany's low inflation (such as the historical memory of hyperinflation)? To the extent that the cross-country differences that account for inflation are also correlated with measures of central bank independence, the standard approach (correlating average inflation with central bank independence measures) will attribute differences in inflation to differences in central banking structures, leading to spurious conclusions about the role of independence in affecting inflation. This point of view has been argued by Posen (1995) and Cargill (1995b).

The problem of individual fixed effects is common in applied microeconomics, but it is traditionally a less common concern in time-series work. Unfortunately, given the fact that until quite recently there have been few changes in central banking structures among the industrialized economies, there is as yet little time-series variation that

could be employed to estimate the effects of central bank independence on inflation.[4] Employing cross-sectional variation is of limited value if country-specific fixed effects cannot be disentangled from the effects of central bank independence.

However, the way in which countries have responded to macroeconomic shocks may provide some information on the role played by central bank independence. Consider the following formulation, where $\bar{\pi}_{i,s}$ is average inflation during period s in country i, $LVAU_i$ is the index of central bank independence for country i, $z_{i,s}$ is a vector of factors that vary by country and by period, and x_s represents factors common to all countries during period s:[5]

$$\bar{\pi}_{i,s} = a_i + bLVAU_i + cz_{i,s} + dx_s + \varepsilon_{i,s} = \bar{a}_i + cz_{i,s} + e_{i,s} \qquad (3)$$

where $\bar{a}_i = a_i + bLVAU_i + dx_s$. The parameter b cannot be identified. The identification assumption implicit in the regressions reported in Table 1 was that $a_i = a_j = a$ for all i and j. If $z_{i,s}$ were excluded (as is the case in Table 1), $LVAU_i$ then captures all the cross-sectional variation in inflation. This is appropriate if $LVAU_i$ is uncorrelated with the country-specific factors that were captured by a_i and $z_{i,s}$. This, however, is unlikely to be the case.

As written, equation (3) assumes that the effect of x_s on inflation is the same for all countries; consequently, its effect on inflation cannot be estimated from the cross-country regressions. However, the basic framework used in most of the theoretical modeling of central bank independence implies that the manner in which countries respond to economic disturbances, and therefore the parameter d, will vary as a function of the preferences of the central bank (see equation [2]). There will be an indirect effect of central bank independence on inflation through the coefficient d (and we should write it therefore as d_i).

To illustrate this, consider modifying the simple model that leads to equation (2) by assuming the aggregate supply shock for country i in period s, $e_{i,s}$, contains both country-specific and common components: $e_{i,s} = \varepsilon_{i,s} + x_s$. With this modification, equation (2) becomes

$$\pi^*_{i,s} = \frac{\alpha k}{\beta} - \frac{\alpha}{\alpha^2 + \beta}(\varepsilon_{i,s} + x_s) + v_{i,s}. \qquad (4)$$

As previously discussed, if greater central bank independence is associated with a larger value for β (greater weight on inflation objectives), then the average inflation rate will be lower in countries with independent central banks, and the larger β is, the smaller the impact is of the disturbance x_s on inflation. Equation (3) should be modified to become $\bar{\pi}_{i,s} = a_i + bLVAU_i + d_i x_s = \bar{a}_i + d_i x_s$ where

$$d_i = \gamma_0 + \gamma_1 LVAU_i \qquad (5)$$

4. But for one attempt to estimate the effects of New Zealand's 1989 central bank changes, see Hutchison and Walsh (1996). Given that there has been some variation in central banking structures, Section III will attempt to use that variation in a panel data framework.

5. x_s could be a vector and would include such common disturbances as the oil price shocks of the 1970s.

and, for the moment, the $z_{i,s}$ term has been dropped for simplicity. The specification in equation (5) assumes that the response of country i's inflation rate to changes in x_s depends on the degree of central bank independence. Then, with data from two periods, s and s', one can difference equation (3) to obtain

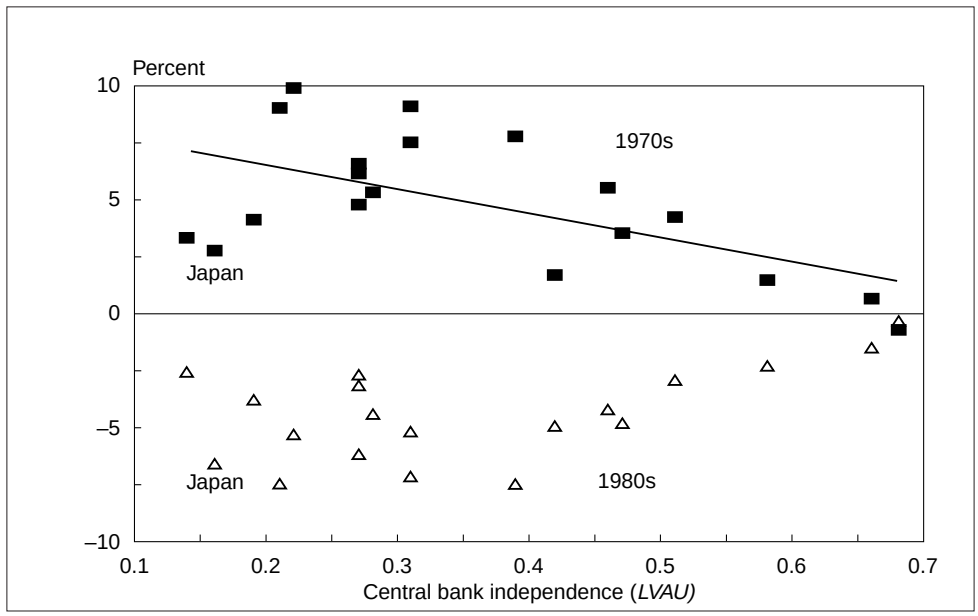
$$\Delta\bar{\pi}_i = \bar{\pi}_{i,s} - \bar{\pi}_{i,s'} = \gamma_0\Delta x + (\gamma_1\Delta x)LVAU_i = \bar{\gamma}_0 + \bar{\gamma}_1 LVAU_i \qquad (6)$$

which is estimable; equation (6) exploits the differences between $\Delta\bar{\pi}_i$ and $\Delta\bar{\pi}_j$, the differences in the differences, to estimate the effect of the difference in $LVAU_i$ and $LVAU_j$.

This approach is an example of a differences-in-differences approach that is common in applied microeconomics. If there are country-specific factors that caused Germany to be a low-inflation economy relative to the United Kingdom in the 1960s, those same factors should also account for part of the difference in inflation between these two countries in the 1970s. But these same factors cannot account for any change between the 1960s and the 1970s in the difference between Germany's and the United Kingdom's inflation rate. Taking the differences of inflation as a means of identifying the effect of central bank independence assumes that country-specific factors that account for average inflation differences are eliminated. The degree of central bank independence, by contrast, is assumed to influence the way in which economies reacted to economic shocks.

