# Macroeconomics
# Lecture 8: Monetary Policy Credibility

Richard G. Pierse

## 1 Introduction

In the final lecture of this module, we look at monetary policy in a new Keynesian model. While Keynesian fiscal policy (running government budget deficits to smooth out output fluctuations) has largely been discredited because of the long term problem of managing the resulting government debt, monetary policy (controlling interest rates or the money supply to achieve target rates of inflation or output relative to trend) has remained a viable way for policymakers to influence the economy.

## 2 The History of Monetary Policy

Taylor (1993) suggested that US monetary policy conducted by the *Federal Reserve Board* was well described by a simple rule of the form

$$r_t = \overline{r} + b(\pi_t - \pi^*) + c(\log Y_t - \log \overline{Y}_t) \tag{2.1}$$

where $r_t$ is the real interest rate, $\pi_t$ the rate of inflation with $\pi^*$ its target rate and $Y_t$ output with $\overline{Y}_t$ its normal rate. The intercept in this relationship $\overline{r}$ is interpreted as the real interest rate that prevails when $Y_t = \overline{Y}_t$ and $\pi_t = \pi^*$. Taylor found empirical estimates of $b = c = 0.5$ and $\overline{r} = \pi^* = 2\%$ that fit the US data since 1985.

More recently, many governments have chosen to delegate monetary policy to an independent central bank. In 1997, UK monetary policy was delegated by the incoming Labour government to The Bank of England, with a remit to achieve an explicit inflation target fixed by the government (initially 2.5% for the $RPIX$ measure of inflation). However, interest rate decisions were left to a monetary policy committee ($MPC$) consisting of senior Bank of England officials and independent economists from academia and business (serving for a fixed period). Similar procedures have been adopted in Canada, New Zealand and many other countries.

# 3 Dynamic Inconsistency

In a seminal paper Kydland and Prescott (1977) show that optimal monetary policy suffers from the problem of *dynamic inconsistency* or *time inconsistency* in that, if the policymaker announces an inflation target and the public believe that target, there is an incentive for the policymaker to cheat and choose a higher rate of inflation.

This issue can be illustrated in a simple model. Suppose the aggregate supply function is

$$y = \overline{y} + b(\pi - \pi^e) \tag{3.1}$$

where $y$ is log output, $\overline{y}$ is log normal output, $\pi$ is inflation, $\pi^e$ is the expected rate of inflation and $b > 0$ is parameter representing the slope of the aggregate supply function. This aggregate supply function, due to Lucas (1972), is similar to the *expectations augmented Phillips curve* discussed in last week's lecture. The policymaker's loss function is

$$L = (y - y^*)^2 + a(\pi - \pi^*)^2 \tag{3.2}$$

where $y^*$ is the desired rate of output, $\pi^*$ the desired rate of inflation and $a > 0$ is the weight given to inflation deviations in the loss function (with the weight on output losses normalised to 1). It is assumed that $y^* > \overline{y}$ so that the policymaker's desired output is greater than normal output. This could be because imperfect competition in the economy means that firms do not capture the full benefits of additional output. The loss function is quadratic so that large deviations are penalised more than small deviations. A quadratic loss function is symmetric which implies that positive and negative deviations cause equal losses.

Substituting (3.1) into (3.2) gives

$$L = (\overline{y} + b(\pi - \pi^e) - y^*)^2 + a(\pi - \pi^*)^2 \tag{3.3}$$

and minimising the loss function with respect to $\pi$ implies the first order condition for optimal monetary policy is

$$\frac{\partial L}{\partial \pi} = 2b(\overline{y} + b(\pi - \pi^e) - y^*) + 2a(\pi - \pi^*) = 0 \tag{3.4}$$

which can be rearranged to give

$$\pi = \frac{b(y^* - \overline{y}) + b^2\pi^e + a\pi^*}{a + b^2} \tag{3.5}$$

or

$$\pi^o = \pi^* + \frac{b}{a + b^2}(y^* - \overline{y}) + \frac{b^2}{a + b^2}(\pi^e - \pi^*). \tag{3.6}$$

