11-1-1990

On the role of monetary policy announcements

Douglas McTaggart
Bond University

David Salant

Follow this and additional works at: http://epublications.bond.edu.au/discussion_papers

Recommended Citation
http://epublications.bond.edu.au/discussion_papers/10

This Discussion Paper is brought to you by the Bond Business School at ePublications@bond. It has been accepted for inclusion in School of Business Discussion Papers by an authorized administrator of ePublications@bond. For more information, please contact Bond University's Repository Coordinator.
"On the Role of Monetary Policy Announcements"

Douglas McTaggart

DISCUSSION PAPER-NO: 10

November 1990
On The Role of Monetary Policy Announcements

by

David Salant

GTE Laboratories and VPI & SU

and

Douglas McTaggart

School of Business, Bond University

Current version: November 7, 1990

Abstract. Monetary targeting, adopted on a widespread basis around 1975, is apparently a policy on the decline. Certainly in the U.S. less emphasis is now placed on the public announcements made by the Fed. Yet targeting is still important in countries which have both successfully achieved targets and, at the same time, managed to reduce the growth rate of monetary aggregates and inflation (West Germany and Switzerland for example). This paper discusses why targeting may have failed in an institutional setting such as provided by the U.S. It proposes a theoretical model for analyzing the practice of making public announcements about future monetary policy and identifies necessary conditions for them to be successful.

Address. D. Salant, GTE Laboratories, 40 Sylvan Road, Waltham, MA 02254
On The Role of Monetary Policy Announcements

David Salant
GTE Laboratories and VPI & SU

and

Douglas McTaggart
School of Business, Bond University

1. Introduction.

House Concurrent Resolution 133, passed by the U.S. Congress in March 1975, and amendments to the Federal Reserve Act as provided in the Full Employment and Balanced Growth Act of 1978 require the Federal Reserve to publicly announce monetary growth targets. Purportedly such announcements reduce the uncertainty, and hence the transactions costs, faced by private agents in an economy where unanticipated monetary disturbances have real effects. As stated by Paul Volcker (1978), then President of the Federal Reserve Bank of New York, and subsequently Chairman of the Board of Governors of the Federal Reserve System:

Monetary targeting is, first, of all, a useful tool of communication to the public. ... So long as the monetary authority's expression of intent has a degree of credibility (and maintenance of credibility will be crucially important over time), the announcement of the so-called growth ranges at the minimum sets a general framework for expectations about inflation in circumstances in which ... fears of

---

This paper has benefitted from suggestions made by Hervé Moulin and comments received in seminars delivered at the Australian National University, Flinders University, the University of Melbourne, The Reserve Bank of Australia and Virginia Polytechnic Institute. Remaining errors are, of course, the responsibility of the authors.
rampant inflation have emerged. There is no doubt that control of inflation in a context of growth itself depends importantly on containing price expectations.

It is clear from Mr. Volcker's comments that the intention of making public announcements was to influence the expectations of the public concerning current and future monetary policy which, it is assumed, affects or alters expectations about inflation. It is also clear that the monetary authorities were aware that the success of the targeting policy rests on the public's trust in the Fed. Credibility is crucial.

Evidence suggests, however, that, at least for the U.S., this experiment with announcements has not been successful. The Fed has constantly failed to achieve its announced targets, notwithstanding the "flexibility" exploitable in setting them. This failure, in turn, has probably precipitated the current trend away from reliance on monetary aggregates altogether. Discreditation of announcements renders unimportant the habitual failure in achieving them.

The trend away from reliance on monetary aggregates followed extended attempts by the Fed to improve its record, and hence credibility, through experimenting with operating procedures to improve its control over the targeted monetary aggregates. The Fed initially targeted the federal funds rate from 1975 through 1979 (while moving progressively towards a money stock intermediate target). In all but one year during this period the Fed failed to achieve both an M1 and M2 target, despite its ability to revise the target range midway through the targeting period. In October 1979, hoping to restore lost confidence, the Fed switched to targeting lagged reserves instead of the federal funds rate as the indicator of monetary policy.
Performance did not improve. Again operating procedures were changed in February 1984, to targeting contemporaneous reserves, as the Fed groped for a stable mechanism for controlling the money supply. In light of this experience, the Fed has concluded that, in the face of significant exogenous shocks resulting from deregulation and financial innovation, it cannot control money aggregates with the precision needed to achieve its announced targets [Lindsey (1986)].

