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We parameterize central-bank independence in terms of partisanship and term length, and we focus on the implications of alternative policy structures for real economic activity. While long terms of office for the central banker can reduce the role of electoral surprises, term lengths that are too long are costly if societal preferences are subject to permanent shifts. The appointment of a conservative central banker increases the optimal term length and leads to lower average inflation but need not increase the volatility of output. (*JEL* E52, E58)

Should monetary policy be conducted by elected members of Congress, by a political appointee with a long term of office, or by a central bank completely insulated from political pressures? This question is at the heart of the continual tensions between the Federal Reserve and the U.S. Congress, as well as the recent discussions of central-bank independence and the worldwide moves toward redesigning central banking institutions. To address it, we focus on three aspects that are of key importance. First, we assume that the economy consists of numerous sectors that differ in terms of their preferred rates of inflation; the government represents the interests of the sector corresponding to the median voter, but the position of the median voter can vary over time. The structure of the central bank will determine the extent to which monetary policy will be affected by shifts in voter preferences, as emphasized by John T. Woolley (1984) and John B. Goodman (1991).[1] Second, the concept of central-bank independence that has played such an important role in recent discussions of central-bank reform must be recognized as a multidimensional characteristic that depends on several aspects of the central bank's legal structure. We focus on the degree of partisanship in policy-making and the length of the central banker's term of office as measures of independence, as well as the more commonly emphasized weight given to inflation objectives by the central banker. By employing a median-voter model in which the preferences of the median voter vary stochastically, we measure the degree of partisanship in policy-making by the extent to which the currently elected government places weight on long-term median preferences. The degree of partisanship in the appointment process interacts with the length of the central banker's term of office to determine the extent to which monetary policy affects the variance of real output. Third, to evaluate alternative central-banking structures we adopt a notion of sectoral anonymity; the value of a particular central-bank structure is evaluated from the perspective of an agent who does not yet know to which sector she will be assigned.

Despite the importance of the question posed above, the existing theoretical literature

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[1] The effects that the preferences of special-interest groups can have on the structure of the central bank is a theme of recent work by Adam S. Posen (1993).

on central-bank independence (for a general survey and extensions, see Alex Cukierman [1992]) gives little direct guidance to attempts to answer it, in part because the literature has lacked an accepted means of parameterizing independence. Thus, models either are unable to capture adequately the notion of political independence that seems key to the empirical relationship between independence and inflation (i.e., Guy Debelle and Stanley Fischer, 1994; King Banaian et al., 1995) or are unable to link differing assumptions about central-bank incentives to specific institutional aspects of actual central-bank design.

While the primary focus of the literature on central-bank independence has been on the implications for average inflation, we focus on the implications for output variability. In a seminal paper, Kenneth Rogoff (1985) showed how social welfare might be improved by placing a "conservative" central banker in charge of monetary policy. By placing greater weight on inflation objectives, such a central banker lowers average inflation but allows greater output variability. This result has been interpreted to imply that average inflation should be negatively correlated with measures of central-bank independence while output variability should be positively correlated. Only the first of these implications appears to hold in the data for the industrialized economies (Alberto Alesina and Lawrence H. Summers, 1993). In our framework, we show that a conservative central banker will allow election surprises to have bigger effects on output, thereby increasing the magnitude of Alesina-type political business cycles (Alesina, 1987). However, we also show that if central-bank independence is associated with a reduction in partisan influences, output variability can be negatively correlated with central-bank independence. Since existing measures of central-bank independence tend to reflect both the degree to which a central bank weighs its inflation objectives and the degree to which it is subject to partisan influences, our results may help to account for the lack of correlation between output variability and independence.[2]

Although considerable work has been done on partisan policy-making and monetary policy, relatively little theoretical work has focused on the importance of term lengths. Long terms serve to insulate the central bank from political pressures and help mitigate the policy uncertainty that arises from the turnover of political leadership. This was the intention of the designers of the European Central Bank, and the Federal Reserve, in establishing term lengths for bank governors that are long relative to the time between elections. The empirical evidence in Cukierman et al. (1992b) and in Cukierman et al. (1993) suggests that, at least for the developing countries, the turnover rate for central-bank governors is more highly related to average inflation than are other aspects of the central-banking structure.

Brendan O'Flaherty (1990) has analyzed the optimal term length within a principal–agent model of the public and the central bank. One-period terms are not optimal because the central banker always inflates in the first period of office in O'Flaherty's framework. Infinite terms of office are undesirable because the public needs to have the opportunity to dismiss any central banker who fails to implement the public's desired policy. Thus, the role of reappointment is to ensure accountability. This role for reappointment is also analyzed in Walsh (1995b). In Michele Fratianni et al. (1997), the central banker's desire for reappointment leads to a political business cycle as policy is adjusted to please the government during election periods. Waller (1992, 1995) and José I. García de Paso (1993) show that, by lengthening and staggering the terms of office of the members of a central-bank board, the probability that a new appointee will shift the median and generate policy changes is reduced. Thus, monetary-policy uncertainty (and output variability) arising from electoral uncertainty is reduced if term lengths are increased.

[2] Alesina and Roberta Gatti (1995) show that if political parties jointly appoint a conservative central banker prior to elections, average inflation and output variance can be reduced. In contrast, we assume that the central banker is appointed by the winning party after the election, we parameterize the degree of partisanship in the appointment process, and we allow both the degree of conservativeness and the term length to vary.

In contrast to this literature, we follow Jean Tirole (1994) in recognizing that a cost of long term lengths is that bad policies may become locked into place. The optimal term length must balance the advantages of political independence in reducing election effects with the need for accountability to ensure that the preferences reflected in monetary policy are those of the voting public.

