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ABSTRACT

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

JEL classification: E5

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

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1. 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, Cukierman, Neyapti and Webb 1992). Independence also seems to be related to lower inflation variability, although here the findings are not quite as unanimous (see Table

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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, Kalaitzidakis, Summers and Webb 1993, 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 the European Community to Mexico to 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 (see Cargill, Hutchison and Ito, forthcoming). In fact, one of the most commonly used measures of central bank independence, that due to Cukierman, Neyapti and Webb (1992), ranks only Norway below Japan among industrialized countries. Yet since 1980 Japan's inflation rate has averaged less than either German's or Switzerland's, two countries often viewed as having achieved among the most successful inflation records. This has caused Cargill (1995) to questioned 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 (1995) 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 express it, "current research leads us to conclude that every society gets the central bank it deserves." (Eijffinger and de Haan 1996, p. 55).

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. For example, Debelle and Fischer (1994), Walsh (1995b), A. 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 (1988) 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 twelve member states of the European Community and finds that increasing independence is associated with a 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 difference countries respond to external disturbances.

While comparisons 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 experi-

ence. 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 no longer large once other important determinants of inflation are taken into consideration. But because of the widely held belief that independence does contribute to lowering averaging inflation, the final section of the paper develops a reputational model of delegation 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.

2. 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 difference 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:

$$y = y^* + \alpha(\pi - \pi^e) + e \tag{2.1}$$

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]

$$\pi = \frac{\alpha k}{\beta} - \frac{\alpha}{\alpha^2 + \beta} e + v \tag{2.2}$$

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 (2.2) also shows that the policy response to the shock e will also 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.

This implication has been tested by looking not at the relationship between the variance of inflation economic disturbances but by looking at output variance and central bank independence. Substituting (2.2) into (2.1) 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 Summer (1993) showed, this implication is not supported by the data.

As noted in the introduction, central bank independence seems to be related to lower inflation variability, although the evidence is not uniform (see 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 (2.2) but 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 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

[1] See Walsh (1995a).

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.

The next subsection 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.

2.1. 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 (see Cukierman 1992). The countries included in the sample are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Norway, Netherlands, New Zealand, Spain, Sweden, Switzerland, U.K., and the U.S.A.

The basic index of central bank independence employed is that due to Cukierman, Neyapti and Webb (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, Kalaitzidakis, Summers and Webb (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 IFS. The sample period covers the 1960 to 1993 period 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 (1992), and Eijffinger and Schaling (1993, 1994). Eijffinger and Schaling provide a detailed discussion of these last three. All incorporate subjective judgements 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 is often quite low.[2]

In Walsh (1995b), several different measure 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 (1993a, 1993b). 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 (1992) and the sum of their political and economic independence indexes, and an index used by de Haan and van't Hag (1995) 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.

2.2. 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 inflation was allowed to respond in the face of an macroeconomic disturbance. From 1960 to 1972, inflation across the economies in the sample averaged 4.8%; from 1973 to 1979, it averaged 9.6%. 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.

[2]For example, the Fendall rank correlation between LVAU and the Eijffinger and Schaling measure is only .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., p. 12. Note that not all measures are available for all 19 countries.

Figure 1 plots average inflation from 1973 to 1979 against the Cukierman, Neyapti and Webb 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 1973-1979 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 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, in under columns (1.1) and (1.2), the results for the pre-oil price shock period, 1960-1972. For this earlier period, the coefficients on the measures of central bank independence are only one fifth to one tenth their value for the 1973-1979 period and are not statistically significant. The insignificance of central bank independence during the 1960-1972 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% to a low of just above 3%; 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 experiences by the industrialized economies during the 1980-1993 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 shows 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 1973-1979 period.

The measure of LVAU for Japan is 0.16, and Japan can be identified 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.

2.3. 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 problem 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 (1995).