There are reasons to doubt this conclusion. First, there appears to be an inherent bias towards exceeding announced targets. For example, only once during the period 1980:4-1981:4 were the growth rates of M1 to M3 not at or above the upper bound of the announced target range. Second is the claim by Brunner and Meltzer (1983), and discussed by Kimbrough (1986), that, by controlling the monetary base, “money growth can be held within plus or minus 1 percent of the annual target within semiannual and quarterly periods.” (Brunner and Meltzer (1983), p. 67). Casual support for the Brunner and Meltzer claim is found in the West German and Swiss experiences since 1973. Using the “central bank money stock”, the sum of currency plus required reserves, as the operating target for monetary policy, the West German Bundesbank has announced and consistently achieved monetary targets. This success has delivered both a relatively low rate of monetary growth and inflation, despite the fact that West Germany has been subject to the same sorts of exogenous disturbances as the United States.¹ In Switzerland, the monetary authorities had a poor record

¹ Akhtar (1983) describes these disturbances worldwide. The Bundesbank switched from a money base operating target to an M3 target in 1988. See Kahn and Jacobson (1989) for a discussion.
1974–1978 in achieving an M1 target. The Swiss central bank enormously improved its record when it converted to a monetary base target in 1979.\(^2\)

In short we have the following picture: The Fed began announcing monetary targets hoping to dampen inflationary expectations but failed dismally to maintain credibility of its announcements. The Fed then experimented with different mechanisms for controlling the money supply, but failed to exercise that option promising the tightest control over monetary growth rates. Rather than continue with a discredited policy, the Fed, along with some other central banks, finessed the problem by downplaying the importance of monetary aggregates as a key tool in the formulation of monetary policy.

In this paper we explain the Fed’s poor performance and its failure to regain credibility by taking control of the monetary base. We begin by providing an analytic framework for discussing the role of public target announcements. In particular we identify conditions necessary for such announcements to be credible and therefore effective. A game-theoretic model is employed where the announcements provide an essential means of coordinating the actions of the players, in the way hypothesised by Volcker, by fixing expectations. With this coordinating device at hand, outcomes Pareto superior to the Nash equilibrium following non-credible announcements can be attained.

The particular model employed is an expanded version of the monetary policy game implicit in Kydland and Prescott (1977) and Barro and Gordon (1983b). Canzoneri (1985) and others\(^3\) formalize this game as one

\(^{2}\) See Argy, Brennan and Stevens (1989).

\(^{3}\) Backus and Drifill (1985a,b) for example.
with perfect information between the Fed and private wage setting agents. Barro and Gordon (1983a) extend the analysis to dynamic games, leading to models in which reputation plays a role, possibly inducing Pareto optimal, time consistent outcomes. This follows in the dynamic game because the Fed wants to act in a way that will preserve its good reputation. In the Barro and Gordon context, reputation depends on past actions. Given a good reputation, current expectations of low inflation allow the Fed to act to fulfill them. It does not want to destroy public confidence by creating surprises: these may lead to expectations of high future inflation which then become self-fulfilling.

We show a similar outcome can occur in a one shot game with announcements. The announcements link the actions of the Fed and private agents, through their effect on expectations, inducing the Fed to incorporate them as an integral part of its overall strategy. In its simplest form we have a one shot two stage variant of the standard one shot game. In the first stage the Fed announces its intentions for the period, sends a signal by making a public announcement, and then, in the second stage, the Fed and wage setters simultaneously choose their actions. Where the Fed cannot commit to abide by its announcement and there are no costs for lying, the equilibrium that emerges depends on how the wage setters perceive the announcement, which is determined in part by the Fed's reputation. In a finite horizon game, the existence of explicit costs for lying modify these perceptions. Thus the cost of lying become a central part of our analysis.

The remainder of the paper proceeds as follows. Section 2 specifies the model and the standard Nash equilibrium in the one shot game. Section 3 considers the two stage game with announcements, given different specifi-
cations of the beliefs of wage setters. Section 4 analyzes the recent behavior of the Fed in this context. Concluding remarks follow.

2. The Basic Model

The Feasible Payoff Set

Consider the following simple variant of the game described in Canzoneri (1985). The economic environment comprises three types of agents: many identical decentralized wage setters, firms and the monetary authority or Fed. Firms and wage setters act together: firms offer wage setters contracts specifying a contingent employment rule and a fixed nominal wage. Following the realization of the price level a real wage is determined which determines the level of employment according to the employment rule. To keep the game simple we restrict the strategic considerations of the firm/wage setter pair to the wage setters choice of an acceptable nominal wage rate. Since all wage setters are alike we can consider the actions of a single representative wage setter. The Fed is the other strategic player in the game choosing the nominal money supply simultaneously with the wage setters' choice of the wage.