From the aggregate supply function (3.1), the optimal level of output is given by

$$y^o = \overline{y} + b(\pi^o - \pi^e) = \overline{y} + b(\pi^* + \frac{b}{a+b^2}(y^* - \overline{y}) + \frac{b^2}{a+b^2}(\pi^e - \pi^*) - \pi^e) \quad (3.7)$$

or

$$y^o = \overline{y} + \frac{b^2}{a+b^2}(y^* - \overline{y}) - \frac{ab}{a+b^2}(\pi^e - \pi^*). \quad (3.8)$$

Equation (3.6) shows the policymaker's incentive to pursue an expansionary monetary policy. Its target rate of inflation is $\pi^*$ yet if the public expects it to choose this target rate (so that $\pi^e = \pi^*$), then it will be optimal for the policymaker to choose a higher rate of inflation

$$\pi^o = \pi^* + \frac{b}{a+b^2}(y^* - \overline{y}) \quad (3.9)$$

and a level of output

$$y^o = \overline{y} + \frac{b^2}{a+b^2}(y^* - \overline{y}) = y^* - \frac{a}{a+b^2}(y^* - \overline{y}) \quad (3.10)$$

higher than normal output $\overline{y}$ (though lower than its announced target $y^*$). The reason why it is optimal for the policymaker to deviate from its inflation target is that the marginal cost of a higher rate of inflation is zero (as long as it is not expected) but the marginal benefit of an output level above normal output is positive.

This issue is known as *dynamic inconsistency* or *time inconsistency.* Imagine a game played between policymaker and the public. The policymaker announces its target for inflation $\pi^*$. The public believe the policymaker and act accordingly, following the aggregate supply function (3.1). However, the policymaker instead, chooses the optimal inflation rate $\pi^o > \pi^*$. The policymaker has cheated and will henceforth lose all credibility and a rational public will cease to believe in future announcements by the policymaker.

The *time consistent* solution that is sustainable can be found by imposing the condition of rational expectations that

$$\pi^e = E(\pi). \quad (3.11)$$

In a world of certainty, we can just impose $\pi^e = \pi$ so that, from (3.6),

$$\pi^e = \pi^* + \frac{b}{a+b^2}(y^* - \overline{y}) + \frac{b^2}{a+b^2}(\pi^e - \pi^*) \quad (3.12)$$

or

$$\pi^c = \pi^e = \pi^* + \frac{b}{a}(y^* - \overline{y}) \quad (3.13)$$

and, from the aggregate supply function (3.1),

$$y^c = \overline{y}. \tag{3.14}$$

The *time consistent* rate of inflation, $\pi^c$, is above the optimal rate of inflation $\pi^o$ since

$$\frac{b}{a} - \frac{b}{a+b^2} = \frac{b(a+b^2)-ab}{a(a+b^2)} = \frac{b^3}{a(a+b^2)} > 0. \tag{3.15}$$

Conversely, the *time consistent* level of output, $y^c = \overline{y}$ is below the optimal level of output $y^0$.