The institutional details of the central-bank structure on which we focus provide an alternative approach to developing solutions to the problems identified with time-consistent, politically determined monetary-policy outcomes. While many researchers have focused on reputational solutions (see Rogoff [1989] for a survey), such solutions tend to be consistent with multiple equilibria, and there is little agreement as to how the economy converges to a particular equilibrium. As argued by Matthew B. Canzoneri et al. (1995), institutional solutions of the type we examine can serve to provide a commitment technology if institutional structures are costly to change. A focus on institutional details is also consistent with the principal-agent perspective found in Walsh (1995a), Torsten Persson and Guido Tabellini (1993), and Fratianni et al. (1997). If state-contingent wage contracts designed to generate the correct incentive effects for the central bank are not feasible, policy can still be affected by other aspects of the central-banking structure. Here, we focus on the effect of term length and partisanship on the mapping from electoral outcomes to monetary-policy outcomes.

We begin in the next section with an analysis of policy by Congress. Each election period, the government in office appoints its own representative to head the central bank. This represents the extreme of maximum partisanship and the shortest term length in our framework. If the position of the median voter shifts randomly between elections, policy by Congress introduces a source of uncertainty that generates output fluctuations (Alesina, 1987). With the central banker reflecting the preferences of the government in office, an additional source of output variability is introduced as the central bank will convert real supply disturbances specific to the median sector into aggregate nominal shocks. By reducing the degree of partisanship or lengthening the central banker's term of office, election-induced uncertainty in the conduct of monetary policy is reduced. But if voter preferences occasionally experience persistent shifts, long terms of appointment run the risk of causing a large divergence between the preferences of the public and those of the central banker.

We show that an increase in the short-run variability of voter preferences increases the optimal term length, while an increase in the variability of persistent shifts in long-term preferences reduces the optimal term length. Appointing a conservative central banker lengthens the optimal term of office. This result provides one explanation for the cross-country correlation between longer terms in office (or lower turnover rates) for central bankers and lower average inflation rates. Since a conservative central banker increases output variability, while an increase in term length reduces it, our result is also consistent with empirical findings that the simple correlation between measures of central-bank independence and output variability is zero.

I. Monetary Policy by Congress

A. *The Economic and Political Environment*

We begin by setting out a baseline case in which monetary policy is conducted directly by the elected government in a discretionary fashion as in Robert J. Barro and David B. Gordon (1983). Each election period, the government in office may change. This introduces uncertainty about monetary policy.

The economy consists of a continuum of sectors, each populated by a continuum of individual agents. All agents within a sector are identical and share preferences that depend on sector output and inflation fluctuations around target values. The loss function of the representative agent in sector i is given by

$$(1) \qquad L_{it} = [(y_{it} - y^N - k)^2 + a(\pi_t - \pi_i^*)^2]$$

where y_{it} is the log of output at time t in sector i, π_t is the rate of inflation at time t, and π_i^* is the target rate of inflation of agents in sector i. For simplicity, let π_i^* be distributed

uniformly over the range $[L, U]$ with variance $\sigma^2_{\pi^*}$. Due to the symmetry of the distribution, there is no difference between the mean and the median; none of our results would be seriously affected if this equality were eliminated. The parameter k in the loss function arises from distortions that lead the natural output level y^N to be inefficiently low.

The representation of the economy is deliberately kept simple, consisting only of an aggregate supply function linking output to inflation surprises and a quantity equation linking the central bank's policy instrument, the money growth rate, to the rate of inflation. The aggregate supply relationship is

$$(2) \quad y_{it} = y^N + \lambda(\pi_t - \pi^e_t) + u_t + e_{it}$$

where y^N is the average level of log output in sector i (normalized to be the same for all sectors), π^e_t is the expected rate of inflation, u_t is an economy-wide aggregate supply disturbance and e_{it} is a supply shock specific to sector i. The number of sectors in the economy is taken to be sufficiently large so that we can assume that the e_{it}'s aggregate to zero across all sectors.

The link between the money growth rate (m) and inflation is given by

$$(3) \quad \pi_t = m_t + v_t - qu_t$$

where v_t is a velocity shock. Equation (3) allows the aggregate supply shock to have a direct effect on inflation.

Each period, elections are held. In this framework, preferences are single-peaked, and the government elected will reflect the preferences of the median voter. Private agents are assumed to enter into nominal contracts before knowing the outcome of elections. After the election, the current realizations of the aggregate and sector specific supply shocks u and e_i are observed. The central bank then determines the growth rate of money. Finally, the velocity shock occurs. Thus, the central bank can make m contingent on u and e_i, but it cannot be set contingent on v.[3]

Prior to the realizations of the sector-specific supply shocks, agents differ only with respect to their preferred rates of inflation π^*_i. Let $\pi^*_{M,t}$ denote the desired inflation rate of the median voter at time t; that is, the median voter is from sector i = M. In order to reflect short-run variation in voter preferences, assume that $\pi^*_{M,t}$ varies randomly around a fixed mean Π^*_M:

$$(4) \quad \pi^*_{M,t} = \Pi^*_M + \varepsilon_t$$

where ε_t is distributed on the bounded support $[-b, b]$ with mean zero and variance σ^2_ϵ. We will refer to $\pi^*_{M,t}$ as the short-run median voter's preferred inflation rate and Π^*_M as the long-run median voter's preferred inflation rate (the median of the population distribution). The short-run median voter might differ from the long-run median voter if, for example, not all agents vote in each election because of random idiosyncratic reasons.[4] In this section, we take Π^*_M to be constant.