With our specification of the contracting procedure, the supply of output is given by

\[ y_t = \dot{y} + k(p_t - w_t) \]  \hspace{1cm} (1)

where \( y_t, p_t \) and \( w_t \) are the logs of output, the price level and the nominal wage rate, in period \( t \), respectively. \( \dot{y} \) is the natural rate of output, defined as that rate of output that would be chosen by wage setters if they could specify both the nominal wage and the price level. However, the demand
for output depends in part on the Fed’s actions and is given by the simple quantity equation
\[ y_t = m_t - p_t, \] (2)
where \( m_t \) is the log of the nominal money supply. Equating supply and demand for output yields the equilibrium price level
\[ p_t = \left( \frac{1}{1 + k} \right) (m_t + kw_t - \hat{y}). \] (3)

Following Canzoneri we assume each wage setter wants to achieve the natural level of output, \( \hat{y} \). In addition we assume that he is concerned about the rate of inflation. The per period utility function for a representative wage setter is thus given by\(^4\)
\[ U_W = -4 \{(y_t - \hat{y})^2 + \rho (\pi_t - \pi^*)^2\}, \] (4)
where \( \pi^* \) is the wage setter’s target rate of inflation, which could be zero, and \( \pi_t = p_t - p_{t-1} \) is the actual rate of inflation.

The Fed has a target rate of inflation, \( \bar{\pi} \), and a target level of output, \( \theta \hat{y} \). \( \theta \neq 1 \) is often assumed in order to justify an interventionist role for the Fed. Thus, the per period payoff to the Fed is
\[ UF = -4 \{(y_t - \theta \hat{y})^2 + s(\pi_t - \bar{\pi})^2\}. \] (5)

Two possible sources of tension arise in this model: the Fed and the wage setters may disagree on the appropriate levels of output (\( \theta \neq 1 \)) and inflation
\(^4\) In Barro and Gordon (1983) and Canzoneri (1985) \( \rho = 0 \). This has the effect of restricting the set of attainable outcomes to the \( U_W \) axis in Figure I as wage setters always achieve their maximal level of utility. However, there seems little reason to assume that agents have no tastes over inflation. If only because of “shoe leather” costs wage setters would lose utility for rates of inflation above some designated level.
Using (3) it is possible to rewrite the payoffs in terms of the actions of the players. To simplify the algebra and without loss of generality we assume that \( k = 1 \) so that:

\[
UW_t = -\{(m_t - w_t - \hat{y})^2 + \rho[m_t + w_t - \hat{y} - 2p_{t-1} - 2\pi^*]^2\} \quad (6)
\]

\[
UF_t = -\{([1 - 2\theta]\hat{y} + m_t - w_t)^2 + s[m_t + w_t - \hat{y} - 2p_{t-1} - 2\hat{\pi}]^2\}. \quad (7)
\]

Figure 1 describes the set of feasible payoff pairs, which are all points lying on or below the utility possibilities frontier AB. Note that in spite of the apparent time dependency in the payoff functions (the payoff for each player in period \( t \) depends on \( p_{t-1} \)) it can be checked that the payoff possibilities set does not itself depend on \( p_{t-1} \).

The One Shot Single Stage Game

In the one shot game strategies are represented as choices of values of \( w_t \) and \( m_t \). A Nash equilibrium is a nominal wage and money supply with the property that the wage setters’ choice of the wage is a best reply to the Fed’s choice of the money supply and vice versa.

Since there are many wage setters in this model no individual wage setter believes his actions affect the equilibrium rate of inflation. And since all wage setters (and firms) are alike, each chooses the same wage strategy. Thus, from our point of view, the representative wage setter chooses the “average” wage which affects the aggregate level of employment. This choice is made as a best reply to the Fed’s behavior, taking as given, and is equivalent to choosing \( w_t \) to maximize (6) with \( \rho = 0 \). Doing so yields the best reply for the wage setter to any \( m_t \),

\[
\hat{w}_t = m_t - \hat{y}. \quad (8)
\]
Substituting back into (3) reveals that \( w_t = p_t \) is always the best (and therefore equilibrium) response for each decentralized wage setter. By setting the nominal wage equal to the anticipated price level the wage setter hopes to achieve the natural rate of output. This restricts the set of attainable equilibria in the decentralized wage setter game to the set of points corresponding to the curve AE in Figure 1.\(^5\)