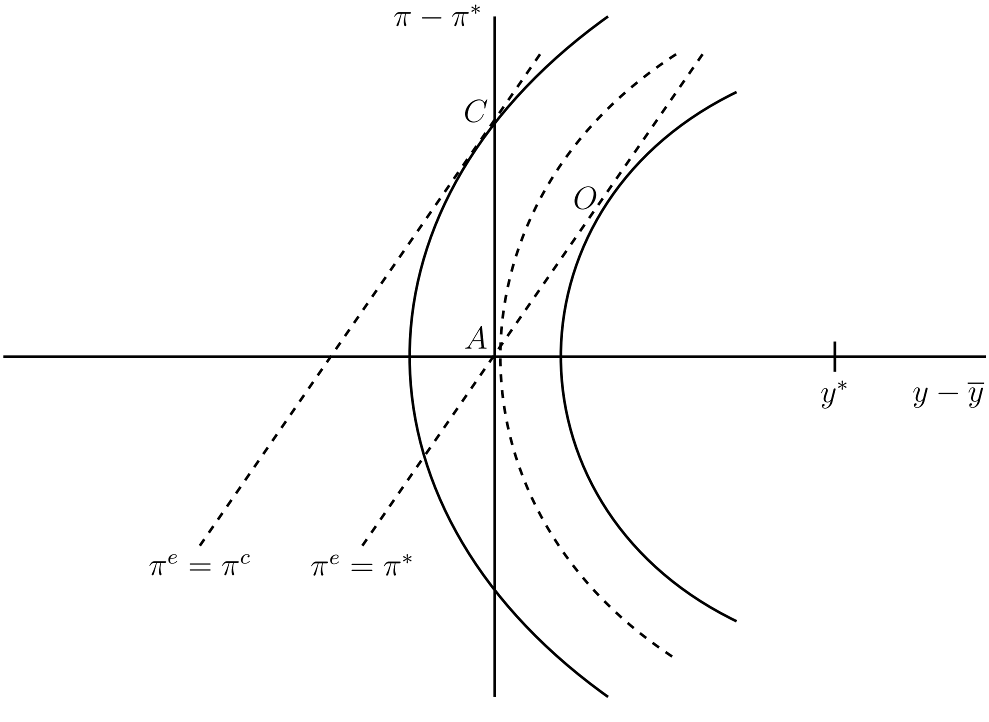


Figure 1: Optimal ($O$), consistent ($C$) and commitment ($A$) monetary equilibria

Figure 1 illustrates the different equilbria. The dashed lines represent the aggregate supply curve with slope $1/b$ for different values of expected inflation $\pi^e$. These intersect the vertical axis where $\pi^e = \pi$. The curved lines are social indifference curves of the policymaker. Given the quadratic nature of the loss function, these are circles centred on the target values $\pi^*$ and $y^*$. The policymaker announces target inflation of $\pi^*$ and the public expects the equilibrium to be at point $A$ where the aggregate supply function for $\pi^e = \pi^*$ intersects the origin.

However, the policymaker can move to a higher indifference curve at point $O$ which is tangent to the aggregate supply curve. This is the optimal discretionary monetary policy but it is not time consistent since actual inflation is greater than expected inflation. The public will revise their expectations of inflation so that the aggregate supply function shifts upwards. For a consistent solution, the policymaker's indifference curve must be tangent to the aggregate supply function on the vertical axis because only on the vertical axis is expected inflation equal to realised inflation. The time consistent optimum is at point $C$ where inflation is higher than at $O$ and output is lower (and equal to $\overline{y}$).

# 4 Commitment Versus Discretion

The Kydland and Prescott result shows that allowing the policymaker discretion to choose inflation after expected inflation is determined simply leads to inefficiently high inflation with no benefit in terms of higher output. One possible solution is to force the policymaker to follow a rule rather than use discretion. Such rules must be binding so that there is no possibility of the policymaker reneging on an announced policy. In Figure 1, once the policymaker has announced an inflation target of $\pi^*$, they are then committed to this target and the solution is point $A$ with $\pi = \pi^*$ and $y = \overline{y}$. The policymaker's loss in this case is given by

$$L^r = (y^* - \overline{y})^2. \tag{4.1}$$

While this is lower than the loss at the consistent optimum at $C$, it is higher than the loss at the time inconsistent optimum at $O$ which is

$$L^o = \left(\frac{a}{a+b^2}(y^* - \overline{y})\right)^2 + a\left(\frac{b}{a+b^2}(y^* - \overline{y})\right)^2 \tag{4.2}$$

$$= \frac{a^2 + ab^2}{(a+b^2)^2}(y^* - \overline{y})^2 \tag{4.3}$$

$$= \frac{a}{a+b^2}(y^* - \overline{y})^2 < (y^* - \overline{y})^2. \tag{4.4}$$

One drawback to commitment to a binding rule is that, although rules can be devised which account for most normal circumstances, such rules cannot always account for unexpected circumstances and will sometimes be inappropriate. In the real world, policymakers do not commit to binding rules but use discretion, yet in many cases they have been successful in achieving low rates of inflation. This suggests that other solutions to the problem of time inconsistency may be possible.