By comparing the period 1960–72 to 1973–79 and 1973–79 to 1980–93, two equations of the form (6) can be estimated. First, however, it is instructive simply to plot the data. As Figure 2 shows, the changes in average inflation from the first

Figure 2 Absolute Changes in Average Inflation



period to the second display a clear negative correlation with *LVAU*. This is confirmed by the regression reported in columns (2.1) and (2.3) of Table 2. Comparing these results from Table 2 with columns (1.3) and (1.4) of Table 1 shows that the estimated coefficients on *LVAU* and *ES* are quite similar in both cases. The predicted regression line implied by column (2.1) of Table 2 based on *LVAU* is also shown in Figure 2; Japan is one of the largest outliers.

Quite a different conclusion appears when the change in average inflation from the 1973–79 period to the 1980–93 period is compared with *LVAU* and *ES*. Figure 2, based on *LVAU*, suggests a positive relationship, and this is confirmed under columns (2.5) and (2.6) of Table 2 for both measures of central bank independence. Clearly what is being captured here is the greater inflation variability experienced by countries with less independent central banks. Countries with relatively dependent central banks experienced larger inflation increases from the first to the second periods; with inflation running at higher rates, these countries experienced larger declines in inflation during the disinflationary period of the 1980s. Figure 3 plots the percentage inflation changes against *LVAU*; this shows quite clearly that the disinflations of the 1980s were not related to the degree of central bank independence.

This suggests that, at a minimum, one needs to control for the initial level of inflation. Column (2.3) shows that average inflation from the 1960–72 period is insignificant in the regression for $\Delta\pi_1$, and its inclusion has little effect on the estimated coefficient on *LVAU*. Average inflation from the earlier period is statistically significant when *ES* is used to measure central bank independence (column [2.4]), but again, including it has little effect on the estimated coefficient on the independence measure. In contrast, columns (2.7) and (2.8) reveal that the extent of disinflation from the 1970s to the 1980s is unrelated to central bank independence once the average level of inflation in the 1970s is controlled for.

These findings are suggestive. Central bank independence seems to have played a role in the way in which inflation responses to the first oil shocks varied across the industrialized economies. The subsequent deflations that occurred in the 1980s were

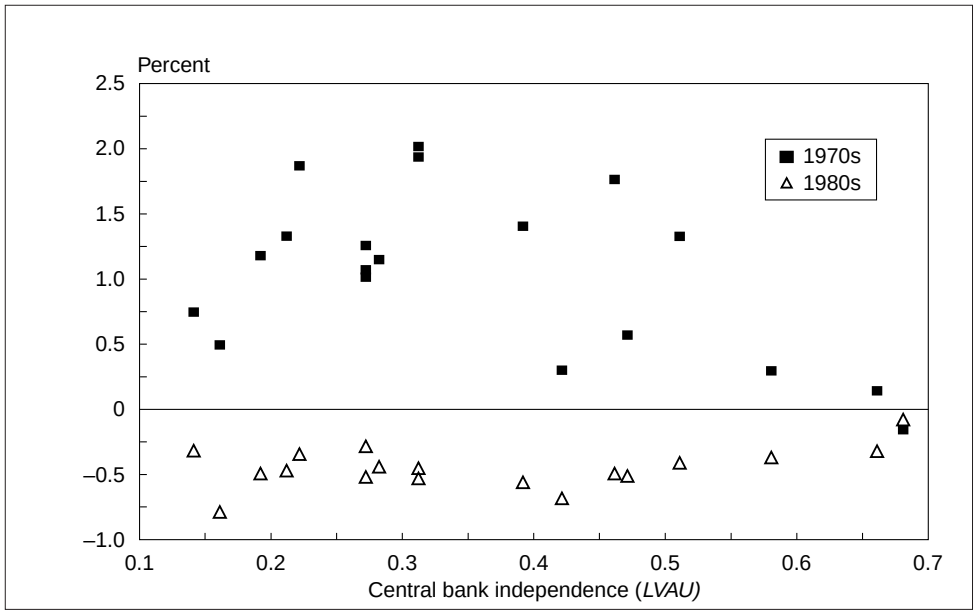
Table 2 Differences in Differences

	$\Delta\pi_1 \equiv \pi_{73-79} - \pi_{60-72}$				$\Delta\pi_2 \equiv \pi_{80-93} - \pi_{73-79}$			
	(2.1)	(2.2)	(2.3)	(2.4)	(2.5)	(2.6)	(2.7)	(2.8)
Constant	0.087**	0.097**	0.079**	0.049**	–0.068**	–0.060**	–0.003	0.005
LVAU	–0.107**		–0.105**		0.067**		0.011	
ES		–0.018**		–0.021**		0.007*		–0.000
π_{60-72}			0.153	1.193**				
π_{73-79}							–0.460**	–0.475**
S.E.	0.025	0.023	0.026	0.020	0.018	0.019	0.013	0.013
$\overline{R^2}$	0.302	0.425	0.262	0.554	0.245	0.094	0.599	0.558

Note: ***, **, and * indicate statistical significance at the 1 percent, 5 percent, and 10 percent levels, respectively.
Given the linear structure, column (1) can be obtained as the difference between columns (1.3) and (1.1) in Table 1. Similarly, column (2.5) can be obtained from Table 1's columns (1.5) and (1.3).

related to the level from which inflation had to be reduced (and therefore indirectly to central bank independence) but were not directly correlated with the measures of central bank independence used here.

Figure 3 Percentage Changes in Average Inflation



III. Panel Evidence

The results reported in Table 2 are similar in nature to the early work focusing on the correlation between a measure of central bank independence and a measure of inflation. By focusing on changes in inflation, however, the results provide some control for country-specific, fixed effects that might account for differences in average inflation rates among the countries in the sample. While such an approach can be suggestive, using only information on inflation rates averaged over various periods ignores the information contained in the time-series variation of inflation rates, information that can be useful in attempting to isolate the influence of central bank structure on inflation. For that reason, recent work has employed panel data techniques to examine the behavior of inflation across countries and across time. In this section, I examine data from 18 OECD countries during the period from 1961 to 1989.[6]

6. I would like to thank Gunnar Jonsson for providing his data set for use in this paper. The countries included are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Sweden, Switzerland, the United Kingdom, and the United States. (See Jonsson [1995].)

A. Time Averages

Consider the following model for the time-series behavior for inflation at time t in country i:

$$\pi_{i,t} = a_i + bs_i + cz_{i,t} + dx_t + \varepsilon_{i,t} \quad (7)$$

where s_i, $z_{i,t}$, and x_s are vectors of determinants of $\pi_{i,t}$ with the distinction being that s_i consists of those factors that are country-specific but time-invariant, while x_t represents factors that are time-varying but the same for all countries. In general, aspects of the central bank's institutional structure would constitute elements of s_i. As specified, this equation is clearly not estimable; identifying restrictions need to be imposed.