For the Fed the best reply to any \( w_t \) satisfies

\[
(1 + s)m_t = (1 - s)w_t - (1 - 2\theta - s)\dot{y} - 2sp_{t-1} - 2s\bar{\pi}.
\]

Solving for the unique Nash equilibrium strategies yields

\[
w_{t}^{NE} = (1/s)[-(1 - \theta)\dot{y} + sp_{t-1} + s\bar{\pi}] \\
m_{t}^{NE} = (1/s)[-(1 - \theta - s)\dot{y} + sp_{t-1} + s\bar{\pi}] 
\]

which imply equilibrium per period payoffs for the wage setter and Fed respectively

\[
UW_{t}^{NE} = -(\rho/s)[s(\pi - \pi^*) - (1 - \theta)\dot{y}]^2 \\
UF_{t}^{NE} = (1 + \frac{1}{s})[(1 - \theta)\dot{y}]^2.
\]

This is point C in Figure 1. Defining \( g_t \) and \( \omega_t \) to be the rate of growth the money supply and nominal wages, respectively, we have

\[
g_t = \omega_t = \pi_t = -(1/s)(1 - \theta)\dot{y} + \bar{\pi}.
\]

\(^5\) This is not true in the two player game. Here the set of attainable equilibria is the entire set on or below the payoff frontier AB. This includes many points where the natural rate of output does not obtain. All points along the frontier are attainable Pareto optimal outcomes. In the decentralised game only point A is an attainable Pareto optimal outcome.
The assumption \( \theta > 1 \) generates a Nash equilibrium rate of inflation that is higher than the Fed prefers. Yet, because \( w_t = p_t \), the natural rate of output prevails. This is precisely the Barro and Gordon solution where we have inflation that is too high but no offsetting output gain. Proposition 1 summarizes the above discussion.

**Proposition 1.** There is a unique Nash equilibrium in the one shot single stage game where equilibrium strategies are given by (9) and (10).

**Proof.** The proof follows by the definition of a Nash equilibrium and the linearity of the best reply functions.

3. The Two Stage Game

The two stage game has the following sequence of moves. First the Fed announces what it intends the money supply will be in the coming period. Then armed with this information the Fed and the wage setters simultaneously choose their actions. The one stage game is thus a proper subgame of the two stage game. The payoffs in the two stage game are the same as in equations (6) and (7), depending only on the values of \( m_t \) and \( w_t \), except for one difference. We assume that there may be a cost, however small, incurred by the Fed for lying. While these costs need not be explicit they must be real. One might want to argue, for example, that, considering the announcements in the U.S. are made in front of various Congressional committees on banking and finance, lost or reduced credibility would ensue from the belief that the Fed wilfully misled the government and this is a real cost, if not readily quantified. The extent to which lost credibility or reputation qualifies as a real cost is an important issue discussed below.
The strategy sets, and strategies, in the two stage game are different from those in the single stage game. For the Fed, a strategy consists of an announcement for the first stage, denoted $a_t$, and a choice of $m_t$ the money supply, for the second stage. Strictly speaking, a monetary policy is a rule or function, $\rho_t$, which maps the announcement into a money supply: $m_t = \rho_t(a_t)$. Denoting the time $t$ strategy set for the Fed as $G^f_t$, then

$$G^f_t = \{(a_t, \rho_t) \mid \rho_t : a_t \to m_t, \ a_t, m_t \in R\}.$$  

For the wage setter, a strategy consists of a rule or function, denoted $\lambda_t$, which specifies the choice of the wage given the announcement of the Fed. The rule $\lambda_t$, in effect, implies a set of beliefs held by the wage setter about the Fed’s actions following the announcement. We show below that different sets of beliefs yield different Nash equilibria in this one shot game, but only one of these is subgame perfect (which means the announcement is “credible”).\(^6\) Denoting $G^w_t$ as the time $t$ strategy set for the wage setter, then $G^w_t$ is a set of functions:

$$G^w_t = \{\lambda_t \mid \lambda_t : a_t \to w_t, \ a_t, w_t \in R\}.$$  

The payoffs are as given by equations (6) and (7), except for the cost the Fed incurs if it lies:

$$UF_t = -\left\{ [(1 - 2\theta)\hat{y} + m_t - w_t]^2 + s[m_t + w_t - \hat{y} - 2\mu_{t-1} - 2\bar{\pi}]^2 \right\} - \xi \delta(a_t, m_t).$$  