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-section 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 different countries have responded to macroeconomic shocks may provide some information on the role played by central bank independence. Consider the following formulation, where $\overline{\pi}_{i,s}$ 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]

$$\overline{\pi}_{i,s} = a_i + bLVAU_i + cz_{i,s} + dx_s + \varepsilon_{i,s} = \overline{a}_i + cZ_{i,s} + e_{i,s} \qquad (2.3)$$

[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, the next section 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.

where $\overline{a}_i = a_i + b * LVAU_i + dx_s$. 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 to be 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, (2.3) assumes 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 modelling 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. Hence, 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 lead to equation (2.2) 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, (2.2) becomes

$$\pi^*_{i,s} = \frac{\alpha k}{\beta} - \frac{\alpha}{\alpha^2 + \beta}(\varepsilon_{i,s} + x_s) + v_{i,s} \tag{2.4}$$

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 is β, the smaller is the impact of the disturbance x_s on inflation. Equation (2.3) should be modified to become $\overline{\pi}_{i,s} = a_i + bLVAU_i + d_i x_s = \overline{a}_i + d_i x_s$ where

$$d_i = \gamma_0 + \gamma_1 LVAU_i \tag{2.5}$$

and, for the moment, the $z_{i,s}$ term has been dropped for simplicity. The specification in (2.5) 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 (2.3) to obtain

$$\Delta\overline{\pi}_i = \overline{\pi}_{i,s} - \overline{\pi}_{i,s'} = \gamma_0 \Delta x + (\gamma_1 \Delta x) LVAU_i = \overline{\gamma}_0 + \overline{\gamma}_1 LVAU_i \tag{2.6}$$

which is estimable; (2.6) exploits the differences between $\Delta\overline{\pi}_i$ and $\Delta\overline{\pi}_j$, the difference in the differences, to estimate the effect of the difference in $LVAU_i$ and $LVAU_j$.

This approach is an example of a *difference-in-differences* approach that is common in applied microeconomics. If there are country specific factors that cause Germany to be a low inflation economy relative to the U.K. 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 U.K.'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 1960-1972 to 1973-1979 and 1973-1979 to 1980-1993, two equations of the form (2.6) 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 period to the second display a clear negative correlation with $LVAU$. This is confirmed in 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 the 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 which 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) show 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 affect 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 seemed to have played 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 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.

3. 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, using a data set constructed by Gunnar Jonsson (1995).[6]

3.1. Time averages

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

$$\pi_{i,t} = a_i + bs_i + cz_{i,t} + dx_s + \varepsilon_{i,t} \tag{3.1}$$

[6] I would like to thank 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, Netherlands, New Zealand, Norway, Sweden, Switzerland, U.K. and U.S.A.

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_s 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 converted (3.1) 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

$$\overline{\pi_i} = \overline{a} + bs_i + c\overline{z_i} + \overline{\varepsilon_i} \tag{3.2}$$

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

Results based on 1961-1989 averages for the 18 countries in Jonsson's sample are reported in Table 3. Columns (3.1) and (3.2) reveal the standard negative relationship between central bank independence and average inflation. In columns (3.3) and (3.4), two 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 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]

Column (3.3) shows that increases in the natural rate of unemployment are associated with higher rates of inflation using $LVAU$, but the import share variable is statistically insignificant. And neither is significant using ES. The lack of any effect of import share on inflation is consistent with Jonsson's work and with pooled regression results and fixed effects estimates reported below. 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.

[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.

While much of the recent literature on inflation has focused on the role of discretion and the inflation bias likely to occur under any time consistent policy, a somewhat separate literature has emphasized the revenue role of inflation. For example, Mankiw (1988) shows how optimal tax considerations can be used to develop a theory of inflation. While the empirical support for the implications of the optimal tax model of inflation is weak (see Trehan and Walsh 1990), the more general notion that inflation might depend on the revenue needs of the government is plausible and suggests inclusion of a measure of the government's deficit in the regression. As shown in Columns (3.5) and (3.6), adding the deficit measure has a significant impact on the results. First, the import share variable is now statistically significant, implying lower inflation in countries that are more open. But more significantly, the coefficient on $LVAU$ falls in magnitude from -5.6 to -1.6 when the deficit measure is added, and it is no longer statistically difference from zero. In contrast, the coefficient on ES falls but remains significant at the 5% level.[8] With either measure of central bank independence, the deficit coefficient is large and highly significant.