The initial literature on central bank independence converted equation (7) to an estimable equation by taking time averages and exploiting the cross-sectional variation in the data. Thus, the effects of central bank independence would be obtained by using ordinary least squares to estimate

$$\overline{\pi}_i = \overline{a} + bs_i + c\overline{z}_i + \overline{\varepsilon}_i. \quad (8)$$

For a survey, see Eijffinger and de Haan (1996).

Results based on 1961–89 averages for the 18 countries in Jonsson's sample are reported in Table 3. Column (3.1) reveals the standard negative relationship between central bank independence and average inflation using Cukierman's index of central bank independence. In columns (3.2) to (3.4), four additional variables often mentioned as determinants of inflation are added to the regression. The first is the share of imports in GDP. Romer (1993) has argued that the incentive for inflation will be smaller in an open economy, and he reports a negative relationship between import share and average inflation. The second variable added to the equation is a measure of the natural rate of unemployment, *UNN*. This is obtained as the estimated trend

Table 3 Average Inflation, 1961–89

	OLS					
	(3.1)	(3.2)	(3.3)	(3.4)	(3.5)	(3.6)
Constant	8.90***	9.21***	7.73***	7.98***	9.40***	8.31***
LVAU	–6.49***	–6.52***	–6.33***	–5.51***	–5.71***	–5.93***
IMPORT		–0.01				
UNN			0.27**			0.22
DEFICIT				0.20		
GOVT					–1.80*	–0.97
$\overline{R}^2$	0.28	0.24	0.36	0.30	0.30	0.33
Obs.	18	18	18	18	18	18

Note: ***, **, and * indicate statistical difference from zero at the 1 percent, 5 percent, and 10 percent levels, respectively.

from a Hodrick-Prescott filter applied to actual unemployment. A higher natural rate might increase the incentive to engineer an economic expansion and thereby raise the time-consistent inflation rate.[7] The third variable is the deficit as a fraction of GDP. If public finance considerations are important, a larger deficit might require a greater reliance on inflation tax revenues, leading to a higher average inflation rate. The fourth is a dummy variable (*GOVT*) equal to one when a conservative government is in office. It is often argued that conservative governments are more likely to support low-inflation policies.

Column (3.2) shows that the import share variable is statistically insignificant. The lack of any effect of import share on inflation is consistent with Jonsson's earlier work. Increases in the natural rate of unemployment are associated with higher rates of inflation according to the results reported in column (3.3). The addition of the natural rate of unemployment and the import share has little effect on the estimated coefficients on the measures of central bank independence. Adding either the deficit share (column [3.4]) or *GOVT* (column [3.5]) tends to lower the estimated impact of central bank independence, but only the effect of *GOVT* on inflation is statistically different from zero, and then only at the 10 percent level. As expected, more conservative governments are associated with lower average rates of inflation. Finally, column (3.6) reports the result of including both *UNN* and *GOVT* in the regression, since these were the only two variables of the four that appeared to be related to inflation. As the results show, neither remains statistically significant when both are included. The effect of central bank independence continues to be highly significant.

B. Pooled Regressions and Fixed Effects

The use of time-averaged data ignores the information contained in the time-series variation of inflation rates. Even if the central banking structure is constant over time within each country (and this is not the case for all the countries in the sample), the time-series information can help to identify the effect of central bank independence on inflation by serving to estimate the effects of those determinants of inflation that do vary with time and across countries. Table 4 reports the results of pooled time-series cross-sectional regressions for the 18 OECD countries from 1961 to 1989 (annual data). Beginning with the results for *LVAU*, column (4.1) is the familiar simple regression of inflation on central bank independence, yielding the standard negative, statistically significant coefficient.

An important characteristic of the time-series data is that the 1961 to 1989 period covers the Bretton Woods period and the post-Bretton Woods era, and the sample included countries that have been in the European Monetary System (EMS) and others that have not. Since the exchange-rate regime would be expected to affect inflation, columns (4.2) and (4.3) report results obtained when dummy variables for exchange-rate regimes are included. In column (4.2), *BW* is a dummy equal to one

7. If the standard model of time inconsistency and inflation is specified in terms of unemployment rather than output, the average inflation rate is related to the difference between the economy's natural rate of unemployment and the policy-maker's target. If changes in the natural rate produce equal changes in the target rate, there would be no relationship between the natural rate and inflation.

Table 4 Pooled Regressions: Inflation and Exchange Rate Regimes

	(4.1)	(4.2)	(4.3)	(4.4)	(4.5)	(4.6)
Constant	9.13***	10.61***	8.96***	8.66***	10.03***	8.43***
LVAU	–7.13***	–6.54***	–14.80***			
ES				–0.81***	–0.72***	–1.87***
BW		–3.97***			–3.85***	
EMS		–1.51**			–1.42**	
NBW · CBI			7.96***			1.04***
NEMS · CBI			3.75***			0.57***
UNN						
$\overline{R^2}$	0.07	0.25	0.18	0.05	0.18	0.17
Obs.	522	522	522	493	493	493

Note: ***, **, and * indicate statistical difference from zero at the 1 percent, 5 percent, and 10 percent levels, respectively.

during the Bretton Woods period and zero otherwise; *EMS* is a dummy equal to one if the country is in the EMS and zero otherwise. Both enter significantly with the expected negative signs; the Bretton Woods period of fixed exchange rates was associated with lower average inflation, as is membership in the EMS. While inclusion of these exchange-rate regime dummy variables lowers the coefficient on *LVAU* slightly, central bank independence remains highly significant.

One might expect the exchange-rate regime and the degree of central bank independence to interact in ways not captured by simply including the dummy variables *BW* and *EMS*. One hypothesis would be that under a system of fixed exchange rates, the degree of legal central bank independence would be less important than under flexible exchange rates. Central bank independence might be expected to have a larger impact on inflation for countries and time periods not under Bretton Woods or the EMS. To examine this hypothesis, column (4.3) replaces *BW* and *EMS* with two new variables; *NBW · CBI* is equal to the measure of central bank independence if country *i* in period *t* is not in the Bretton Woods system and zero if country *i* in period *t* is in the Bretton Woods system. The variable *NEMS · CBI* is defined correspondingly. The results in column (4.3) imply that under the Bretton Woods system, the point estimate of the coefficient on the *LVAU* measure of central bank independence was –11.05 (–14.8 + 3.75).[8] After the end of Bretton Woods, the impact of central bank independence for countries not in the EMS is estimated to be –3.09 (–14.8 + 7.96 + 3.75), while for those in the EMS the point estimate is –6.84. Similar results are found if Eijffinger and Schaling's measure of central bank independence *ES* is employed (see columns [4.4] to [4.6]).[9] The finding that central bank independence continues to play a role under fixed exchange rates is of interest.

8. That is, under Bretton Woods, *NBW · CBI* = 0, and *NEMS · CBI* = *CBI*.
9. Using the Alesina, the Grilli, Masciandaro, and Tabellini, and the de Haan and van't Hag measures of central bank independence yielded similar results.