(14)

$\xi$ parameterises the costs of lying and $\delta$ is the indicator function:

$$\delta(a_t, m_t) = \begin{cases} 0, & \text{if } a_t = m_t \\ 1, & \text{otherwise}. \end{cases}$$

\(^6\) A subgame perfect equilibrium is a strategy pair that when restricted to any subgame results in a Nash equilibrium for the subgame.
When $\xi = 0$ the announcements have no real effect on the game as there are no costs associated with conveying false information. For the one shot two stage game announcements are arbitrary and ignored by the wage setter. The equilibrium is the same as in the one shot one stage game, with the Barro and Gordon inflation bias but no output gains.

For $\xi > 0$ it may be possible for the Fed to credibly commit to deviation from $m_t = m_t^{NE}$ and announce a lower target money supply. An announced money supply below $m_t^{NE}$ which is believed and implemented yields lower equilibrium inflation, benefitting both the Fed and wage setters. On the other hand, if the announcement is believed the Fed has the opportunity to exploit the low inflationary expectations by increasing the money supply and generating a surprise inflation that increases output. Offsetting this incentive are the costs incurred for lying. The wage setters, of course, understand the Fed’s incentives and calculate that level of the money supply at which the Fed is indifferent between playing honestly and cheating. Denote this money supply by $m_t^\ast$. Any announcement below $m_t^\ast$ is not credible because, if believed, it always pays for the Fed to cheat. Announcements above $m_t^\ast$ are credible. The value of $m_t^\ast$ depends on the Fed’s reputation, i.e., on the initial beliefs of the wage setters which determine how the announcement is interpreted. If the Fed has a “good reputation” then its announcement, if credible, is believed. Where the Fed has a “bad reputation” its announcements, even if credible, are not believed. The Fed’s reputation need not be consistent with its behavior. However, we show below that there is a unique equilibrium with consistent announcements, reputation, and behavior.
The Case of a Good Initial Reputation

Consider first the case where the wage setter simply believes that if the Fed's announcement is credible then, by virtue of its good reputation, it will in fact implement that money supply. This implies

$$w_t = \lambda_t(a_t) = a_t - \hat{y}.$$ 

With these beliefs the payoff to the Fed from announcing \(m^*_t\) and not cheating when believed by the wage setter is

$$UF_t^{FC} = -4[h^2 + sg^2],$$

where \(h = 2(1 - \theta)\hat{y}\) and \(g = 2(m^*_t - \hat{y} - \pi_{t-1} - \bar{\pi})\), and where we assume wage setters believe the Fed’s announcement of \(m^*_t\) and set wages at

$$w_t^* = m^*_t - \hat{y} = a_t - \hat{y}.$$ 

Given \(w_t\) the Fed could cheat and issue a money supply different from that announced. Suppose the Fed does cheat, then its optimal choice of a money supply is

$$m_t = \frac{1}{1 + s}[(1 - s)m^*_t - 2(1 - s - \theta)\hat{y} + s(\pi_{t-1} + \bar{\pi})].$$

This yields the Fed utility \(UF_t^{FC}\):

$$UF_t^{FC} = -\frac{s}{1 + s} \{h - g\}^2 - \xi.$$ 

By setting \(UF_t^{FR}\) equal to \(UF_t^{FC}\) we can solve for that announced money supply \(m^*_t\) as a function of \(\xi\) at which the Fed is indifferent between cheating and not cheating. Any announced money supply below \(m^*_t\) would be ignored.
because the wage setters would anticipate cheating. What they would do in this case is arbitrary. We suppose that if the Fed does announce a monetary policy that is not believable then wage setters would demand a nominal wage equal to that which would emerge in a Nash equilibrium without announcements. (This is also the only equilibrium in the continuation game after a non-credible announcement). Solving for the lowest announced value for $m_t^*$ which, for $\xi$ not too large, just balances net benefits from cheating and not cheating yields\(^7\)

$$m_t^* = m_t^{NE} - \nu \sqrt{\xi},$$

where $\nu = (1/2s)\sqrt{1 + s}$, which implies

$$w_t^* = w_t^{NE} - \nu \sqrt{\xi}.$$

The inflation rate associated with $(m_t^*, w_t^*)$ is

$$\pi_t = \pi_t^{NE} - \nu \sqrt{\xi}.$$

Any announced monetary policy $m_t$ contained in the interval $[m_t^*, m_t^{NE}]$ is credible. Wage setters who expect that the Fed will follow that announcement will set the wage accordingly. If the Fed then attempted to surprise the workers with an inflation, output gains could be had but these are outweighed by the costs of lying, $\xi$.