Two possible conclusions are suggested by the finding that adding the deficit variable weakens the apparent effect of central bank independence on inflation. One interpretation is that the central bank measure was simply serving as a proxy for the deficit. The true causal effect runs from the need for government revenue to inflation, but central bank independence in this sample of OECD countries is negatively correlated with deficits. Countries with large deficits rely on seigniorage as a revenue source and therefore have higher average rates of inflation. The fact that they also tend to have less independent central banks may indicate that, given their need for seigniorage, they adopt central banking structures that provide for greater political control over monetary policy. Under this interpretation, moves to grant increase independence to central banks are unlikely to have much impact on average inflation unless countries also succeed in reducing their deficits.

However, there is a second interpretation. Both inflation and fiscal deficits are measures of policy *outcomes*. The regressions in Table 3 are based on averages for the entire sample, so it is appropriate to treat both the inflation variable and the deficit variable as the result of policy choices. That is, while year to

[8] Results using Grilli, Masciandero and Tabellini's index of central bank independence (either their political independence measure or the sum of their political and economic independence measures) and de Haan and van't Hag index were similar to those obtained using $LVAU$ in that none was significant once the deficit variable was included. Like ES, Alesina's measure remained statistically significant.

year variations in either variable will reflect the influence of both policy and non-policy related factors, average inflation and the average deficit as a fraction of GDP reflect government policy decisions. Because they are both policy choice variables, it is inappropriate to include the deficit variable as an explanatory variable in the inflation regression and then to use ordinary least squares as an estimation method. The country specific factors that produce the disturbance term in the inflation equation are also likely to be related to the deficit variable. One needs to employ an instrumental variables estimation technique in order identify the effect of deficits on inflation.

In order to re-estimate deficit effects consistently using an instrumental variables approach, the natural rate of unemployment, import share, central bank independence and a measure of the fraction of years in the sample a country had a conservative government in power were used as exogenous variables. Columns (3.7) and (3.8) reports the results of the IV estimation.

The effects are dramatic, and strongly suggest that the OLS results arose from the simultaneity between deficits and inflation. While the deficit is still statistically significant (indicating higher deficits are associated with higher inflation), the coefficients on the central bank independence measures are also statistically significant, as is the measure of the natural rate of unemployment.

Given the earlier evidence that Japan represented an outlier, it is instructive to examine the residuals from regression (3.7) to see if this remains the case once additional determinants of inflation are incorporated into the analysis. Figure 4 presents the residuals from equation (3.7). While the equation does tend to over-predict the average inflation rate for Japan, the prediction error is relatively small (-.70 which is just under one half the estimated standard error of the regression).[9] Thus, the evidence from the time averaged data, the type of data typically used to argue that central bank independence is an important determinant of inflation, suggests that Japan is *not* an outlier. The regression "attributes" Japan's low inflation to its low natural rate of unemployment. Interpreted in terms of the basic Barro-Gordon model, the incentive for inflation has been small in Japan. Thus, the inflationary bias associated with discretionary policy is likely to also be small.

[9]The large negative residual in Figure 5 is for Denmark. Using ES as the measure of central bank independence, the residual for Japan is -0.57 which is also less than half the standard error of 1.26.

3.2. Pooled regressions and fixed effects

The use of 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 helping 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). Columns (4.1) and (4.2) are the familiar simple regression of inflation on central bank independence, yielding the standard negative, statistically significant coefficient. As before, we will be interested in examining how this coefficient is affected when other potential determinants of inflation are incorporated into the analysis and whether there is any evidence that the degree of central bank independence affects the way in which policy has responded to economic disturbances.

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. And the oil price shocks of the 1970s played a major role in affecting the level of inflation. Thus, columns (4.3) and (4.4) report the results from including two lags of both the inflation rate and 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 -6.7 to -1.5 with a t-statistic of only 1.27. Generally similar results are obtained using ES; including the lagged inflation variables reduces the coefficient on ES from -1.07 to -.30 with marginal significance of .07 (column 4.4).

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^o. 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 Bretton Woods dummy variable.

The time averaged results did indicate that the natural rate of unemployment

and the deficit were related systematically to inflation. Columns (4.5) and (4.6) report the results of addition the measure of the natural rate of unemployment. For neither measure of central bank independence is the natural rate is significant.