Two features of the model play an important role in the results we obtain: (i) heterogeneity of preferred trend inflation rates, and (ii) electoral uncertainty over the short-run median voter's preferred inflation rate. We have chosen to incorporate these features into our model for three reasons. First, the effects of electoral uncertainty seems to be (or is at least believed to be) a prominent concern in democracies. The empirical evidence that uncertainty about election outcomes translates into macroeconomic disturbances when competing political parties have differing preferences is documented by Alesina (1988). That this type of policy uncertainty is important can be seen by the way in which legislative structures are designed. In the United States, for example, members of the House of Representatives have the shortest term lengths and are elected simultaneously; therefore they should best

[3] In models of this type, it will always be optimal for the central bank to offset completely any forecastable component to the velocity disturbance. Thus, the v shock can be interpreted as the remaining unforecastable component of any velocity shock.

[4] An alternative explanation would be that the median voter's preferred inflation rate is subject to transitory shocks. In Subsection IV-B, we allow for permanent shifts in Π^*_M.

reflect the current desires of the electorate. Nevertheless, the other branches of government that act as a check on the policies passed by the House (the President, the Senate, and the Supreme Court) have members who serve increasingly long terms. Long terms are intended to protect political leaders from pressure to enact current legal "fads" that drop from favor with time. Thus, electoral uncertainty seems to have played a key role in the design of legislative structures in the United States and probably in other countries as well. We believe that the same influences should be considered when determining how monetary institutions are structured. The advantage of using equation (4) to capture electoral uncertainty is that it enables us to avoid introducing a much more complicated voting mechanism which in itself would add very little to the substance of the paper.

Second, heterogeneous inflation preferences appear to have played a key role historically in political debates regarding the appropriate monetary policy regime. In the United States, for example, the monetary debates of the late 19th century are usually interpreted as a debate between debtors and creditors over the rate of inflation (Richard H. Timberlake, 1993). Jon Faust (1996) has argued that differences in desired rates of inflation among groups in the economy account for the structure of the Federal Reserve's Federal Open Market Committee.

Third, from a modeling standpoint, assuming that voters have heterogeneous preferences over the desired rate of inflation allows us to apply the median-voter theorem to determine policy in the long run. Allowing the position of the median voter to shift stochastically is a convenient way to model this source of macroeconomic fluctuations. It also allows us to obtain analytically tractable solutions, which would not be possible if, for example, we assumed that agents had heterogeneous weights in their respective loss functions.

B. *Policy by Congress*

Once in office, the median voter, now the government, is responsible for the conduct of monetary policy. Since m is determined after private-sector nominal wage contracts are set, policy under discretion will involve setting m to minimize the expected value of $L_{M,t}$, taking the public's expected rate of inflation as given. The optimal m will be a function of the supply shocks u and $e_{M,t}$ and is given by

$$(5)\quad m_{M,t} = \frac{\lambda^2}{\lambda^2 + a} m_t^e + \frac{a}{\lambda^2 + a} \pi^*_{M,t} + \left(q - \frac{\lambda}{\lambda^2 + a} \right) u_t + \frac{\lambda}{\lambda^2 + a} (k - e_{M,t})$$

where m^e is the money growth rate expected by the public prior to the election.[5]

Private agents will use equation (5) in forming their expectations about the rate of money growth. Since expectations are formed prior to the election, the expected rate of money growth is equal to $m_t^e = \lambda k/a + E_{t-1}(\pi^*_{M,t})$. Substituting this into (5) and using (3), the equilibrium inflation rate when monetary policy is conducted with discretion by the median voter is:[6]

$$(6)\quad \pi_{M,t} = \frac{\lambda k}{a} + E_{t-1}\pi^*_{M,t} + \frac{a}{\lambda^2 + a} [\pi^*_{M,t} - E_{t-1}\pi^*_{M,t}] + v_t - \frac{\lambda}{\lambda^2 + a} [u_t + e_{M,t}].$$

Because of the temptation to engage in a surprise expansion, discretionary policy results in an inflationary bias equal to $\lambda k/a$. The third term represents the impact of political uncertainty in generating inflation surprises. The final term in (6) represents the government's response to contemporaneous supply shocks. A negative u lowers

[5] Details of the derivations are available from the authors upon request.

[6] Given the assumptions on the stochastic disturbances ε_t, $E_{t-1}(\pi^*_{M,t})$ will just equal Π^*_M, and $\pi^*_{M,t} - E_{t-1}(\pi^*_{M,t}) = \varepsilon_t$. Because we will eventually allow Π^*_M to vary randomly, we require the more cumbersome notation used here.

aggregate real output and raises the rate of inflation; the optimal response for monetary policy is to increase the rate of money growth in an attempt to offset some of the output effects of such a disturbance. Because policy is conducted by the government in office, whose preferences reflect those of the median voter, monetary policy also responds to the shock specific to sector M, $e_{M,t}$. Since $e_{M,t}$ has no aggregate effect on output, the government converts a sector-specific real shock into an aggregate nominal disturbance.

Using equation (2), output in sector i under the policy in (5) will be equal to

$$(7)\quad y_{it} = y^N + \frac{\lambda a}{\lambda^2 + a}[\pi^*_{M,t} - E_{t-1}(\pi^*_{M,t})] - \frac{\lambda^2}{\lambda^2 + a} e_{Mt} + \frac{a}{\lambda^2 + a} u_t + e_{it} + \lambda v_t.$$

The second term on the right-hand side of (7) is the Alesina effect. The third term in (7) arises because sector M's idiosyncratic supply shock, $e_{M,t}$, is translated into an aggregate nominal shock by the government.