Denoting $D'$ as that outcome associated with $m_t = m_t^*$ then the set of points on the segment $CD'$ in Figure 1 correspond to the credible announcements $[m_t^*, m_t^{NE}]$. Each of these is a possible Nash equilibrium. However,

\(^7\) The solution for $m_t^*$ is a quadratic equation. We take the negative root as this corresponds to the lowest cost or highest utility outcome.
the optimal credible announcement from the Fed in the first stage of the
game is that which yields it the highest possible utility, where announce-
ments are believed only if they are credible. Optimality therefore requires
the Fed to announce \( a_t = m_t^* \), corresponding to D'.

D', however, depends on \( \xi \). If \( \xi = 0 \) we restore the Nash equilibrium in
the game with no announcements as the only possible equilibrium (the set
CD' corresponds to point C in Figure 1). As noted above, the signal has no
value when there are no costs to conveying false information. On the other
hand, if we set

\[
xige = \frac{d}{1 + s}[(1 - \theta)\hat{y}]^2
\]

then \( m_t^* = \hat{y} + p_{t-1} + \pi \), which corresponds to point D in Figure 1. That is
we can find a punishment, denoted \( \xi^* \), such that D' converges to D, where
D is the best attainable equilibrium from the Fed's point of view, subject to
the restriction that \( m_t = p_t \). Thus there exists a range of possible equilibria
depending on the value of \( \xi \).

The Case of a Bad Initial Reputation

Continuing with the simple specification of the wage setters beliefs, we
ask the following question: If the Fed has a bad reputation, in that wage
setters always believe that the Fed is lying, does it ever pay for the Fed to
fulfil those beliefs?

With a bad reputation, given any announcement, wage setters believe
that the Fed will consistently implement a different money supply and the
Fed's announcement is never taken literally. For simplicity, assume that
wage setters believe that the Fed's announcement always understates the
true expected rate of growth of the money by a constant amount. That is, if

$$a_t = \bar{m}_t$$

then we suppose that wage setters act on the belief that

$$m_t = (1 + \beta)a_t,$$

where $\beta \neq 0$, and is generally greater than one. $\beta = 0$ is equivalent to the good reputation case. The wage will be set accordingly as

$$w_t = \lambda_t(a_t) = (1 + \beta)a_t - \hat{y}.$$ 

When operating with the stigma of a bad reputation the Fed has three options following its announcement: (i) it can play what it announced even though it was not believed; (ii) it can play to fulfil the beliefs of wage setters; or (iii) it can choose $m_t$ optimally given the beliefs of wage setters, reneging on its announcement. It is a straightforward matter to show that the second option is always dominated by the first, so we can discard it. That is, the Fed would never want to live up (or down?) to its bad reputation. This leaves the comparison as before. We look for that announced money supply below which the Fed will always want to renege, given the beliefs of wage setters. Announcements above this level are credible even though the Fed has a bad reputation. Following the algebra of the good reputation case we derive,

$$m_t^* = \gamma[m_t^{NE} - \nu \sqrt{\xi}],$$

where $\gamma = 2s/(2s - k(1 - s))$. If the announcement is too low wage setters will revert to the high inflationary expectations of the one stage Nash equilibrium. Having made a credible announcement, however, the Fed always
implements that announcement; it never pays to fulfill the wage setters’ prior expectations of lying. The question now is: Since the Fed never fulfills the wage setters prior beliefs that it never makes a truthful announcement, is it equilibrium behavior for the wage setters to hold such beliefs in the first place? The answer is no: given that \( m_t = a_t \) the wage setters are always better off when \( \beta = 0 \). This assertion is verified by comparing \( U W_t(m_t) \) evaluated at \( \beta = 0 \) and any nonzero \( \beta \). Thus \( \beta \neq 0 \) cannot part of a subgame perfect equilibrium.

