

there is no further value in maintaining a reputation, so type W inflates at the rate $a\lambda$. Equation (7.17) shows that the critical cutoff value for β depends on q , the prior probability the public assigns to a type D setting policy. A larger q makes pooling an equilibrium for more values of β , so that even less patient type W banks will find it advantageous to not deviate from the pooling equilibrium. If q is large, then the public thinks it likely that the central bank is a type D . This leads them to expect low inflation in period 2, so the output gains of inflating at the rate $a\lambda$ will be large. By pooling during period 1, a type W can then benefit from causing a large expansion in period 2. If the type W deviates and reveals its type during period 1, the first-period output gain is independent of q .²⁶ So a rise in q leaves the period 1 advantage of deviating unchanged while increasing the gain from waiting until period 2 to inflate.

Comparing (7.16) and (7.17) shows that $\underline{\beta} < \bar{\beta}$, so there will be a range of values for the discount factor for which neither the separating nor the pooling outcomes will be an equilibrium. For β in this range, there will be mixed-strategy equilibria (see Cukierman and Liviatan 1991).

This model reveals how public uncertainty about the intentions of the central bank affects the equilibrium inflation rate. In both the separating equilibrium and the mixed-strategy equilibrium, the type D central bank inflates in the first period even though it is (by assumption) capable of commitment and always delivers on its announcements.

The formulation of Cukierman and Liviatan provides a nice illustration of the role that announcements can play in influencing the conduct of policy. It also illustrates why central banks might be required to make announcements about their inflation plans. The type D central bank is clearly better off making announcements; as long as $q > 0$, making an announcement allows the type D to influence expectations and reduce the first-period inflation rate (this occurs in the separating and pooling equilibria and also in mixed-strategy equilibria). Even when there may be incentives to manipulate announcements, they can serve to constrain the subsequent conduct of policy. They may also convey information about the economy if the central bank has private and unverifiable information such as its own internal forecast of economic conditions.²⁷

7.3.2 Preferences

An alternative approach to solving the inflationary bias of discretion focuses directly on the preferences of the central bank. This branch of the literature has closer connections with the extensive empirical work that has found, at least for the

26. This is because expected inflation equals zero during the first period of a pooling equilibrium. Consequently, the output expansion of inflating at the rate $a\lambda$ is $a(a\lambda - 0) = a^2\lambda$, which is independent of q .

27. See Persson and Tabellini (1993); Muscatelli (1999); and Walsh (1999).

industrialized economies, that average inflation rates across countries are negatively correlated with measures of the degree to which a central bank is independent of the political authorities.²⁸ If the central bank is independent, then one can begin to think of the preferences of the central bank as differing from those of the elected government. And if they can differ, then one can ask how they might differ and how the government, through its appointment process, might influence the preferences of the central bank(er).

Rogoff (1985b) was the first to analyze explicitly the issue of the optimal preferences of the central banker.²⁹ He did so in terms of the relative weight the central banker places on the inflation objective. In the objective function (7.2), λ measures the weight on output relative to a weight normalized to 1 on inflation objectives. Rogoff concluded that the government should appoint as central banker someone who places greater relative weight on the inflation objective than does society (the government) as a whole. That is, the central banker should have preferences that are of the form given by (7.2) but with a weight on inflation of $1 + \delta > 1$. Rogoff characterized such a central banker as more *conservative* than society as a whole. This is usefully described as *weight conservatism* (Svensson 1997b) because there are other interpretations of conservatism; for example, the central bank might have a target inflation rate that is lower than that of the government. In most of the literature, however, *conservative* is interpreted in terms of the weight placed on inflation objectives relative to output objectives.