It suggests that the Maastricht requirements that European Union members revise their laws to ensure greater independence of their central bank is of relevance; membership in *EMS* actually seems to have emphasized the importance of central bank independence. However, it should be noted that the regression sum of squared residuals is lower with the simple dummies *BW* and *EMS* rather than the interactive terms, so in the rest of the paper, only results for these measures of the exchange-rate regimes will be reported.

One characteristic of the univariate time-series process followed by inflation in most countries is that it exhibits a relatively high degree of persistence, even when dealing with annual observations.[10] And the oil price shocks of the 1970s played a major role in affecting the level of inflation. The pooled cross-sectional and time-series data allow for these effects to be incorporated. Thus, column (5.1) in Table 5 reports the results of including three lags of the inflation rate and the current plus three lags of the percentage rate of change in crude oil prices. Both lagged inflation and lagged oil prices are highly significant. The estimated coefficient on *LVAU* falls from –6.54 (column [4.2]) to –1.84, although it is still significant. Generally similar results are obtained using *ES*; including the lagged inflation variables reduces the coefficient on *ES* from –0.72 (column [4.5]) to –0.30 (column [5.4]).[11]

Table 5 Pooled Regressions: Other Determinants of Inflation

	(5.1)	(5.2)	(5.3)	(5.4)	(5.5)	(5.6)
Constant	2.74***	2.51***	2.47***	2.89***	2.97***	2.92***
LVAU	–1.84***	–1.78***	–1.82***			
ES				–0.30***	–0.32***	–0.31***
UNN		0.08**	0.08**		–0.00	–0.00
IMPORT		0.00			0.00	
DEFICIT		–0.01			–0.04	
GOVT		–0.19			–0.19	
$\pi_{i,t-i}, i = 1 - 3$	0.74***	0.72***	0.72***	0.74***	0.74***	0.74***
$\pi^{0}_{i,t-i}, i = 0 - 3$	0.30***	0.31***	0.31***	0.30***	0.29***	0.29***
BW	–0.24	–0.13	–0.11	–0.25	–0.28	–0.26
EMS	0.09	–0.31	–0.29	0.19	0.25	0.20
$\overline{R^2}$	0.76	0.76	0.76	0.75	0.75	0.75
Obs.	468	468	468	442	442	442

Note: ***, **, and * indicate statistical difference from zero at the 1 percent, 5 percent, and 10 percent levels, respectively.

10. Not surprisingly, the residuals from the Table 4 regressions displayed significant serial correlation.
11. Results, not reported, for the Grilli, Masciandaro, and Tabellini measure of political independence were similar to those using *LVAU*. The use of *GMTPOL* with exchange-rate regime dummies in regressions parallel to columns (4.2) and (4.5) yielded a coefficient estimate for central bank independence of –0.54, which fell to –0.16 in an equation with the same specification as that used in columns (5.1) and (5.4). Thus, the coefficient on this index also falls when lagged inflation and the oil price variable are included.

The results from the differences-in-differences analysis in the previous section suggested that cross-country differences in inflation responses to the oil shocks of the 1970s varied systematically with the degree of central bank independence. To investigate whether this holds true in the pooled cross-country time-series regression, *LVAU* was interacted with the oil price variable π^0. While the point estimate of the coefficient was negative, it was not statistically different from zero (the estimates are not reported). No evidence of an interaction effect is apparent. Similarly, I found no evidence that dummy variables for the Bretton Woods period or for membership in the EMS contributed statistically to explaining inflation. Nor did the measure of central bank independence enter significantly when interacted with the *BW* or *EMS* dummy variables.

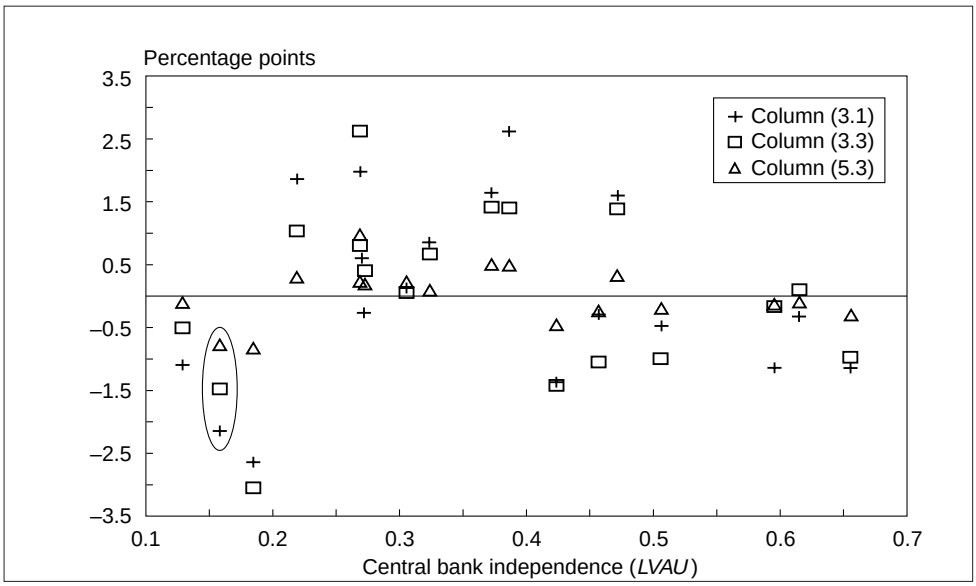
The four variables—*UNN*, *IMPORT*, *DEFICIT*, and *GOVT*—used in the time-averaged regressions were also included in the pooled regressions. Column (5.2) using *LVAU* indicates a statistically significant (at the 10 percent level) positive effect of the natural rate of unemployment; the other variables were not significant. Column (5.3) re-estimated the equation with only *UNN*; dropping the other three variables has essentially no impact on the estimates. The positive effect of the natural rate on inflation in the pooled regression results using *LVAU* is consistent with the findings reported in Table 3 for the time-averaged data. Table 5 also reports the results using the *ES* measure of central bank independence. When *ES* is used to measure independence, none of the other candidate variables enters significantly.[12]

Given the earlier evidence that Japan represented an outlier, it is instructive to examine the residuals from the time-averaged and the pooled regressions to see if this remains the case once the dynamics of inflation, oil price inflation, and the natural rate of unemployment are taken into consideration. Figure 4 presents the residuals from three estimated equations. First, the residuals from the basic regression of inflation on central bank independence using time-averaged data from column (3.1) of Table 3 are shown as crosses. The residual for Japan is enclosed within the ellipse. The open boxes represent the residuals from column (3.3) of Table 3, the regression that included a measure of the natural rate of unemployment. This reduces the residual for Japan from –1.8 to –1.0, a more than 40 percent reduction.[13] Thus, Japan appears less of an outlier. The regressions partially "attribute" Japan's low inflation to its low natural rate of unemployment. Interpreted in terms of the basic Barro-Gordon (1983a) model, the incentive for inflation has been small in Japan. Thus, the inflationary bias associated with discretionary policy is likely to also be small.