**Conditional Beliefs**

Instead of simply believing the Fed or not, suppose that the wage setters hold conditional beliefs that are triggered by the announcement. Consider the following: Pick an \( \hat{m}_t \). If \( a_t = \hat{m}_t \) then the wage is set \( w_t := a_t - \hat{y} \). If \( a_t \neq \hat{m}_t \) then \( w_t = za_t \) where \( z \) is an arbitrarily large number. If the Fed believes that these are the wage setters beliefs then the best reply by the Fed is to choose \( a_t = m_t = \hat{m}_t \). This behavior generates different Nash equilibrium for every \( \hat{m}_t \). In particular the wage setters could choose \( \hat{m}_t = \hat{y} + p_{t-1} + \pi^* \) which would yield point A in Figure 1 as the Nash equilibrium. This is the best possible outcome from the wage setters point of view.\(^8\)

It turns out, however, that this multitude of Nash equilibria with conditional beliefs are not subgame perfect. To see this, suppose the strategies are as above with \( \hat{m} = \hat{y} + p_{t-1} + \pi^* \), but the wage setters find themselves at an

---

\(^8\) Under some definitions, this outcome is time consistent. Thus wage setters, by acting on conditional beliefs, can force the Fed to the only feasible Pareto optimal outcome as a time consistent solution. See McTaggart and Salant (1989) for more on the relationship between time consistency and the underlying game theoretic solution concepts.
unexpected node in the game because the Fed announced something other than \( \hat{m}_t \). For example, the Fed could have announced \( a_t = m_t^{NE} - \nu \sqrt{\xi} \), corresponding to point D in Figure 1. Each wage setters’ strategy now requires them all to bargain for a very large nominal wage so that, as a group, they precipitate a large inflation and penalise the Fed. However, if \( m_t \) is large, say \( ka_t \), then \( w_t = za_t \) is not a best response for the wage setters unless \( k = z \). But if \( k = z \) then \( m_t = ka_t \) is not a best response for the Fed. So in the second stage of the game \( m_t = w_t = za_t \) cannot be an equilibrium and thus, as such, is not subgame perfect. Moreover, each wage setter has an incentive to defect from the punishment strategy because his own individual action has, by itself, no effect on the aggregate price level. This means that threats conditioned on the announcement of the Fed are not credible, unless the threats are credible, and those Nash equilibria with conditional beliefs cannot be subgame perfect.\(^9\)

Proposition 2 summarizes the discussion to this point.

**Proposition 2.** There is a unique subgame perfect equilibrium in the one shot two stage game, which depends on the size of the costs of lying. At this equilibrium the Fed announces

\[
a_t = m_t^{NE} - \nu \sqrt{\xi} \quad \text{for} \quad \xi \leq \frac{4}{1 + s} [(1 - \theta)\hat{y}]^2 = \xi^*.
\]

This announcement is believed by wage setters. The Fed then plays its announcement. If \( \xi > \xi^* \) then

\[
a_t = m_t^{NE} - \nu \sqrt{\xi^*}, \quad m_t = a_t, \quad w_t = a_t - \hat{y}
\]

\(^9\) The following is the unique credible threat for play in the subgame after an announcement \( a_t \): If \( a_t \in [m_t^{*}, m_t^{NE}] \) then set \( w_t = a_t - \hat{y} \). Otherwise set \( w_t = w_t^{NE} \). This corresponds to the unique equilibrium action of the wage setter in the subgame.
is the unique subgame perfect equilibrium.

Proof. See the Appendix.

In our framework, a positive cost of lying cannot arise from reputational considerations alone unless the Fed has an indefinitely long time horizon. With a finite horizon, however long, the costs for lying must be made explicit. This follows because the unique equilibrium in the finitely repeated game is the repeated play of the actions of the one shot two stage game. This is due to the fact that the one shot game has a unique equilibrium. If the one shot game had multiple equilibria then reputation may have a significant effect on the costs of lying.

Since reputation cannot always be a source of a positive cost of lying, other penalties must exist. These might include reduced employment opportunities for members of the Board of Governors, and their staffs, after leaving office or legislation providing sanctions for failing to achieve some specified level of performance. Alternatively, the recent example of New Zealand’s central bank could be followed where the Governor’s salary is tied to certain state variables, including the rate of inflation.

4. Explaining the Fed’s Behavior

For announcements to be effective in the one shot game they must be accompanied by explicit costs for lying. This means that, even though the Fed (and wage setters) are better off with announcements, the Fed might find it difficult to unilaterally initiate an announcements policy and have it work. For such a regime to be workable the Fed must convince wage setters that it suffers when it fails to fulfil its own announcements. Failing that, the unilateral move to announce corresponds to a world where \( \xi = 0 \) and the
Nash equilibrium without announcements would prevail. This logic applies to any finite horizon game with announcements.