Table 5 reports the results from the pooled data set when the deficit variable is included. Columns (5.1) and (5.2) show the estimates obtained by ordinary least squares using $LVAU$ and ES respectively. The natural rate variable UNN is not significant in this regressions, nor is the import share measure, so they are eliminated in Columns (5.3) and (5.4). Instrumental variable estimates are shown in columns (5.5) and (5.6). The deficit variable has a significant positive effect on inflation according to the OLS estimates but not according to the IV estimates.[10] Note that in none of the Table 5 regressions are either measure of central bank independence statistically significant at the 5% level. Once lagged inflation and a measure of oil price changes are incorporated into the pooled regressions, none of the other variables appear to have much explanatory power.

Earlier, it was argued that it was important to attempt to control for country specific fixed effects. At a minimum, it is necessary to employ a fixed effects model, as in Eijffinger, v. Rooij and Schaling (1994) or Jonsson (1995). Eijffinger, v. 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 (3.1), 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 $x_{i,.} = \frac{1}{T}\sum_t x_{i,t}$ is the average over the time dimension. Thus, any variable such as s_i in equation (3.1) 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, Neyapti and Webb, it is possible to employ a fixed effects model and obtain an estimate of the effect

[10] In addition to the variables used as instrumental variables for the Table 4 results, two lagged values of the deficit variables were employed as instrumental variables for the Table 5 estimates.

of central bank independence. However, the variation in $LVAU$ across the time dimension is limited.[11]

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. As shown in column (6.2), $LVAU$ no longer enters significantly once lagged inflation and oil prices are added. In contrast to the time averaged results but consistent with the pooled regression results, the natural rate of unemployment no longer enters significantly (column 6.3), although the deficit does when OLS is used (column 6.4). Neither of these variables are estimated to have a significant effect when the equation is estimated using instrumental variables.

As noted above, Eijffinger, v. Rooij and Schaling (1994) 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).

3.3. Summary of the empirical results

The empirical results based on the panel data suggest that central bank independence may be a less important explanation for cross country differences in inflation rates than is commonly thought. Thus, the results tend to support the skepticism of Cargill and Posen and the recent empirical findings of Campillo and Miron. While the evidence was not entirely consistent, both the natural rate of unemployment and the deficit as a share of GDP seems to be important in accounting for inflation differences between countries (the time averaged results), although they seemed less important in explaining differences across time (the pooled results).

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

4. The case of Japan

What do these empirical results tell us about Japan? Referring back to Figure 1, Japan is easy to identify, particularly for the 1980-1993 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 1973-1979 period also pictured in Figure 1, it is joined 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 can be misleading by not correcting for other determinants of the cross country and time series variations in inflation rates.

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 not robust, and therefore the fact that Japan has combined low average inflation with a dependent central bank is not of any particular note. This conclusion is consistent with those of Campillo and Miron (1996); central bank independence does not seem to be of particular important 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 less than half the equation standard error.

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 2.4). 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 inflation. Third, average inflation depends on β, the weight on inflation in the policy maker's preference function.

While these three parameters summarize the determinates 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.[12] 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% with a target of 8% and a natural rate of 3% with a target of 2.4% both imply a k of .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 determinate of inflation and that these other determinants such as unemployment and the budget deficit were such that Japan's inflation remained low. This interpretation is clearly consistent with the regression results from Table 3 and the prediction errors shown in Figure 5. 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 (Chapter 8, 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 mon-

[12] 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.

etary policy for short-term political gain. They then argue that the increased electoral competition in Japan makes this reputational equilibrium fragile.

The empirical evidence that measures of legal central banking structure may not be important serves to provide evidence that reputational considerations may play a paramount role in supporting low inflation outcomes. That is, 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.

The role of electorial uncertainty and optimal delegation can be developed 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 the government followed a low inflation policy in the previous period. For simplicity, assume that low inflation corresponds to a zero rate of inflation. If the central bank deviated from zero inflation 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

$$\frac{1}{2}\frac{\alpha^2 k^2}{\alpha^2 + \beta} \tag{4.1}$$

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

$$\frac{1}{2}\frac{\rho_g \alpha^2 k^2}{\beta} \tag{4.2}$$

It is multiply 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 (4.1) and (4.2), 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

$$\rho_g < \frac{\beta}{\alpha^2+\beta} \equiv \overline{\rho} \tag{4.3}$$

Hence, if $\rho_g > \overline{\rho}$, 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 $\rho_g > \overline{\rho}$), 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 credible commit to a low inflation policy itself. Note that $\overline{\rho}$ is decreasing in α; if, as suggested above, α is small in Japan, this implies that $\overline{\rho}$ will be large and make it more likely that $\rho_g < \overline{\rho}$. With a small incentive to inflate, a zero inflation equilibrium in the repeated game can be sustained with policy conducted by the government. Thus, perhaps it is not surprising that monetary policy in Japan is not delegated to an independent agency.