Moving from the regressions based on time-averaged data to the ones in Table 5 based on pooled data, Figure 4 also includes the average residual (averaged over the 29 annual observations) for each country from column (5.3) of Table 5, the regression that contained *LVAU* and *UNN* as well as lagged inflation, oil price inflation, and exchange-rate regime dummy variables. The residuals from this regression appear as the open triangles in the figure. Incorporation of the effects of oil and lagged inflation further lowers the estimated residual for Japan quite significantly.

12. Interestingly, the results for *GMTPOL*, the measure of political independence, are similar to those obtained using *LVAU* in that the natural rate of unemployment has a significant effect on inflation when *GMTPOL* is used to measure central bank independence.
13. The estimated standard error of the overall regression equation was reduced 5 percent by the inclusion of *UNN*.

Figure 4 Inflation Prediction Error



Earlier, it was argued that it was important to control for country-specific fixed effects. At a minimum, it is necessary to employ a fixed-effects model, as in Eijffinger, Van Rooij, and Schaling (1996) or Jonsson (1995). Eijffinger, Van Rooij, and Schaling estimate policy reaction functions using pooled data and identify the estimated fixed effects as a measure of central bank independence. They then show that their constructed measure is significant in inflation regressions.

A fixed-effects model exploits the within-country time-series variation in a variable to estimate its effects on inflation. Thus, in terms of equation (7), within-country averages are subtracted to obtain

$$(\pi_{i,t} - \pi_{i,.}) = b(s_i - s_i) + c(z_{i,t} - z_{i,.}) + (\varepsilon_{i,t} - \varepsilon_{i,.}) = c(z_{i,t} - z_{i,.}) + (\varepsilon_{i,t} - \varepsilon_{i,.})$$

where $x_{i,.} = (1/T)\sum_t x_{i,t}$ is the average over the time dimension. Thus, any variable such as s_i in equation (7) that is constant within each country over time drops out; its coefficient cannot be identified.

The lack of time-series variation in most measures of central bank independence means that within-country variation cannot be used to identify the effect of independence on inflation. Because there is some variation in the measure of central bank independence that was constructed by Cukierman, Webb, and Neyapti, it is possible to employ a fixed-effects model and obtain an estimate of the effect of central bank independence. However, the variation in *LVAU* across the time dimension is quite limited, so the fixed-effects regressions are likely to be suggestive at best.[14]

14. The countries in Jonsson's data set for which Cukierman, Webb, and Neyapti estimate there has been some variation in the degree of central bank independence are Austria, Belgium, France, Norway, Switzerland, and the United Kingdom.

Table 6 contains the results from estimating a fixed-effects model. Column (6.1) begins with the standard specification obtained by regressing inflation on central bank independence, *UNN*, *IMPORT*, *DEFICIT*, and *GOVT*. All are statistically significant, although *UNN* and *IMPORT* enter with signs that are opposite to what would be expected. As shown in column (6.2), only *IMPORT* enters significantly once lagged inflation and oil prices are added. Central bank independence no longer enters significantly. Column (6.3) shows this remains the case when the insignificant *UNN*, *DEFICIT*, and *GOVT* are dropped.

As noted above, Eijffinger, Van Rooij, and Schaling (1996) also employ a fixed-effects model to investigate the effects of central bank independence and inflation. Their approach, however, is quite different. They estimate country-specific fixed effects from regression estimates of central bank reaction functions. The estimated fixed effect captures the average difference in the central bank's policy instrument (taken to be a market interest rate) from the sample mean, and this is interpreted as an empirical measure of central bank independence. This measure has the expected correlation with average inflation (i.e., greater independence is associated with lower average inflation).

Table 6 Fixed Effects

	(6.1)	(6.2)	(6.3)
LVAU	–12.54***	–1.15	–0.17
UNN	–0.59***	–0.12	
IMPORT	0.18***	0.13***	0.14***
DEFICIT	0.19***	–0.09	
GOVT	–1.14***	–0.14	
$\pi_{t-i}, i = 1 - 3$		0.64***	0.62***
$\pi^0_{t-i}, i = 0 - 3$		0.30***	0.32***
BW	–4.14***		–0.26
EMS	–1.55*		–0.52
$\overline{R^2}$	0.33	0.73	0.73
Obs.	522	468	468

Note: ***, **, and * indicate statistical difference from zero at the 1 percent, 5 percent, and 10 percent levels, respectively.

C. Summary of the Empirical Results

The empirical results based on the panel data suggest that central bank independence may be somewhat less important as an explanation for cross-country differences in inflation rates than is commonly thought. Specifically, incorporating inflation dynamics, oil price effects, and an estimate of the natural rate of unemployment reduces significantly the estimated coefficient on central bank independence, regardless of which measure of independence is used. While the evidence was not entirely consistent, the natural rate of unemployment appears to be an important determinant of inflation when either Cukierman's index or Grilli, Masciandaro, and

Tabellini's political index of central bank independence is used. This unemployment effect did not appear when Eijffinger and Schaling's index was used.

IV. The Case of Japan

What do these empirical results tell us about Japan? Referring to Figure 1, Japan is easy to identify, particularly for the 1980–93 period; it is the obvious outlier close to the origin with relatively low average inflation yet a low value of central bank independence. For the earlier 1973–79 period also pictured in Figure 1, it is joined by two other countries with relatively low degrees of central bank independence as measured by *LVAU*. Yet the empirical findings reported in the previous sections imply that comparisons based on simple regression results may be misleading if the other determinants of the cross-country and time-series variations in inflation rates are not corrected for.

In some sense, the solution to the puzzle of Japan is provided by the panel data estimates; the effect of central bank independence on inflation is much smaller, and therefore the fact that Japan has combined low average inflation with a dependent central bank is of less note. This conclusion is broadly consistent with that of Campillo and Miron (1996), who conclude that central bank independence does not seem to be of particular importance for explaining cross-country differences in inflation. So in that sense, Japan is not an outlier or a puzzle to be explained. Perhaps a more modest conclusion comes from the time-averaged results in Table 3; measures of central bank independence are significant, but the residual for Japan is only about one standard error from the regression line.[15]

While Japan may not be the puzzle that simply looking at Japan's inflation record and the legal structure of the Bank of Japan and the Ministry of Finance might suggest, Japan has been very successful in maintaining low rates of inflation, and it is of interest to examine why. Within the context of the Barro-Gordon framework, the equilibrium inflation rate under a discretionary policy regime is equal to $\alpha k/\beta$ (see equation [2]). This framework suggests that there are several potential determinants of the average inflation rate. First, average inflation under discretion is increasing in α. This parameter is equal to the short-run real output effect of an inflation surprise. It affects the incentive to create inflation. Walsh (1995b) estimates such a trade-off parameter for 20 industrialized economies and finds that Japan has one of the lowest values of α. Second, average inflation will be low if k is small. The empirical results generally suggested that inflation was increasing in the natural rate of unemployment, and the natural rate could be viewed as a proxy for k; Japan's low unemployment rate is consistent with there being little incentive to inflate. Third, average inflation depends on β, the weight on inflation in the policy-maker's preference function.