The intuition behind Rogoff's result is easily understood by referring to (7.7), which showed the inflation rate under discretion for the quadratic loss function (7.2). If the central banker conducting monetary policy has a loss function that differs from (7.2) only by placing weight $1 + \delta$ on inflation rather than 1, then inflation under discretion will equal

$$\pi^d(\delta) = \Delta m + v = \frac{a\lambda k}{1 + \delta} - \left(\frac{a\lambda}{1 + \delta + a^2\lambda} \right) e + v. \quad (7.18)$$

The equilibrium inflation rate is a function δ . Two effects are at work. First, the average inflation bias is reduced, since $1 + \delta > 1$. This tends to reduce the social loss function (the loss function with weight 1 on inflation and λ on output). But the coef-

28. The empirical literature on central bank independence and inflation and other macroeconomic outcomes is large. See Cukierman (1998) for an excellent treatment. I surveyed this literature in previous editions (see section 8.5 of the second edition). That material is now available at <<http://people.ucsc.edu/~walshe/mtp3e/>>.

29. Interestingly, Barro and Gordon recognized that outcomes could be improved under discretion by distorting the central banker's preferences so that "there is a divergence in preferences between the principal (society) and its agent (the policymaker)" (Barro and Gordon 1983a, 607, n. 19). This insight is also relevant for the contracting approach (see section 7.3.3).

ficient on the aggregate supply shock is also reduced; stabilization policy is distorted, and the central bank responds too little to e . As a consequence, output fluctuates more than is socially optimal in response to supply shocks. The first effect (lower average inflation) makes it optimal to appoint a central banker who places more weight on inflation than does society; this is usually interpreted to mean that society should appoint a conservative to head the central bank. But the second effect (less output stabilization) limits how conservative the central banker should be.

Using (7.18), one can evaluate the government's loss function V as a function of δ . By then minimizing the government's expected loss function with respect to δ , one can find the *optimal preferences* for a central banker. The expected value of the government's objective function is

$$\begin{aligned} E[V] &= \frac{1}{2} E\{\lambda\{a[\pi^d(\delta) - \pi^e] + e - k\}^2 + [\pi^d(\delta)]^2\} \\ &= \frac{1}{2} \left[\lambda k^2 + \lambda \left(\frac{1 + \delta}{1 + \delta + a^2 \lambda} \right)^2 \sigma_e^2 + a^2 \lambda \sigma_v^2 \right] \\ &\quad + \frac{1}{2} \left[\left(\frac{a \lambda k}{1 + \delta} \right)^2 + \left(\frac{a \lambda}{1 + \delta + a^2 \lambda} \right)^2 \sigma_e^2 + \sigma_v^2 \right], \end{aligned}$$

where (7.18) is used to replace π^e with $a \lambda k / (1 + \delta)$ under the assumption that the public knows δ when forming its expectations. Minimizing this expression with respect to δ yields, after some manipulation, the following condition that must be satisfied by the optimal value of δ :

$$\delta = \left(\frac{k^2}{\sigma_e^2} \right) \left(\frac{1 + \delta + a^2 \lambda}{1 + \delta} \right)^3 \equiv g(\delta). \quad (7.19)$$

The function $g(\delta)$ is shown in figure 7.4.³⁰ Equation (7.19) is satisfied where $g(\delta)$ crosses the 45° line. Since $g(0) > 0$ and $\lim_{\delta \rightarrow \infty} g(\delta) = k^2 / \sigma_e^2 > 0$, the intersection always occurs in the range $\delta \in (0, \infty]$; given the trade-off between distorting the response of policy to aggregate supply shocks and reducing the average inflation bias, it is always optimal to appoint a central banker who places more weight ($\delta > 0$) on inflation objectives than the government itself does.

Rogoff's solution is often characterized as involving the appointment of a conservative to head an independent central bank. The concept of *independence* means that,

30. See Eijffinger, Hoerichts, and Schaling (1995) for a discussion of this graphical representation of the determinants of the optimal degree of conservatism. Eijffinger and Schaling (1995) extended the framework to an open-economy context.