In order to evaluate alternative institutional arrangements for the conduct of monetary policy, we consider the expected loss function (1) aggregated across sectors, where expectations are taken from the perspective of sectoral anonymity. By this we mean that we evaluate institutions from the perspective of agents *prior* to their allocation to a specific sector. Consequently, while a term such as $(\pi^*_{it} - \Pi^*_M)^2$ is a known constant from the perspective of an agent in sector i, its expectation from the perspective of sectoral anonymity is $\sigma^2_{\pi *}$.

Using equations (6) and (7), and the fact that $E_{t-1}\pi^*_{M,t} = \Pi^*_M$, the expected loss for an agent in sector i when policy is conducted by the median voter can be calculated. From equation (7), the first term in sector i's loss function is equal to

$$(8)\quad E(y_i - y^N - k)^2 = \lambda^2\sigma^2_v + \left(\frac{a}{\lambda^2 + a}\right)^2 \sigma^2_u + \left(\frac{a\lambda}{\lambda^2 + a}\right)^2 \sigma^2_\varepsilon + \left[1 + \left(\frac{\lambda^2}{\lambda^2 + a}\right)^2\right]\sigma^2_e + k^2.$$

The second term in the loss function, associated with the deviation of sector i's desired rate of inflation from that of sector M, is equal to

$$(9)\quad E(\pi - \pi^*_i)^2 = \left(\frac{\lambda k}{a}\right)^2 + \sigma^2_{\pi *} + \sigma^2_v + \left(\frac{\lambda}{\lambda^2 + a}\right)^2 \sigma^2_u + \left(\frac{a}{\lambda^2 + a}\right)^2 \sigma^2_\varepsilon + \left(\frac{\lambda}{\lambda^2 + a}\right)^2 \sigma^2_e.$$

From equations (8) and (9) the value of the expected aggregate loss function averaged over all sectors is

$$(10)\quad (1 - \delta)L = \left(1 + \frac{\lambda^2}{a}\right)k^2 + (\lambda^2 + a)\sigma^2_v + \frac{a}{\lambda^2 + a}\sigma^2_u + a\sigma^2_{\pi *} + \left(\frac{a^2}{\lambda^2 + a}\right)\sigma^2_\varepsilon + \left[1 + \left(\frac{\lambda^2}{\lambda^2 + a}\right)\right]\sigma^2_e$$

where $\delta < 1$ is the factor used to discount future losses.

Aggregate losses are attributable to several sources. The first arises from the output distortion k which causes both a direct social loss and a loss from the inflation bias that it generates. Velocity disturbances and aggregate supply shocks affect the loss function by producing undesired fluctuations in both output and inflation. The fourth term on the right-hand side in (10) reflects losses that arise from variation in desired inflation rates around the long-term median. Because the sector that represents the median voter shifts over time, election surprises produce output and inflation fluctuations when each newly elected government gets to pick a new central banker; the losses these generate are measured by the fifth right-hand-side term in (10). Finally, with policy reflecting the preferences of the

currently elected government, idiosyncratic supply shocks to the median sector become converted into aggregate nominal disturbances through the response of the central bank. The last two terms in (10), therefore, reflect losses arising from the political side of the model.

Equation (10) represents expected aggregate loss under one particular institutional arrangement. This arrangement, monetary policy conducted by the government currently in office, can be viewed as the case of a politically dependent central bank. The central bank's policy reflects the sector-specific interests of the current government; this introduces uncertainty into the economy as a result of the periodic shifts in governmental preferences as the identity of the median voter changes. We will evaluate alternative central-banking structures by comparing expected aggregate loss under each structure to its value in (10).

II. Eliminating Sectoral Stabilization

One immediate problem with having the median voter set policy is that she will use monetary policy to give preferential treatment to her own sector in stabilizing output shocks. This is then translated into larger average output fluctuations in all other sectors. Consequently, society is made worse off. This problem can be overcome by mandating that the policymaker only be concerned with aggregate output, not sectoral output. This mandate can be interpreted as legislating certain restrictions on the preferences of the policymaker to ensure that "special interests" are not given preferential treatment in stabilizing output. Such restrictions are typically described as corresponding to central-bank independence. The type of staggered terms of appointment on the policy-making board that are studied by Waller (1992) and García de Paso (1993) would serve to reduce the impact of sector-specific concerns on aggregate monetary policy. Preventing the central bank from responding to certain types of disturbances does not imply that aggregate output variability will be higher; in this case, it will be lower. In the previous literature, constraints on central-bank flexibility (e.g., targeting rules) increase aggregate real fluctuations. However, especially when inflation has important distributional consequences, government control over monetary policy can lead to increased variability that is reduced by imposing restrictions that limit the central bank's flexibility.

For the rest of the paper, we will assume that such a restriction is imposed on the policymaker—even if that policymaker is Congress. Thus, we ignore the last term in (10). It is important to remember that this restriction on the policymaker's stabilization response does not imply that aggregate output variability is higher; in fact, it may well have the opposite effect. This is a theme that we return to throughout this paper: greater central bank independence does not imply that output will be more variable.