15. The equation standard error for column (3.3) is 1.46; the residual for Japan is –1.48.

While these three parameters summarize the determinants of average inflation in the basic Barro-Gordon model, they do not provide a completely satisfactory explanation for Japan's inflation experience. First, while inflation surprises may generate little benefit in the form of an output expansion (i.e., Japan may have a small α), the short-run trade-off between output and inflation is not independent of the behavior of inflation. The slope of the short-run Phillips Curve is endogenous and likely to be influenced by the past behavior of inflation and monetary policy.[16] Second, the inflation bias should depend on k, which may or may not be related to the economy's natural rate of unemployment; a natural unemployment rate of 10 percent with a target of 8 percent and a natural rate of 3 percent with a target of 2.4 percent both imply a k of 0.2 (i.e., k is the percentage difference between y and y^*, or, equivalently, between the natural rate and the target rate of unemployment). Third, since preferences are unobserved, it is obvious that any inflation experience, whether it be high inflation or low inflation, could be "explained" by an appropriate value of β. For that reason, however, explanations based on preferences are somewhat less satisfactory.

This leaves two alternative explanations for Japan's low inflation. One is simply that central bank independence is not the only determinant of inflation and that these other determinants, such as unemployment, were such that Japan's inflation remained low. This interpretation accords broadly with the prediction errors shown in Figure 4. The residual for Japan was less than one standard error from zero. So "other" factors were sufficient to produce low inflation, although based on the time-averaged results (but not the pooled regressions), this interpretation also implies that Japan's inflation might have been lower still if the Bank of Japan had enjoyed more independence.

That leaves a final explanation, one that is certainly not mutually exclusive with the previous one; perhaps Japan is not in a time-consistent discretionary equilibrium. Instead, as emphasized by Cargill, Hutchison, and Ito (forthcoming), Japan's recent inflation experience is probably best thought of as representing a reputational equilibrium. Cargill, Hutchison, and Ito argue that bureaucratic control of the Bank of Japan has insulated it from electoral considerations. This, combined with effectively a one-party system during the sample period used here for the empirical work, has reduced the incentive to exploit monetary policy for short-term political gain. They then argue that the increased electoral competition in Japan makes this reputational equilibrium fragile.

In a reputational equilibrium, even politically dependent central banks may find it advantageous to behave in ways that mimic the behavior of hard-nosed inflation fighters (Ball [1995]). And if that is the case, then it is useful to develop more formally a model of delegation in order to understand the conditions under which a legally dependent central bank might sustain a reputation for low inflation and when it may be necessary to delegate monetary policy to a more independent central bank in order to maintain low inflation.

16. As discussed in Hutchison and Walsh (1996), however, most of the channels linking inflation to α would suggest that countries with low and stable inflationary experiences should have large α's.

The role of electoral uncertainty and optimal delegation can be examined in the context of the model of Barro and Gordon (1983b). To do so, we will employ a simple framework in which the government conducts monetary policy directly. This represents the case of no delegation. The resulting equilibrium can then be compared to alternative outcomes under delegated monetary policy. The focus is on reputational equilibria supported by trigger strategies.

Suppose, then, that the public expects low inflation if it has not been fooled by the government in the previous period. For simplicity, assume that low inflation corresponds to a zero rate of inflation. If the government has fooled the public in the previous period, the public expects the inflation rate that arises under pure discretion. That is, the public follows a trigger strategy that punishes the central bank if it should deviate from a policy of zero inflation.

Assume that the *government*'s objective function is given by

$$E_t \sum_{i=0}^{\infty} \rho_g^i V_t$$

where V_t is given by

$$-\frac{1}{2}(y_t - y^* - k)^2 - \frac{1}{2}\beta\pi_t^2$$

and $0 < \rho_g < 1$ is the government's discount factor. Government utility is decreasing in squared deviations of output from $y^* + k > y^*$, where y^* is the economy's equilibrium value of output, and squared deviations of inflation from zero.

The economy is modeled by an aggregate supply relationship that makes deviations of output from y^* a positive function of inflation surprises:

$$y_t = y^* + \alpha(\pi_t - \pi_t^e).$$

For simplicity, assume the government can directly control inflation, so π is taken as the policy instrument. This model differs from that used earlier only in that the aggregate supply shock is ignored. As long as such disturbances are publicly observable *ex post*, the reputational equilibria to be studied are consistent with optimal stabilization policy. The equilibrium inflation rate under pure discretion (defined as a situation in which π is set after expectations have been formed) is, as noted earlier, $\alpha k/\beta$.

The hypothesized behavior of the public is summarized by

$$\pi_t^e = 0 \text{ if } \pi_{t-1} = \pi_{t-1}^e$$

$$\pi_t^e = \alpha k/\beta \text{ otherwise.}$$

When the public forms expectations in this way, the setting of inflation at time t affects expectations at time $t + 1$ and therefore the expected value of V_{t+1}. Thus, we have a repeated game in which the government needs to take into account the effects its time t actions will have on future expectations.

Suppose, then, that the government has set $\pi_s = 0$ for all $s < t$. So $\pi_t^e = 0$. What can the government gain by deviating from the zero inflation equilibrium? Setting $\pi = \varepsilon > 0$ reduces the time t value of the loss function by

$$\left(\frac{1}{2}k^2\right) - \left[\frac{1}{2}(\alpha\varepsilon - k)^2 + \frac{1}{2}\beta\varepsilon^2\right] = \frac{1}{2}\left[2\alpha k\varepsilon - (\alpha^2 + \beta)\varepsilon^2\right] \geq 0$$

for $\varepsilon \leq 2\alpha k/(\alpha^2 + \beta)$. This gain is maximized if $\varepsilon = \alpha k/(\alpha^2 + \beta)$. Given the assumed punishment strategy, it will be optimal for the government, if it does deviate, to set $\varepsilon = \alpha k/(\alpha^2 + \beta)$. In this case, the maximum gain is

$$\frac{1}{2}\frac{\alpha^2 k^2}{\alpha^2 + \beta}. \tag{9}$$

This is the temptation to cheat. What is the cost of cheating? If the central bank cheats and generates a positive rate of inflation in period t, the public expects an inflation rate of $\alpha k/\beta$ in period $t + 1$. Since this is the inflation rate that arises under discretion, it is the rate that minimizes the central bank's loss function, given that $\pi^e = \alpha k/\beta$. So the government sets $\pi_{t+1} = \alpha k/\beta$. The subsequent loss, relative to the zero-inflation path, is given by

$$\frac{1}{2}\frac{\rho_g \alpha^2 k^2}{\beta}. \tag{10}$$

It is multiplied by the government's discount factor ρ_g, since the loss occurs in period $t + 1$.