# 5 Reputation

In practice, monetary policy is not a one-off choice but a repeated game. Also, the public may not know the loss function of the policymaker or whether they will commit to announced targets or renage. In this situation, the reputation of the policymaker is important and this is built up over time.

Backus and Driffill (1985) and Barro (1986) present a simple two-period model. The aggregate supply function is given by

$$y_t = \overline{y}_t + b(\pi_t - \pi_t^e), \qquad t = 1, 2. \tag{5.1}$$

The policymaker may be one of two types occuring with probability $p$ and $1 - p$. The first type has welfare function in period $t$ defined by

$$w_t = (y_t - \overline{y}_t) - \frac{1}{2}a(\pi_t)^2. \tag{5.2}$$

The differences between this welfare function and the Kydland-Prescott loss function (3.2) are that the inflation target $\pi^*$ is assumed to be zero, the output target is assumed to be normal output $\overline{y}$ and the output term is linear rather than quadratic. This last change is to simplify the algebra. The policymaker aims to maximise

$$W = w_1 + \beta w_2 \tag{5.3}$$

where $0 < \beta \leq 1$ is related to the time discount factor which is $1/(1 + \beta)$.

The second type of policymaker, occuring with probability $1 - p$ cares only about inflation and sets inflation to zero in both periods.

For the first type of policymaker, the problem in period 2 where $\pi_2^e$ is taken as given is

$$\max_{\pi_2} w_2 = b(\pi_2 - \pi_2^e) - \frac{1}{2}a(\pi_2)^2 \tag{5.4}$$

which has solution

$$\frac{\partial w_2}{\partial \pi_2} = b - a\pi_2 = 0 \Rightarrow \pi_2 = \frac{b}{a}. \tag{5.5}$$

For the first period, the problem is more complicated because the choice of inflation in the first period affects the reputation of the policymaker and influences expected inflation in the second period. If the policymaker chooses any $\pi_1 \neq 0$, the public will know that it faces a type-1 policymaker and so will expect that $\pi_2 = b/a$. Thus, conditional on $\pi_1 \neq 0$, the policymaker's choice of $\pi_1$ does not influence $\pi_2^e$.

The policymaker maximises

$$\max_{\pi_1 \neq 0} w_1 = b(\pi_1 - \pi_1^e) - \frac{1}{2}a(\pi_1)^2 \tag{5.6}$$

which has solution

$$\frac{\partial w_1}{\partial \pi_1} = b - a\pi_1 = 0 \Rightarrow \pi_1 = \frac{b}{a}. \tag{5.7}$$

In this case, since $\pi_2$ and $\pi_2^e$ are both equal to $b/a$, it follows from (5.1) that $y_2 = \overline{y}_2$. The overall welfare function is given by

$$W^c = b\left(\frac{b}{a} - \pi_1^e\right) - \frac{a}{2}\left(\frac{b}{a}\right)^2 - \beta\frac{a}{2}\left(\frac{b}{a}\right)^2 \tag{5.8}$$

$$= \frac{b^2}{a} - b\pi_1^e - \frac{1}{2}\frac{b^2}{a} - \beta\frac{1}{2}\frac{b^2}{a} \tag{5.9}$$

$$= \frac{1}{2}\frac{b^2}{a}(1-\beta) - b\pi_1^e. \tag{5.10}$$

The other possibility for the type-1 policymaker is to set $\pi_1 = 0$. In this case the public will not know if the policymaker is of type-1 or type-2. If they think the policymaker is type-2 then they will expect zero inflation in period 2, $\pi_2^e = 0$. In this case the overall welfare function will be

$$W = b(\pi_1 - \pi_1^e) - \frac{1}{2}a(\pi_1)^2 + \beta\left(b(\pi_2 - \pi_2^e) - \frac{1}{2}a(\pi_2)^2\right) \tag{5.11}$$

$$= -b\pi_1^e + \beta\left(b\pi_2 - \frac{1}{2}a(\pi_2)^2\right) \tag{5.12}$$

and the policymaker is free to choose $\pi_2$ to maximise welfare, giving

$$\frac{\partial W}{\partial \pi_2} = \beta(b - a\pi_2) = 0 \Rightarrow \pi_2 = \frac{b}{a}. \tag{5.13}$$