III. Appointing a Central Banker

Rogoff (1985) has shown that, in the presence of a positive inflationary bias, society will be better off by appointing a "conservative" central banker—someone who dislikes inflation relatively more than society as a whole. Rogoff's approach focuses attention on the weight placed on inflation goals by the central banker. An additional dimension of the central banker's preferences is represented by the target inflation rate around which the central bank would like to stabilize inflation. In the median-voter model outlined in Section I, the winner of the election gets to set the preferred inflation rate. This is equivalent to a completely partisan central banker. However, in most countries it is reasonable to assume that there is some degree of compromise regarding the degree of "partisanship" displayed by the central banker. Again, this is an institutional feature that typically is viewed as being important for determining the degree of central-bank independence. In order to parameterize the degree of partisanship in the appointment process, we assume that the winner of the period-t election appoints a central banker whose preferred inflation rate is

$$\pi^*_{cb,t} \equiv \Pi^*_M + \theta(\pi^*_{M,t} - \Pi^*_M) \qquad (11)$$

$$0 \leq \theta \leq 1.$$

Once again, $\pi^*_{M,t}$ is the current government's preferred inflation rate. The parameter θ is

between 0 and 1 and measures the degree of partisanship in the appointment process: $\theta = 1$ corresponds to a completely partisan central banker; on the other hand, if $\theta = 0$, the current government appoints the long-run median voter to be the central banker. This case corresponds to appointing a nonpartisan central banker.[7]

Suppose, then, that the central banker minimizes the expected value of the following loss function:

$$(12) \quad L_t^{CB} = [(y_t - y^N - k)^2 + a\beta(\pi_t - \pi^*_{cb,t})^2]$$

with $\pi^*_{cb,t}$ given by (11). The weight $\beta \geq 1$ allows for the possibility that the central banker may put additional weight on inflation stabilization relative to the rest of society.

With these changes, the equilibrium inflation rate and output level with an appointed central banker will be given by

$$(13) \quad \pi_t^{CB} = \frac{\lambda k}{a\beta} + E_{t-1}\pi^*_{cb,t} + \frac{a\beta\theta}{\lambda^2 + a\beta}[\pi^*_{M,t} - E_{t-1}\pi^*_{M,t}] - \frac{\lambda}{\lambda^2 + a\beta}u_t + v_t.$$

$$(14) \quad y_{it}^{CB} = y^N + \frac{\lambda a\beta\theta}{\lambda^2 + a\beta}[\pi^*_{M,t} - E_{t-1}\pi^*_{M,t}] + \frac{a\beta}{\lambda^2 + a\beta}u_t + e_{it} + \lambda v_t.$$

[7] Equation (11) is viewed as the reduced-form solution forthcoming from a bargaining model. Interested readers should see Waller (1992, 1995) for an analysis of the appointment process when nominees are subject to confirmation.

Using (13), (14), and the fact that $E_{t-1}\pi^*_{cb,t} = \Pi^*_M$, the average sectoral loss is given by

$$(15) \quad (1-\delta)L_1^{CB} = \left(1 + \frac{\lambda^2}{a\beta^2}\right)k^2 + (\lambda^2 + a)\sigma_v^2 + \frac{a(\lambda^2 + a\beta^2)}{(\lambda^2 + a\beta)^2}\sigma_u^2 + a\sigma^2_{\pi^*} + \frac{(a\beta\theta)^2(\lambda^2 + a)}{(\lambda^2 + a\beta)^2}\sigma_\varepsilon^2 + \sigma_e^2.$$

Inspection of equation (15) shows that, with $\beta = 1$ and $\theta = 1$, L_1 collapses to equation (10) once the sector-specific stabilization response is eliminated.

As Rogoff (1985) pointed out, a conservative central banker will generate a smaller inflationary bias and more stable inflation, but at the cost of greater output variability from supply shocks. This is reflected in the third term on the right-hand side in (15). However, from (15) we also see that the coefficient on σ_ε^2 is increasing in β: a conservative central banker will allow election surprises to have a bigger impact on output relative to the case where $\beta = 1$. Since the central banker puts a larger weight on the inflation target, the equilibrium inflation rate becomes more sensitive to shifts in the inflation target. Political risks will thus be larger the more conservative is the central banker.

The parameter β is frequently interpreted to reflect the degree of central-bank independence. This interpretation implies that the variance of output should be higher with a more independent central bank, an implication that does not appear to hold empirically (Alesina and Summers, 1993). However, if independence is affected by the degree of political influence, then our model suggests that central-bank independence should be negatively correlated with the variability of output. This result becomes apparent by examining how θ affects the variability of output. Equation (15) implies that partisanship *only* affects the impact of election surprises on output. A reduction in partisanship (a decrease in θ) reduces the effect of political uncertainty. Thus, structuring the appointment process to reduce the degree of partisanship in monetary policy (i.e., increasing central-bank independence along this dimension) will reduce the variance of output.

The losses from output and inflation variability induced by election surprises are maximized, for any given value of β, when political influence is maximized ($\theta = 1$). On the other hand, these losses can be eliminated by appointing the long-run median voter in every period (setting $\theta = 0$). With the long-run median voter's preferred inflation rate being reflected in policy every period, no electoral uncertainty arises with regard to monetary policy. Hence, no political risk arises, and inflation is at its long-run average value. In short, partisanship in policy-making is "bad" for society since it generates excessive output and inflation variability.[8] Restricting political influence and increasing central-bank independence can actually lower both output and inflation variability, rather than worsening them.