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 re-election; $0 < \theta < 1$. 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 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 (1993) has shown how the appointment process itself can affect policy outcomes. Finally, Waller and Walsh (forthcoming) 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 $\overline{\rho}$.

The first outcome arises if $\overline{\rho} < \rho_g < \rho$. In this case, the government can support a zero inflation equilibrium without delegating monetary policy. Thus, monetary policy can be conducted by a dependent central bank, one that can be closely tied to the government. This condition holds whenever $\theta > \overline{\rho}/\rho = \frac{\beta}{\rho(\alpha^2+\beta)} \equiv \Omega$. As long as the re-election probably exceeds Ω, there is no need to delegate. The parameter Ω is increasing in β and decreasing in ρ and α. Thus, a small α (and therefore a large Ω) makes it more likely that the government can directly sustain a zero inflation policy. A large re-election probability (θ) also makes it more likely that zero inflation can be supported as an equilibrium even if the government directly controls monetary policy.

As previously noted, Japan may be characterized by a small α. In addition, 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 $\rho_g < \overline{\rho} < \rho$. In this case, (4.3) 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 inflation exceeds the cost of so doing. Consequently, 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 $\overline{\rho} < \rho$, an independent central bank would be able to support a zero inflation

equilibrium. Thus, 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 $\theta < \overline{\rho}/\rho = \Omega < 1$. So a fall in the probability of re-election 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 $\rho_g < \rho < \overline{\rho}$. 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 political dependent central bank. With the important role played in Japan by the government bureaucracy, and with little direct electoral competition for most of the post-war 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.

5. 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. Once other potential determinants of inflation are incorporated into the analysis, the measure of central bank independence is often not significant. Instead, inflation seems related to such factors as the natural rate of unemployment and the government deficit. Japan's low inflation would appear to result from a very low natural rate of unemployment. With the incentives to inflate low, the degree of discretion exercised in the conduct of monetary policy becomes less im-

portant, and the government may be able to support a zero inflation reputation even when it does not delegate monetary policy to an independence 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 re-election 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 policymakers 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 policymaker 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 1995d). 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 the central bank is held accountable for achieving and maintaining low inflation.

TABLE 1: AVERAGE INFLATION						
	1960-1972		1973-1979		1980-1993	
	(1.1)	(1.2)	(1.3)	(1.4)	(1.5)	(1.6)
Constant	.053**	.040**	.141**	.138**	.074**	.077**
LVAU	-.015		-.122**		-.054*	
ES		.003		-.015**		-.008**
S.E.	.010	.010	.028	.029	.020	.020
$\overline{R}^2$	.006	.043	.320	.221	.132	.145

* Statistically significant at the 5% level.

** Statistically significant at the 1% level.

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)[13]	(2.2)	(2.3)	(2.4)	(2.5)	(2.6)	(2.7)	(2.8)
Constant	.087**	.097**	.079**	.049**	-.068**	-.060**	-.003	.005
LVAU	-.107**		-.105**		.067**		.011	
ES		-.018**		-.021**		.007*		-.000
π_{60-72}			.153	1.193**				
π_{73-79}							-.460**	-.475**
S.E.	.025	.023	.026	.020	.018	.019	.013	.013
$\overline{R}^2$	.302	.425	.262	.554	.245	.094	.599	.558

* Statistically significant at the 5% level.

** Statistically significant at the 1% level.

[13] 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).