The overall welfare function in this case is

$$(W^0|\pi_2^e = 0) = -b\pi_1^e + \beta\left(b\frac{b}{a} - \frac{1}{2}a\left(\frac{b}{a}\right)^2\right) \tag{5.14}$$

$$= \frac{1}{2}\frac{b^2}{a}\beta - b\pi_1^e. \tag{5.15}$$

For $\beta = 0.5$, this is the same as the welfare in (5.10) and for $\beta > 0.5$ it is greater. Thus, as long as the policymaker's time discount rate is not too high (i.e. $\beta$ not too low) it can potentially pay the type-1 policymaker to try and fool the public in the first period and then cheat them in the second.

However, if the public are not fooled then they will expect $\pi_2 = b/a$ so that the policymaker's welfare will be

$$(W^0|\pi_2^e = \frac{b}{a}) = -b\pi_1^e - \beta\left(\frac{1}{2}a\left(\frac{b}{a}\right)^2\right) \tag{5.16}$$

$$= -\frac{1}{2}\frac{b^2}{a}\beta - b\pi_1^e \tag{5.17}$$

which is clearly worse than (5.10).

The policymaker may choose to randomise between setting $\pi_1 = 0$ and $\pi_1 = b/a$. Assume that $q$ is the probability that the policymaker chooses $\pi_1 = 0$. Now the public knows that the probability that the policymaker is type-1 is $p$. If the public observes zero inflation in period 1, it knows that either the policy maker is type-2 or that the policymaker is type-1 but has chosen to set $\pi_1 = 0$. The combined probability is

$$\Pr(\pi_1 = 0) = (1 - p) + pq \tag{5.18}$$

and it follows from Bayes' law that the probability that the policymaker is type-1 given that $\pi_1 = 0$ is the conditional probability

$$\begin{aligned}\Pr(\text{type} = 1|\pi_1 = 0) &= \frac{\Pr(\text{type} = 1, \pi_1 = 0)}{\Pr(\pi_1 = 0)} && (5.19)\\ &= \frac{pq}{(1-p) + pq}. && (5.20)\end{aligned}$$

This implies that the expected value for $\pi_2$ given $\pi_1 = 0$ is

$$\pi_2^e = \mathrm{E}(\pi_2|\pi_1 = 0) = \frac{pq}{(1-p)+pq}\frac{b}{a} + (1-p)0 = \frac{pq}{(1-p)+pq}\frac{b}{a}. \tag{5.21}$$

The expected welfare to type-1 policymakers from setting $\pi_1 = 0$ is

$$\begin{aligned}\mathrm{E}(W^0) &= \beta\left(b(\pi_2 - \pi_2^e) - \frac{1}{2}a(\pi_2)^2\right) - b\pi_1^e && (5.22)\\ &= \beta\left(b\left(\frac{b}{a} - \frac{pq}{(1-p)+pq}\frac{b}{a}\right) - \frac{1}{2}a(\frac{b}{a})^2\right) - b\pi_1^e && (5.23)\\ &= \beta\frac{b^2}{a}\left(\frac{1}{2} - \frac{pq}{(1-p)+pq}\right) - b\pi_1^e. && (5.24)\end{aligned}$$

Note that this is decreasing in $q$ since

$$\begin{aligned}\frac{\partial\,\mathrm{E}(W^0)}{\partial q} &= \beta\frac{b^2}{a}\left(-\frac{p}{(1-p)+pq} + \frac{p^2q}{[(1-p)+pq]^2}\right) && (5.25)\\ &= \beta\frac{b^2}{a}\left(\frac{p^2q - (1-p)p - p^2q}{[(1-p)+pq]^2}\right) && (5.26)\\ &= -\beta\frac{b^2}{a}\left(\frac{(1-p)p}{[(1-p)+pq]^2}\right) < 0. && (5.27)\end{aligned}$$

This means that the higher the probability of the policymaker setting $\pi_1 = 0$ the smaller the expected return from doing so. The reason is that the public knows $q$ so that $\pi_2^e$ is increasing in $q$.