This arrangement, whereby the long-run median voter is chosen to be the central banker (or the central banker is told to behave like the long-run median voter) can also be interpreted as giving the central bank a clear inflation mandate with constitutional status. Again, these types of constitutional mandates are typically classified in empirical work as increasing central-bank independence. However, as was the case earlier, associating inflation mandates with central-bank independence does not necessarily imply that output will be more variable. The implications of central-bank independence for the variance of output can be ambiguous, depending on whether "independence" is associated with a less partisan appointee or with a greater weight on inflation objectives. Hence, the theoretical linkage between central-bank independence and real economic activity depends critically on the manner in which central-bank independence is modeled. Increased independence resulting in greater weight on the inflation goal should be associated with greater output volatility. In contrast, increased political independence achieved through reduced partisanship in policy-making should be associated with reduced output volatility.

[8] For similar conclusions applied to the level of government debt and average inflation, see Tabellini and Alesina (1990) and Cukierman et al. (1992a).

IV. Partisanship and Term Lengths

If society could suspend partisanship and appoint the long-run median voter every period, output and inflation variability from election surprises could be eliminated. But even if partisanship exists, there may well be other institutional arrangements whereby electoral uncertainty is reduced, at least over the long term. Election surprises occur because private agents do not know, at the time they write their wage contracts, what policy will be implemented after the election. However, if the central banker is in office for more than one period, electoral uncertainty disappears in the periods after the first period. Waller (1989) has demonstrated that the variance of output can be reduced by making the central banker's term in office longer than the election cycle. We will follow this line of reasoning in this section to determine the optimal term length for the central banker in a partisan-policy model.

Developing a theory of optimal term lengths is important not only for the partisan influences we consider, but also for other proposals for dealing with the time-inconsistency problem. For example, all reputation-building solutions for the time-inconsistency problem hinge on the length of the game played by the monetary authority and the private sector. If reputation belongs to the individual central banker (and not the institution), these solutions work for only as long as the central banker is in office. In fact, once a credible central banker is found, these models suggest that the optimal term length is infinity, or a lifetime appointment. However, we do not observe lifetime appointments for central bankers, so these models are clearly missing some key facet that societies feel is important when setting up central-bank institutions. If reputation belongs to the institution, then term lengths would be irrelevant, and recent reforms that have tended to give long terms of office to central bankers (and the debates that occur in the United States whenever the Fed Chairman's term nears its end) would be difficult to understand.

The issue of optimal term length is also crucial for "rules-based" solutions to the time-inconsistency problem such as the optimal-targeting-horizon model of Michelle Garfinkel and Seonghwon Oh (1993). In their model,

there is an implicit assumption that the central banker cares enough about reappointment that she will do whatever is needed in the last period of the horizon to ensure that the target is met; otherwise, why does she care about hitting the target? The worst that can happen is she gets fired. Hence, reappointment concerns play an important role in these models. But this implicitly ties the optimal targeting horizon to the term length of the central banker.[9]

Finally, term lengths also matter for the recent performance-contract literature initiated by Walsh (1995a) and Persson and Tabellini (1993). Those papers show that the inflationary bias can be overcome by offering an appropriate compensation contract to the central banker. Walsh (1995b) has shown that, even if such financial payments are infeasible, the conditions for reappointment of the central banker can be structured to resemble a performance contract. But the issue of reappointment naturally raises the question of how long the central banker's term in office should be. Thus, the question of the optimal term length for central banker's plays an important, if implicit, role in most studies of monetary-policy games.

A. *The Cost of Having a Multiperiod Central Banker*

No matter who the central banker is, inflation and output will be determined according to equations (13) and (14). The variable that differs from period to period is the expected value of $\pi^*_{cb,t}$, the preferred inflation rate of the central banker in office in period t. Suppose that an election is held in period t and a new central banker is appointed. The winner of the current election appoints a central banker according to equation (11), and the appointee then chooses the money stock to minimize the expected value of the loss function (12). Since wage-setters do not know who the period-t central banker will be when contracts are signed at the end of period $t-1$, they set $E_{t-1}\pi^*_{cb,t} = \Pi^*_M$. This generates expected loss $(1-\delta)L_1^{CB}$ [from (15)] in period t.

However, in period $t+j, j \geq 1$, of the central banker's term, wage-setters know the identity of the central banker when they sign their wage contracts; hence they set

$$E_{t+j-1}\pi^*_{cb,t+j} = \pi^*_{cb,t}.$$

As a result, inflation and output will be given by

$$(16)\quad \pi_{t+j} = \frac{\lambda k}{a\beta} + \Pi^*_M + \theta(\pi^*_{M,t} - \Pi^*_M) - \frac{\lambda}{\lambda^2 + a\beta}u_{t+j} + v_{t+j}.$$

$$(17)\quad y_{i,t+j} = y^N + \frac{a\beta}{\lambda^2 + a\beta}u_{t+j} + e_{i,t+j} + \lambda v_{t+j}.$$

The expected loss in period $t+j$, L_{t+j}, evaluated at time $t-1$, is given by

$$(18)\quad L_{t+j} = \left(1 + \frac{\lambda^2}{a\beta^2}\right)k^2 + (\lambda^2 + a)\sigma_v^2 + \frac{a(\lambda^2 + a\beta^2)}{(\lambda^2 + a\beta)^2}\sigma_u^2 + a\sigma^2_{\pi^*} + a\theta^2\sigma_\varepsilon^2 + \sigma_e^2.$$

Although there are no election surprises in period $t+j$ [so output in (17) does not depend on ε], there is an expected loss given by $a\theta^2\sigma_\varepsilon^2$ from having a central banker who generates a target inflation rate that differs from the long-run median voter. Because wage-setters know the identity of the central banker after the first period of a term, there will be no new surprises about the central banker's preferences that would cause output movements. Hence, the marginal cost of achieving her desired inflation rate is now lower, and the central banker will push the inflation rate to her most preferred rate, ceteris paribus.[10] As a result, expected squared deviations

[9] We obtain a result similar to Garfinkel and Oh (1993), namely, that the longer the central banker's term length (or targeting horizon), the greater is the stability of the real economy—but for markedly different reasons.