The government will deviate from the proposed equilibrium if the gain exceeds the loss. Using equations (9) and (10), this condition becomes

$$\frac{1}{2}\left(\frac{\alpha^2 k^2}{\alpha^2 + \beta}\right) > \frac{1}{2}\frac{\rho_g \alpha^2 k^2}{\beta}$$

or the government will cheat as long as

$$\rho_g < \frac{\beta}{\alpha^2 + \beta} \equiv \bar{\rho}. \tag{11}$$

Hence, if $\rho_g > \bar{\rho}$, the loss exceeds the temptation, and zero inflation is supported by the assumed punishment strategy. If the government places sufficient weight on the future (and in this case, this means that $\rho_g > \bar{\rho}$), reputation can sustain low inflation and overcome the time-inconsistency problem. This is the standard result; with a sufficiently low rate of discount (high ρ_g), the government has no need to delegate the conduct of monetary policy; it can credibly commit to a low-inflation policy itself.

Now consider the possibility of delegating control of monetary policy to an independent agency. I assume that the defining characteristic of such an agency lies in its discount rate relative to the government. That is, unlike the approach adopted by Rogoff (1985) in his analysis of delegation to a policy-maker who places more weight on inflation than does the government, I follow Lockwood, Miller, and Zhang (forthcoming) in assuming that the government can delegate to a bureaucracy that is longer-lived than the government. This is represented by assuming that the central bank has a discount factor of $\rho > \rho_g$. Otherwise, the central bank is assumed to share society's preferences between output expansion and inflation stabilization as captured by the parameter β. Further, let $\rho_g = \rho\theta$, where θ is the probability of reelection; $0 < \theta < 1$. That is, the independent agency, or central bank, and the elected government are assumed to share the same basic discount factor ρ, but because an elected government may lose a future election, it discounts the future at the rate $\rho\theta < \rho$.

While I have stressed election uncertainty as the source of the divergence between ρ and ρ_g, this is not the only possible interpretation. For example, suppose that the government delegates the conduct of monetary policy to a central bank board whose members are appointed to multiperiod, overlapping terms. Even if the individual members of the board share the same discount rate preference as the government, the board structure can serve to increase the effective discount factor of the central bank if term lengths are long. And Waller (1992) has shown how the appointment process itself can affect policy outcomes. Finally, Waller and Walsh (1996) show how term length and the degree of partisanship in the appointment process can interact in affecting the conduct of monetary policy. The key distinction here is the possibility of delegating responsibility for policy to an individual or a board that places greater weight on future outcomes than does the government.

Whatever the reason for ρ exceeding ρ_g, three outcomes are possible depending on the relationship between ρ_g, ρ, and $\bar{\rho}$.

The first outcome arises if $\bar{\rho} < \rho_g < \rho$. In this case, the government can support a zero-inflation equilibrium without delegating monetary policy. Monetary policy can be conducted by a dependent central bank, one that can be closely tied to the government. This condition holds whenever $\theta > \bar{\rho}/\rho = \beta/\rho(\alpha^2 + \beta) \equiv \Omega$. As long as the reelection probability exceeds Ω, there is no need to delegate. The parameter Ω is increasing in β and decreasing in ρ and α. A large reelection probability (θ) makes it more likely that zero inflation can be supported as an equilibrium even if the government directly controls monetary policy. Until recently, a single party controlled the government in Japan, implying a high value for θ. Thus, Japan might be described as in a situation in which $\theta > \Omega$. The government is capable of maintaining a

reputation for low inflation even without delegating policy control to an independent central bank.

The second possibility is that $\rho_g < \bar{\rho} < \rho$. In this case, equation (11) is not satisfied, and the government cannot maintain a reputation for zero inflation. The government places too little weight on the future and, as a result, the temptation to inflate exceeds the cost of so doing. The government faces an incentive to inflate, the public is aware of it, and the equilibrium is characterized by the discretionary outcome and a positive rate of inflation. However, because $\bar{\rho} < \rho$, an independent central bank would be able to support a zero-inflation equilibrium. It will be optimal to delegate the conduct of monetary policy to an independent central bank and achieve $\pi = 0$. This condition leading to delegation holds whenever $\theta < \bar{\rho}/\rho = \Omega < 1$. So a fall in the probability of reelection below the critical value Ω is still consistent with zero inflation, but only if policy is delegated. Note that once delegation occurs, further changes in θ have no impact on policy or the equilibrium inflation rate. This means that delegation insulates monetary policy and inflation from the uncertainty associated with elections.

Finally, the third possible outcome occurs whenever $\rho_g < \rho < \bar{\rho}$. In this case, neither the government nor an independent central bank places sufficient weight on the future to support a reputation that would be consistent with zero inflation. It will still be optimal to delegate, though, since doing so will achieve a lower average inflation rate than if the government (or a dependent central bank) continued to conduct policy. But zero inflation will not be achievable.

The possible outcomes under various parameter configurations depend on the particular structure of the trigger strategy analyzed here. But the basic conclusions hold more generally. That is, greater uncertainty in the political process, if it leads policy-makers to act as if they had shorter time horizons or to discount the future more heavily, make delegation to an independent central bank more desirable. And, conversely, a government that places sufficient weight on the future can sustain a low rate of inflation. In this case, average inflation will be low even with a politically dependent central bank. With the important role played in Japan by the government bureaucracy, and with little direct electoral competition for most of the postwar era, Japan may best be described by the low-inflation equilibrium without delegation that was shown to be possible when $\theta > \Omega$. This argument, then, is consistent with the stress Cargill, Hutchison, and Ito place on reputational considerations in Japan.

V. Summary

The empirical results reported in this paper suggest that Japan may not be quite the outlier that the recent focus on central bank independence has tended to make it seem. Japan's low inflation would appear to result, in part, from a very low estimated natural rate of unemployment. With the incentives to inflate low, the degree of discretion exercised in the conduct of monetary policy becomes less important, and the government may be able to support a zero-inflation reputation even when it does not delegate monetary policy to an independent agency.

Delegation is unnecessary if policy is controlled by a long-lived bureaucracy or a long-lived government. If the new political environment in Japan reduces the implicit weight the government in office places on future inflation, possibly because of lower reelection probabilities, then the maintenance of low inflation may require that responsibility for monetary policy be delegated to a more independent central bank.

Finally, it is important to note that this discussion of delegation has treated the one-period loss functions of the policy-makers as given. When monetary policy is delegated to an independent central bank, the conduct of policy can also be affected by the formal design of the central banking structure. For example, optimal incentive contracts as discussed in Walsh (1995a) can be used to affect directly the incentives the policy-maker faces. Incentive structures that overcome the inflation bias in the one-period model can be achieved through inflation targeting (Svensson [forthcoming]) or dismissal rules (Walsh [1995c]). The former may be more appropriate when policy is conducted by a board, the latter if a single individual is responsible for policy. And the experience of New Zealand highlights the important role that can be played by explicit mechanisms that serve to ensure that the central bank is held accountable for achieving and maintaining low inflation.

References

Alesina, Alberto, "Macroeconomics and Politics," in Stanley Fischer, ed. *NBER Macroeconomics Annual*, Cambridge: MIT Press, 1988.