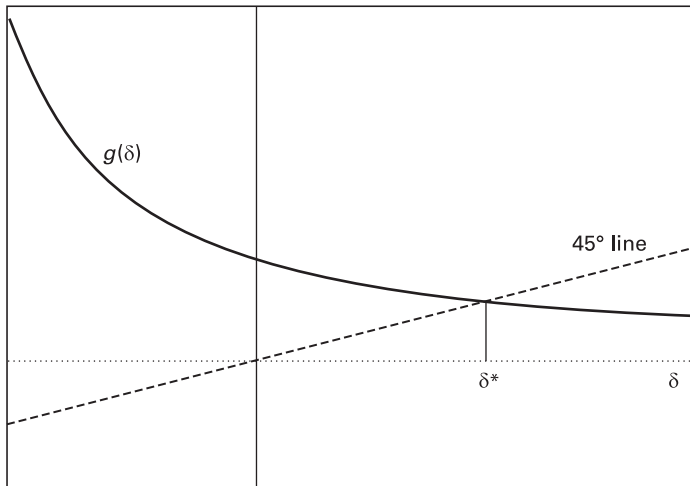


Figure 7.4
Optimal degree of conservatism.

once appointed, the central banker is able to set policy without interference or restriction and will do so to minimize his own assessment of social costs. Thus, the inflation bias problem is solved partly through delegation; the government delegates responsibility for monetary policy to an independent central bank. The benefit of this independence is lower average inflation; the cost depends on the realization of the aggregate supply shock. If shocks are small, the gain in terms of low inflation clearly dominates the distortion in stabilization policy; if shocks are large, the costs associated with the stabilization distortion can dominate the gain from low inflation.³¹

Lohmann (1992) showed that the government can do even better if it appoints a weight-conservative central banker but limits the central bank's independence. If the aggregate supply shock turns out to be too large, the government overrides the central banker, where the critical size determining what is too large is determined endogenously as a function of the costs of overriding. The knowledge that the government can override also affects the way the central banker responds to shocks that are less than the threshold level that triggers an override. By responding more actively to large shocks, the central banker is able to extend the range of shocks over which she maintains independence.

31. Since society is better off appointing a conservative, the expected gain from low inflation exceeds the expected stabilization cost, however.

Rogoff's solution highlights a trade-off; one can reduce the bias but only at the cost of distorting stabilization policy. One implication is that countries with central banks that place a high weight on inflation objectives should have, on average, lower inflation, but they should also experience greater output variance. The variance of output is equal to

$$\left(\frac{1 + \delta}{1 + \delta + a^2 \lambda} \right)^2 \sigma_e^2 + a^2 \sigma_v^2,$$

and this is increasing in δ . Highly independent central banks are presumed to place more weight on achieving low inflation, and a large literature has investigated the finding that measures of central bank independence are negatively correlated with average inflation, at least for the industrialized economies (see Cukierman 1992; Eijffinger and de Haan 1996). Alesina and Summers (1993) showed, however, that such measures do not appear to be correlated with the variance of real output. This runs counter to the implications of the Rogoff model.

Solving the inflationary bias of discretionary policy through the appointment of a conservative central banker raises several issues. First, how does the government identify the preference parameter δ ? Second, how does it commit to a δ ? Once expectations are set, the government has an incentive to fire the conservative central banker and appoint a replacement who shares the government's preferences. Finally, the focus on preferences, as opposed to incentives, clouds the model's implications for institutional structure and design. Should institutions be designed to generate appropriate incentives for policymakers? Or does good policy simply require putting the right people in charge?

7.3.3 Contracts

The problems that occur under discretion arise because central banks respond optimally to the incentive structure they face, but the incentives are wrong. This perspective suggests that rather than relying on the central bank having the right preferences, one might try to affect the incentives the central bank faces. But this requires first determining what incentives central banks *should* face.

The appropriate perspective for addressing such issues is provided by the principal agent literature.³² A key insight that motivated the large literature on the analysis of the time inconsistency of optimal plans was the recognition that central banks respond to the incentives they face. These incentives may be shaped by the institutional structure within which policy is conducted. For example, as has been noted, Lohmann showed how policy is affected when the central banker knows that the government

32. This section draws heavily on Walsh (1995c). See also Persson and Tabellini (1993) and Waller (1995).