[10] In the first period of her term, the central banker does not push inflation all the way to her most preferred

of inflation around the long-term median voter's preferred value will be greater in the later periods of the central banker's term.

Thus, if a new appointment is made after the period-t election, the effect of the election surprise on inflation will be, from equation (13), $a\beta\theta\varepsilon_t/[\lambda^2 + a\beta] < \theta\varepsilon_t$ in period t and $\theta\varepsilon_t$ in all subsequent periods until a new central banker is appointed. In contrast, election-induced inflation uncertainty when a new central banker is appointed each period is $a\beta\theta\varepsilon_t/[\lambda^2 + a\beta]$ in period t, $a\beta\theta\varepsilon_{t+1}/[\lambda^2 + a\beta]$ in period $t + 1$, and so on. If the term of office is of length T, the contribution to the expected variance of inflation around Π_M^* from the perspective of period $t - 1$ is $\{a\beta\theta/[\lambda^2 + a\beta]\}^2\sigma_\varepsilon^2 + (T - 1)\theta^2\sigma_\varepsilon^2$, while the variance over the same T periods if a new appointment is made each period will simply be $T\{a\beta\theta/[\lambda^2 + a\beta]\}^2\sigma_\varepsilon^2$, which is smaller. Thus, although society reduces the welfare losses due to the output fluctuations that arise from election surprises by having a central banker with a term longer than one period, it will incur a new cost associated with greater expected inflation fluctuations in the latter periods of the central banker's term in office.

The optimal term length balances the value of the marginal reduction in output fluctuations achieved by lengthening the term of office against the greater expected cost of deviations from the median voter's perferred inflation rate. If the presented discounted value of losses incurred by society from having a central banker appointed for T periods is minimized with respect to the term length T (ignoring integer constraints) the first-order condition determining the optimal term length for the central banker can be shown to be independent of T.[11] The optimal value of T is either infinity or 1 (the minimum possible value). If the net gain from eliminating the political risk exceeds the loss from excessive inflation variability the optimal term length is $T^* = \infty$; otherwise, $T^* = 1$. It can be shown that $\beta > 2$ is a necessary (but not sufficient) condition for $T^* > 1$. It is only when the inflation bias is sufficiently large and the central banker is sufficiently conservative that society benefits from appointing the central banker to a long (in this case infinite) term in office.

B. *The Costs of Commitment: Shifts in the Long-Run Median Voter*

If the central banker is sufficiently conservative, then giving the central banker permanent tenure dominates the alternative under which a new central banker is appointed after each election. This result, however, depends critically on the assumption that the long-run median voter's preferred inflation rate is constant. But if the economy experiences stochastic inflows (new young voters) and outflows (dying old voters) each period, there could be persistent shifts in Π_M^*. As noted earlier, Faust (1996) has emphasized the role of the Fed's structure in reconciling competing views on the optimal rate of inflation in a model that emphasizes generational differences in preferred rates of inflation. Jeffrey A. Frieden (1994) argues that debates over monetary policy, which in our context can be thought of as debates over the optimal rate of inflation, have historically reflected variations in the degree of openness of the U.S. economy. Changes over time in the economy's industrial structure, the world economy and international integration, or the age or wealth distribution could induce persistent shifts in social preferences.[12] A central banker whose preferences may have closely represented those of the voters at the time of appointment might pursue policies that diverge

inflation rate [note that the coefficient on the election surprise term in equation (13) is less than θ]; doing so would create a larger inflation surprise and cause too much output variability.

[11] Details are available from the authors upon request.

[12] David J. Smyth and Pami Dua (1986) use surveys conducted by the University of Michigan's Survey Research Center to estimate the median voter's inflation/unemployment preferences. Their equation 6, evaluated at the natural rate of unemployment, provides an estimate of the median voter's preferred inflation rate. Stuart Weiner (1993) estimates the natural rate jumped from around 5.4 percent in the late 1960's to 7.3 percent in the late 1970's before declining to 6.3 percent in the late 1980's. Combining these estimates with those of Smyth and Dua produces values of Π_M^* that range from near 3.5 percent to almost 6 percent. Unfortunately, the Survey Research Center discontinued asking the question used by Smyth and Dua, so it is not possible to update their estimates.

over time from those desired by the long-run median voter. Such a situation introduces a cost to permanent appointments.

Suppose the basic model of the previous sections is modified to allow for persistent but infrequent shifts in Π_M^*. In particular, assume that

$$(19)\quad \Pi^*_{M,t+1} = \begin{cases} \Pi^*_{M,t} & \text{with probability } q \\ \Pi^*_{M,t} + \Delta_{t+1} & \text{with probability } 1-q \end{cases}$$

where Δ is a mean-zero process with variance σ^2_Δ.[13]

Again consider the case in which the government elected at time t appoints the central banker to serve for T periods. Let $E_{t-1}L_{t+s}$ denote the expectation as of time $t-1$ of the value of the loss function in period $t+s$, $s < T$, of the central banker's term. Relative to the previous case, a new term proportional to $s(1-q)\sigma^2_\Delta$ is added to the expected loss each period. Having the central banker serve for T periods now leads to a present discounted value of current and future expected losses, evaluated at time $t-1$, of

$$(20)\quad L_1^T = \left(\frac{1}{1-\delta}\right)Z + \frac{a\delta(1-q)\sigma^2_\Delta}{(1-\delta)^2} + \left(\frac{a}{1-\delta^T}\right) \times \left[\left(\frac{a\beta^2(\lambda^2+a)}{(\lambda^2+a\beta)^2} + \frac{\delta(1-\delta^{T-1})}{1-\delta}\right)\theta^2\sigma^2_\varepsilon - \left(\frac{T\delta^{T-1}}{1-\delta}\right)\delta(1-q)\sigma^2_\Delta\right]$$

where Z is composed of losses unrelated to term length.