TABLE 3: AVERAGE INFLATION, 1961-1989*								
	OLS						IV	
	(3.1)	(3.2)	(3.3)	(3.4)	(3.5)	(3.6)	(3.7)	(3.8)
Constant	6.84**	7.90**	4.91**	6.38**	3.77**	5.43**	4.91**	6.38**
LVAU	-5.86**		-5.56**		-1.59		-5.56**	
ES		-1.20**		-0.95**		-0.60*		-0.95**
Import			-0.02	-.01	-0.06**	-0.05**	-0.02	-0.01
*UNN*1			0.56**	0.27	0.09	-0.08	0.55**	0.27*
Deficit					.086**	0.82*	0.87**	0.84**
$\overline{R}^2$	.096	.403	.307	.371	.627	.705	.633	.729
Obs.	18	18	18	18	18	18	18	18

* White-corrected t-statistics reported below each estimated coefficient.

TABLE 4: POOLED REGRESSIONS						
	(4.1)	(4.2)	(4.3)	(4.4)	(4.5)	(4.6)
Constant	7.15**	7.45**	1.98**	2.27**	1.62**	1.95**
LVAU	-6.69**		-1.49		-1.48	
ES		-1.07**		-0.30		-0.26
$\pi_{i,t-i}, i = 1,2$			0.72**	0.71**	0.72**	0.71**
$\pi^o_{i,t-i}, i = 1,2$			.30**	0.29**	0.31**	0.30**
UNN					0.10*	0.06
$\overline{R}^2$	.027	.038	.567	.545	.569	.545
Obs.	522	522	486	486	486	486

TABLE 5: POOLED REGRESSIONS							
	OLS				IV		
	(5.1)	(5.2)	(5.3)	(5.4)	(5.5)	(5.6)	(5.7)
Constant	1.45*	1.90**	1.28*	1.82**	2.00**	2.28**	1.40**
LVAU	-0.74		-0.75		-1.51		
ES		-0.25		-0.27		-0.30	
$\pi_{i,t-i}, i = 1,2$	0.67**	0.68**	0.67**	0.67**	0.73**	0.71**	0.74**
$\pi^o_{i,t-i}, i = 1,2$	0.30**	0.29**	0.30**	0.29**	0.27**	0.29**	0.30**
UNN	0.02	-0.00					
Import	-0.01	-0.01					
Deficit	0.22**	0.20**	0.21**	0.19**	0.06	0.02	0.06
$\overline{R}^2$	.573	.548	.575	.550	.567	.544	.566
Obs.	486	486	486	486	486	486	486

TABLE 6: FIXED EFFECTS					
	OLS				IV
	(6.1)	(6.2)	(6.3)	(6.4)	(6.5)
LVAU	-29.62**	-6.22			
$\pi_{t-i}, i = 1,2$		0.67**	0.68**	0.64**	0.67**
$\pi^o_{t-i}, i = 1,2$		0.30**	0.30**	0.30**	0.30**
UNN			0.04	-0.03	0.05
Deficit				0.20*	0.06
$\overline{R}^2$	.02	.506	.505	.508	.508
Obs.	522	486	486	486	486