Under what conditions will it pay the type-1 policymaker to set $\pi_1 = 0$? We have already seen that if the policymaker has a high rate of time discount with $\beta < 0.5$, it will never pay to pretend to be a type-2 policymaker by setting $\pi_1 = 0$ so that the policymaker will always set $\pi_1 = b/a$. The other extreme is where the expected welfare from setting $\pi_1 = 0$ exceeds the welfare from setting $\pi_1 = b/a$, even when $q = 1$ so that the policymaker is known with certainty to be choosing $\pi_1 = 0$. This will be the case when $E(W^0|q = 1) > W^c$ or, using (5.24) and (5.10) when

$$\beta \frac{b^2}{a}\left(\frac{1}{2} - \frac{p}{(1-p)+p}\right) - b\pi_1^e > \frac{1}{2}\frac{b^2}{a}(1-\beta) - b\pi_1^e \tag{5.28}$$

$$\beta\left(\frac{1}{2} - p\right) > \frac{1}{2}(1-\beta) \tag{5.29}$$

$$\beta > \frac{1}{2}\frac{1}{1-p}. \tag{5.30}$$

Thus for low rates of time discount (high $\beta$) it will always pay the policymaker to try and deceive the public. In the intermediate case for $0.5 < \beta < 0.5(1/(1-p))$ it will pay the policymaker to randomise policy and switch randomly between setting $\pi_1 = 0$ and $\pi_1 = b/a$ at the probability $q$ that equates $E(W^0)$ and $W^c$. Using (5.24) and (5.10) and, solving for $q$,

$$\beta \frac{b^2}{a}\left(\frac{1}{2} - \frac{pq}{(1-p)+pq}\right) - b\pi_1^e = \frac{1}{2}\frac{b^2}{a}(1-\beta) - b\pi_1^e \tag{5.31}$$

$$\beta\left(\frac{1}{2} - \frac{pq}{(1-p)+pq}\right) = \frac{1}{2}(1-\beta) \tag{5.32}$$

$$q = \frac{1-p}{p}(2\beta - 1). \tag{5.33}$$

Note that for $\beta = 0.5$, $q = 0$ and for $\beta = 0.5(1/(1-p))$, $q = 1$ so the two extreme cases are limiting cases of the formula (5.33).

We can calculate expected (average) inflation for each period in this model. In both periods

$$\mathrm{E}(\pi_t) = p(1-q)\frac{b}{a} < \frac{b}{a}. \tag{5.34}$$

This important result says that uncertainty about the characteristics of the policymaker helps to keep inflation lower than it would be otherwise and this result generalises to more complicated and realistic models. The concern about reputation is greater when the policymaker places more weight on later periods (high $\beta$) and when there are more periods.

# 6 Delegation

Concern over reputation in a world where the public are uncertain about the characteristics of the policymaker is one way in which the dynamic inconsistency of low-inflation monetary policy can be overcome. An alternative idea, first suggested by Rogoff (1985), is that monetary policy could be delegated to an individual who does not share the public's view about the relative importance of output and inflation but is particularly averse to inflation.

Suppose, as in Section 3, that the aggregate supply function and social loss function are defined by

$$y = \overline{y} + b(\pi - \pi^e) \tag{6.1}$$

and

$$L = (y - y^*)^2 + a(\pi - \pi^*)^2 \tag{6.2}$$

respectively where $y^* > \overline{y}$ and $a, b > 0$. Suppose now, however, that monetary policy is made by a policymaker who has the loss function

$$L' = (y - y^*)^2 + a'(\pi - \pi^*)^2 \tag{6.3}$$

where $a' > a$. Such a policymaker is known as a *conservative central banker.*

The policymaker's objective function is

$$L' = (\overline{y} + b(\pi - \pi^e) - y^*)^2 + a'(\pi - \pi^*)^2 \tag{6.4}$$

and the optimal solution gives

$$\pi^o = \pi^* + \frac{b}{a' + b^2}(y^* - \overline{y}) + \frac{b^2}{a' + b^2}(\pi^e - \pi^*). \tag{6.5}$$

The inflation rate is lower than it would have been for a given level of expected inflation because of the increased penalty on inflation in the conservative central banker's loss function.