Minimizing equation (20) with respect to T yields the following first-order condition:

$$(21)\quad \frac{\partial L_1^T}{\partial T} = \left[\frac{-\delta^T \ln\delta}{(1-\delta^T)^2}\right]\left[\frac{a\delta(1-q)\sigma^2_\Delta}{(1-\delta)}\right] \times \left[\delta^T - T\ln\delta - 1 + \left(\frac{a\beta^2(\lambda^2+a)}{(\lambda^2+a\beta)^2} - 1\right) \times \left(\frac{a\theta^2(1-\delta)\ln\delta\sigma^2_\varepsilon}{(1-q)\sigma^2_\Delta}\right)\right] \geq 0.$$

Examination of this first-order condition shows that the value of T that minimizes the loss function satisfies the following condition:[14]

$$(22)\quad \delta^T - T\ln\delta \geq 1 + \left[1 - \frac{a\beta^2(\lambda^2+a)}{(\lambda^2+a\beta)^2}\right] \times \left[\frac{a\theta^2(1-\delta)\ln\delta\sigma^2_\varepsilon}{(1-q)\sigma^2_\Delta}\right].$$

Although equation (22) is nonlinear in T, it is a fairly simple nonlinear equation. Thus, we can infer some basic comparative-static results. Since the left-hand side of (22) is monotonically increasing in T, any parameter change that causes the right-hand side of (22) to increase will cause the optimal value of T to increase. The second term in brackets on the right side of (22) is always negative (since $\ln\delta < 0$), and for $\beta < H = 1 + (1+\lambda^2/a)^{1/2}$, the first term in brackets is positive. In this case, the right-hand side of (22) is less than 1. Since the left-hand side is greater than 1 for

[13] This process is equivalent to shifting the support of the inflation preference distribution to the left or right by the same amount (i.e., $U_t = U_{t-1} + \Delta_t$ and $L_t = L_{t-1} + \Delta_t$ with probability $1-q$).

[14] Although $T = \infty$ is also a solution to the first-order condition in (21), it is not a global minimum; in fact, it may be a maximum value since the second-order condition evaluated at $T = \infty$ is zero also. The solution in (22) does satisfy the second-order condition for a minimum.

all $T \geq 1$, the optimal term length is just $T = 1$. However, if $\beta > H$, the first term in brackets on the right-hand side of (22) is negative, and the optimal term length may exceed one period.

As β rises above H, the first term in brackets becomes negative, and equation (22) implies that an increase in partisanship (an increase in θ) will lead to a longer term length for the central banker. Since more partisanship causes uncertainty about policy to increase, society can counteract this by lengthening the central banker's term in office. In addition, an increase in the relative variance of the short-run median voter to the long-run median voter will induce society to increase the central banker's term, since political risks are more problematic than shifts in society's inflation preferences when $\sigma_\varepsilon^2/\sigma_\Delta^2$ rises. Finally, an increase in β will lead to an increase in the optimal term length for the central banker. The more conservative is the central banker, the less likely she will be to stabilize the output effects of election surprises; consequently, society will lengthen the central banker's term in office to reduce the number of times election surprises occur.

This last result is quite important because a key variable used to construct empirical measures of central-bank independence is the length of the central banker's term in office. However, to our knowledge, there are almost no theoretical models that show why longer terms in office should be correlated with a lower average inflation rate.[15] In our model, an increase in the degree of conservatism of the central banker will cause the inflationary bias to decrease and the variability of output to increase, because supply shocks and election surprises will be allowed to have larger impacts on real output. Society can counteract the greater political risk by increasing the central banker's term in office. Therefore, longer term lengths would be correlated with lower inflation rates. However, it is important to note that longer term lengths in this model do not cause the inflation bias to decrease; the model merely shows how the two are related through the choice of a conservative central banker.

Society can offset some of the output costs arising from one element of central-bank design by changing some other dimension of the design so that institutional characteristics that are thought to increase central-bank independence need not cause aggregate output variability to increase. Therefore, the lack of correlation between measures of central-bank independence and the variance of GDP should not be too surprising; some features of central-bank institutions that cause output variability to increase (conservative central bankers) may be offset by other features (lengths of terms) that tend to lower output variability.

[15] Exceptions are, as noted earlier, O'Flaherty (1990) and Fratianni et al. (1997). While O'Flaherty's model obtains an optimal term length between 1 and infinity, the latter paper has either one period or infinity as the optimal term length.

V. Conclusions

Recent work in monetary economics has highlighted the importance of institutional structure for the macroeconomic behavior. Extensive work has been done investigating the empirical relationship between economic behavior and various measures of central-bank independence, but the theoretical modeling of independence has tended to capture the notion of independence very imperfectly. While the most common approach has been to identify independence with the weight the central bank places on its inflation goals, this fails to capture the degree to which a central bank is independent from partisan political influence, and it is this political influence that is often thought to be directly related to average inflation. By characterizing independence in terms of conservativeness, partisanship, *and* term length, we are better able to capture the effects of political independence on the behavior of the macroeconomy.

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