———, and Lawrence H. Summers, "Central Bank Independence and Macroeconomic Performance: Some Comparative Evidence," *Journal of Money, Credit and Banking*, 25, 1993, pp. 157–162.

Bade, Robin, and Michael Parkin, "Central Bank Laws and Inflation—A Comparative Analysis," Department of Economics, University of Western Ontario, 1982.

Ball, Laurence, "Time-Consistent Policy and Persistent Changes in Inflation," *Journal of Monetary Economics*, 36 (2), 1995, pp. 329–350.

———, "What Determines the Sacrifice Ratio?" in N. Gregory Mankiw, ed. *Monetary Policy*, Chicago: University of Chicago Press, 1996.

Banaian, King, Leroy O. Laney, and Thomas D. Willett, "Central Bank Independence: An International Comparison," *Federal Reserve Bank of Dallas Economic Review*, 1983, pp. 1–13.

Barro, Robert, and David Gordon, "A Positive Theory of Monetary Policy in a Natural-Rate Model," *Journal of Political Economy*, 91 (4), 1983a, pp. 589–610.

———, and ———, "Rules, Discretion, and Reputation in a Model of Monetary Policy," *Journal of Monetary Economics*, 12 (1), 1983b, pp. 101–121.

Campillo, Marta, and Jeffrey Miron, "Why Does Inflation Differ across Countries?" paper presented at the NBER Conference on Monetary Policy and Low Inflation, January 1996.

Cargill, Thomas, "The Bank of Japan and the Federal Reserve: An Essay on Central Bank Independence," in Kevin Hoover and Steven Sheffrin, eds. *Monetarism and the Methodology of Economics*, Aldershot, England: Edward Elgar Publishing, 1995a.

———, "The Statistical Association between Central Bank Independence and Inflation," *Banca Nazionale del Lavoro Quarterly Review*, No. 193, 1995b, pp. 159–172.

———, Michael Hutchison and Takatoshi Ito, *The Political Economy of Japanese Monetary Policy*, Cambridge: MIT Press (forthcoming).

Cukierman, Alex, *Central Bank Strategy, Credibility, and Independence: Theory and Evidence*, Cambridge: MIT Press, 1992.

———, Steven B. Webb, and Bilin Neyapti, "Measuring the Independence of Central Banks and Its Effects on Policy Outcomes," *The World Bank Economic Review*, 6, 1992, pp. 353–398.

———, Pantelis Kalaitzidakis, Lawrence H. Summers, and Steven B. Webb, "Central Bank Independence, Growth, Investment, and Real Rates," *Carnegie-Rochester Conference Series on Public Policy*, 39, 1993, pp. 95–140.

Debelle, Guy, and Stanley Fischer, "How Independent Should a Central Bank Be?" in Jeffrey C. Fuhrer, ed. *Goals, Guidelines, and Constraints Facing Monetary Policymakers*, Federal Reserve Bank of Boston Conference Series No. 38, 1994.

de Haan, Jakob, and Gert Jan van't Hag, "Variation in Central Bank Independence across Countries: Some Empirical Evidence," *Public Choice* (forthcoming).

Eijffinger, Sylvester C. W., and Eric Schaling, "Central Bank Independence in Twelve Industrialized Countries," *Banca Nazionale del Lavoro Quarterly Review*, No. 184, 1993, pp. 1–44.

———, and Jakob de Haan, *The Political Economy of Central-Bank Independence*, Special Papers in International Economics No. 19, Princeton University, 1996.

———, Maarten Van Rooij, and Eric Schaling, "Central Bank Independence: A Panel Data Approach," *Public Choice*, 89, 1996, pp. 163–182.

———, ———, and ———, "Central Bank Independence: Theory and Evidence," *European Journal of Political Economy* (forthcoming).

Fischer, Andreas, "Central Bank Independence and Sacrifice Ratios," *Open Economy Review*, 7, 1996, pp. 5–18.

Froyen, Richard T., and Roger N. Waud, "Central Bank Independence and the Output-Inflation Tradeoff," *Journal of Economics and Business*, 47 (2), 1995, pp. 137–149.

Grilli, Vittorio, Donato Masciandaro, and Guido Tabellini, "Political and Monetary Institutions and Public Financial Policies in the Industrial Countries," *Economic Policy*, 1991, 13, pp. 342–392.

Hutchison, Michael M., and Carl E. Walsh, "Central Bank Institutional Design and the Output Cost of Disinflation: Did the 1989 New Zealand Reserve Bank Act Affect the Inflation-Output Tradeoff?" University of California at Santa Cruz, mimeo, August 1996.

Jonsson, Gunnar, *Institutions and Incentives in Monetary and Fiscal Policy*, Ph.D. dissertation, Institute for International Economic Studies, Stockholm University, Monograph Series No. 28, 1995.

Lockwood, Ben, Marcus Miller, and Lei Zhang, "Central Banks and Reputation: Some Transatlantic Contrasts," *The New Trans-Atlantic Economy* (forthcoming).

Persson, Torsten, and Guido Tabellini, eds. *Macroeconomic Policy, Credibility and Politics*, Chur, Switzerland: Harwood Academic Publishers, 1990.

Posen, Adam S., "Declarations Are Not Enough: Financial Sector Sources of Central Bank Independence," in Ben Bernanke and Julio Rotemberg, eds. *NBER Macroeconomics Annual 1995*, Cambridge: MIT Press, 1995.

Rogoff, Kenneth, "The Optimal Degree of Commitment to an Intermediate Monetary Target," *Quarterly Journal of Economics*, 100, 1985, pp. 1169–1189.

Romer, David, "Openness and Inflation: Theory and Evidence," *Quarterly Journal of Economics*, 108 (4), 1993, pp. 869–903.

Svensson, Lars E. O., "Optimal Inflation Targets, 'Conservative Central Banks' and Linear Inflation Contracts," *American Economic Review* (forthcoming).

Waller, Christopher J., "A Bargaining Model of Partisan Appointments to the Central Bank," *Journal of Monetary Economics*, 29 (3), 1992, pp. 411–428.

———, and Carl E. Walsh, "Central Bank Independence, Economic Behavior and Optimal Term Lengths," *American Economic Review*, 86 (5), 1996, pp. 1139–1153.

Walsh, Carl E., "Central Bank Strategies, Credibility and Independence: A Review Essay," *Journal of Monetary Economics*, 32 (2), 1993, pp. 287–302.

———, "Optimal Contracts for Central Bankers," *American Economic Review*, 85 (1), 1995a, pp. 150–167.

———, "Central Bank Independence and the Short-Run Output-Inflation Tradeoff in the European Community," in Barry Eichengreen, Jeffry Frieden, and Jurgen v. Hagen, eds. *Monetary and Fiscal Policy in an Integrated Europe*, Berlin: Springler Verlag, 1995b, pp. 12–37.

———, "Is New Zealand's Reserve Bank Act 1989 an Optimal Central Bank Contract?" *Journal of Money, Credit and Banking*, 27, November 1995c, Part 1, pp. 1179–1191.