The public is assumed to understand how inflation is determined so that a time-consistent solution where $\pi^e = \pi$ is given by

$$\pi^c = \pi^e = \pi^* + \frac{b}{a'}(y^* - \overline{y}) \tag{6.6}$$

and

$$y^c = \overline{y}. \tag{6.7}$$

The situation is illustrated in Figure 2. Here the unbroken curve represents an indifference curve of the social loss function but the broken curve represents an indifference curve of the conservative central banker. The central banker's indifference curves are more compressed in the y-dimension since changes in inflation $\pi$

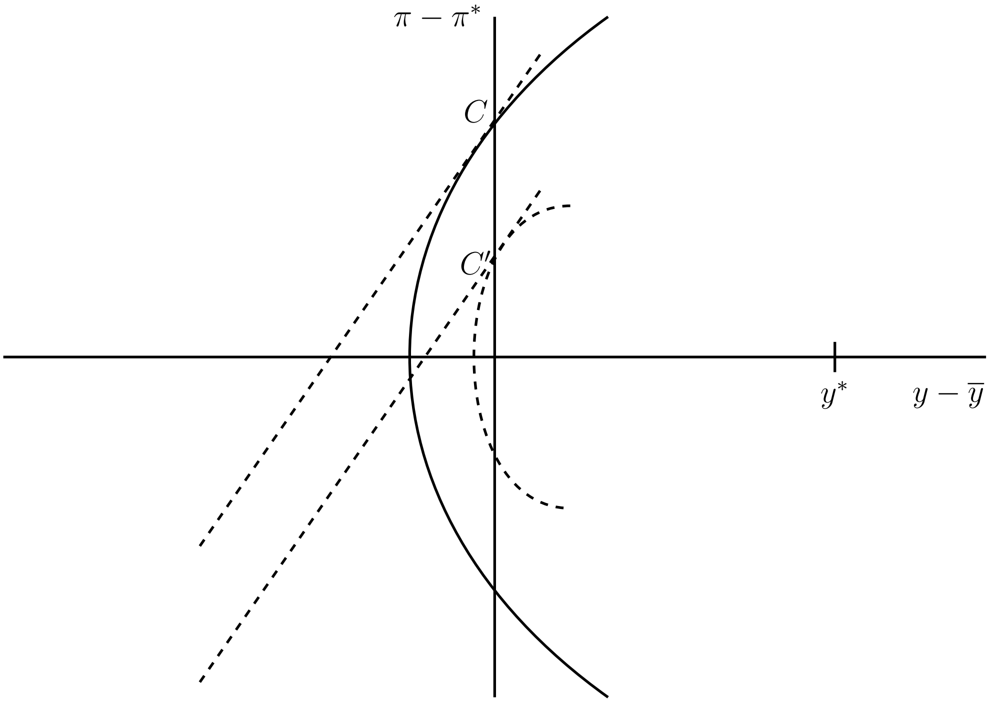


Figure 2: Consistent ($C'$) monetary equilibrium with a conservative banker

have a bigger effect on loss to the central banker than they do to society. Without delegated monetary policy, consistent equilibrium would be at point $C$ but with delegation it moves to point $C'$ where inflation is lower. At both equilibria, $y = \overline{y}$.

Rogoff extends the analysis to the case where the economy is subject to shocks. It turns out that the conservative banker, with different preferences over inflation and output from society, does not respond optimally to shocks. There is thus a trade-off in choosing the delegated policymaker between performance in terms of average inflation and response to disturbances. As a result there is some optimal level of 'conservatism' for the central banker.

Although the idea of the conservative central banker might seem fanciful, it underlies the move in many economies (including Canada, New Zealand and the UK) towards the delegation of monetary policy to an independent central bank, rather than let monetary policy be under the control of the government.

# 7 Conclusions

In this lecture we have looked at issues arising from the conduct of monetary policy in a world where the public understands the policy and has rational expectations. In such a world, optimal monetary is time inconsistent and time consistent monetary policy leads to inefficiently high inflation. Two different ways to reduce this loss are a concern with reputation and the delegation of monetary policy to a conservative central bank.