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

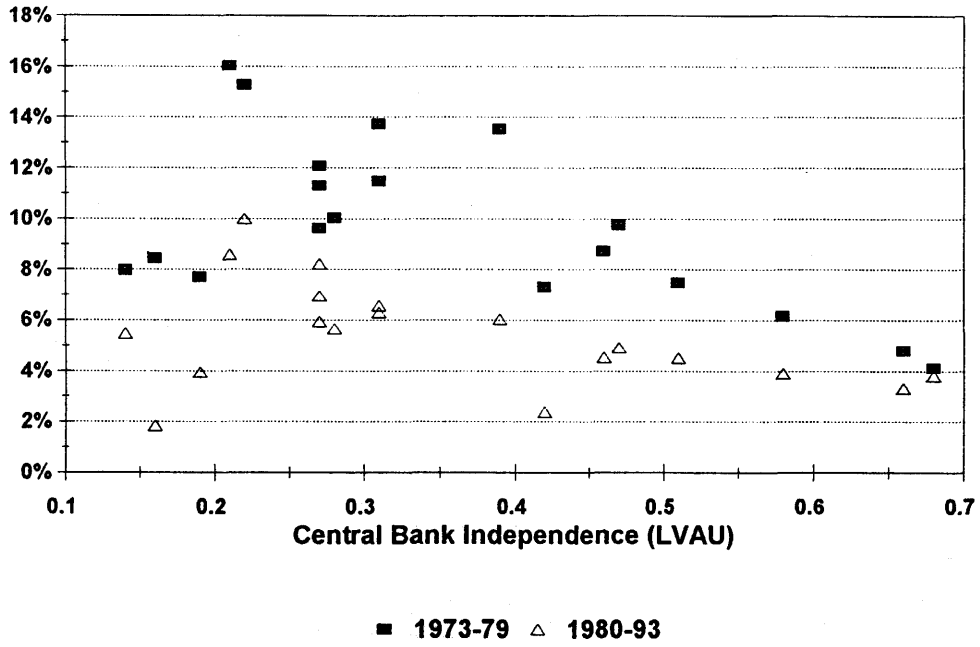

Figure 2: Changes in Average Inflation

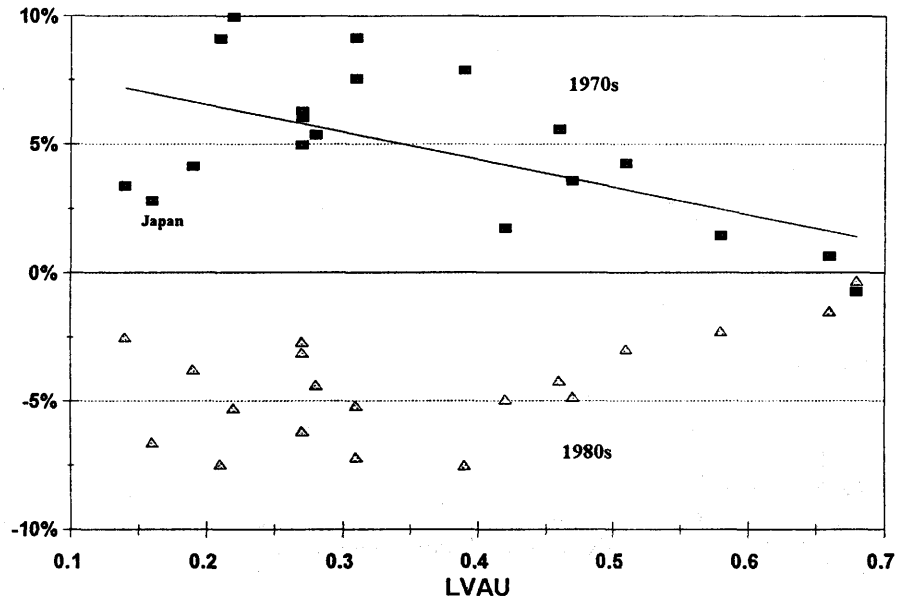

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Figure 3: Percentage Changes in Average Inflation

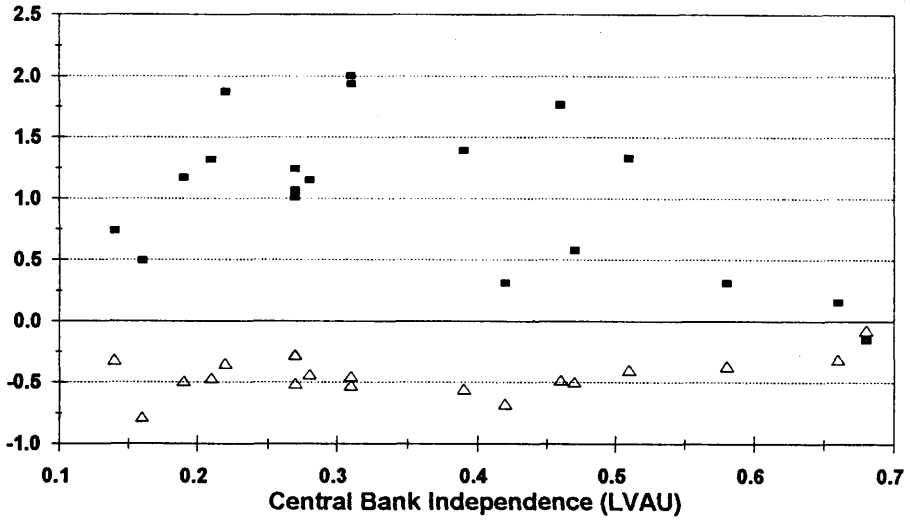

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Figure 4: Inflation Prediction Error
(Based on Table 3, Column 3.7)