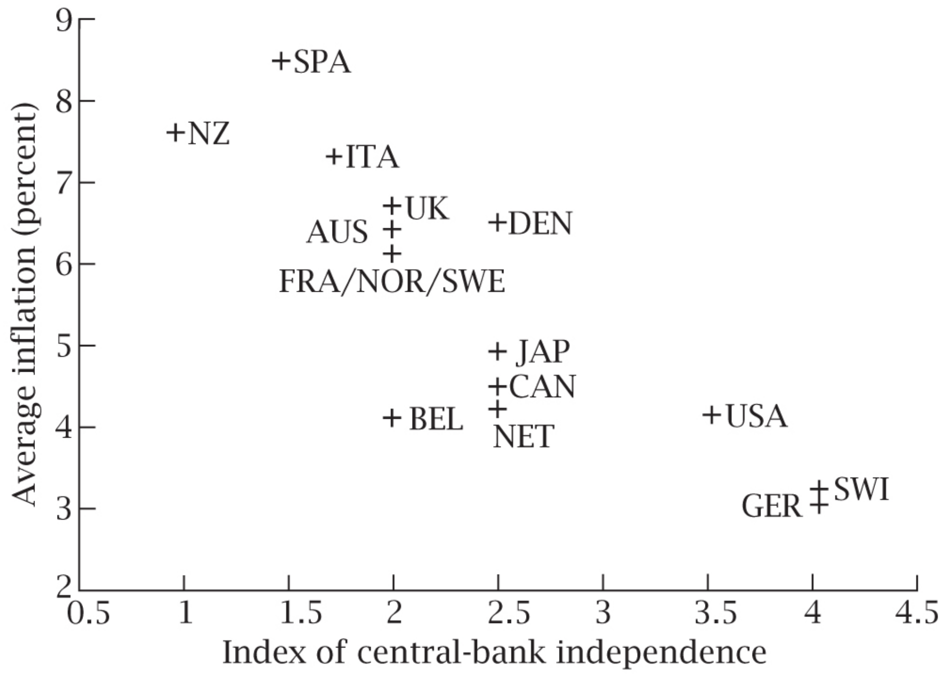


**FIGURE 11.5 Central-bank independence and inflation[26]**

Figure 3: [Figure 11.5 in Romer (2012)]

Central bank independence has been a practical way to attempt to delegate monetary policy. How successful has this been? Figure 3 from Romer (2012) shows a graph of average inflation against a measure of central bank independence from a paper by Alesina and Summers (1993). While this graph is now very out-of-date (it predates the formation of the Euro and the independence of the Bank of England) it does show a significant negative correlation between independence and average inflation, suggesting that delegation can help to reduce inflation.

# References


[1] Alesina, A. and L. H. Summers (1993), ‘Central bank independence and macroeconomic performance’, *Journal of Money, Credit and Banking*, 25, 151–162.

[2] Backus, D. and J. Driffill (1985), ‘Inflation and reputation’, *American Economic Review*, 75, 530–538.

[3] Barro, R. J. (1986), ‘Reputation in a model of monetary policy with incomplete information’, *Journal of Monetary Economics*, 17, 3–20.

[4] Galí, J. (2008), *Monetary Policy, Inflation and the Business Cycle*, Princeton University Press, Princeton, NJ.

[5] Kydland, F. E. and E. C. Prescott (1977), ‘Rules rather than discretion: the inconsistency of optimal plans’, *Journal of Political Economy*, 85, 473–492.

[6] Lucas, R. E. Jr. (1972), ‘Expectations and the neutrality of money’, *Journal of Economic Theory*, 4, 103–124.

[7] Rogoff, K. (1985), ‘The optimal degree of commitment to an intermediate monetary target’, *Quarterly Journal of Economics*, 100, 1169–1189.

[8] Romer, D. (2012), *Advanced Macroeconomics*, Fourth edition, McGraw-Hill, Berkeley.

[9] Taylor, J. B. (1993), ‘Discretion versus policy rules in practice’, *Carnegie-Rochester Conference Series on Public Policy*, 39, 195–214.