Within this context the Fed’s recent experience with monetary targeting can be understood. Lindsey (1984) notes that the Full Employment and Balanced Growth Act of 1978 which formalises the procedures for making announcements also specifies that

“nothing in this Act shall be interpreted to require that the objectives and plans ... be achieved if the Board of Governors and the Federal Open Market Committee determine that they cannot or should not be achieved because of changing conditions ... provided ... the Board of Governors shall include an explanation of the reasons for any revisions to or deviations from such objectives and plans.” (our italics)

In other words, in practice there is no *exogenous* penalty for not fulfilling announcements, as long the Fed explains why. This has been explicitly incorporated into the Act governing the announcements regime. The onus thus rests with the Fed to convince private agents that it will effectively punish itself in the event of a violation of its promise. Clearly the Fed has been unable to do this. With the failure of self-regulation, the Barro and Gordon equilibrium has emerged wherein actual monetary growth rates always exceed announced growth rates. Consequently announcements are ignored. Moreover, it is not optimal for the Fed to ever try and establish a reputation for honesty or credibility by unilaterally acting to fulfil its announcements. And it never wants to place itself in the position of being able to precisely control the money supply, say by targeting the money base, because failure to achieve targets could been seen as intentional.
This interpretation of events is consistent with the persistent criticism of the Fed of which David Fand's (1986) comment is representative:

"[T]he Federal Reserve missed its monetary targets, changed its monetary targets, used multiple targets, and allowed base drift in those targets. The monetary authority acted as if the enunciation of targets were a routine that they were required to go through but were not required to adhere to."

Thus it is fair to conclude that for the announcements regime to work legislative action may be necessary in order to impose convincing exogenous costs for lying on the Fed.

5. Concluding Comments

Requiring the Fed to announce its intended future monetary policy enables the attainment of Pareto improved outcomes if the failure to fulfil those announcements meets with a credible punishment. In any finite game, the one shot game in particular, such costs need to be explicit and real. In the game considered here it is possible to attain the low inflation rate associated with games in which binding commitments are feasible. Thus, games with announcements can be viewed as a bridge between games with commitment and games without. While the Fed’s announcement is not binding, the imposition of costs for lying and a consistent specification of the beliefs of wage setters combine in such a way that in equilibrium the Fed always fulfils its announcement. Forcing the Fed to make monetary target announcements is one way of imposing commitment.

\[10\] In an infinitely repeated game revisionary play will generally provide a credible threat of punishment. See McTaggart and Salant (1989). However, often policy-makers have finite tenure and finite horizons.
There may be other ways to avoid the inflationary Nash equilibrium, a number of which are discussed in Rogoff (1985). He uses a structure similar to the one used here. Of particular interest is the proposal that the Fed ought to be controlled by a monetary authority who places a heavier weight on the costs of inflation than does the general public—a "conservative banker". In our framework, this implies increasing $s$ in (7). The effect of this action is to push the Nash equilibrium, point C in Figure 1, towards the best attainable equilibrium, point D. This may explain, in part, the superior performances of the West German and Swiss central bankers. However, we require $s \to \infty$ in order to actually achieve D. That is, the outcome that could be attained by enacting an announcements regime with appropriate explicit costs, can only be attained by a suitably deviant conservative banker with a paranoid fear of inflation in the standard one shot game. Changing the Central Banking Act may be preferable to changing central bankers.

Finally note that at equilibrium in a game with perfect information, as we have have considered here, the Fed always has a good reputation when there are real costs to lying. Wage setters know what the Fed will do and the Fed always does exactly what it says. A bad reputation, in that the Fed is believed to systematically deviate from announced policy, cannot be an equilibrium state when the costs for lying are positive. This follows because the actions of the Fed are always completely detectable. This result probably would not follow in a world where the money supply is only partly determined by the actions of the Fed and partly determined by forces unknown to private agents.
6. References


Figure 1.
Proof of Proposition 2

First we characterize the set of (Nash) equilibria in the second and last stage of the game. Proceeding backwards we find the unique subgame perfect equilibrium.

Let \( \tilde{a}_t \) be any given announcement. To find the equilibrium in the subgame following the announcement recall that the payoff to the Fed is:

\[
UF_t(\tilde{a}_t) = -[(1 - 2\theta)\hat{y} + m_t - w_t]^2 - s[m_t + w_t - \hat{y} - 2p_{t-1} - 2\pi]^2 - \xi \delta(\tilde{a}_t, m_t).
\]

And for the wage setter:

\[
UW_t = -[m_t - w_t - \hat{y}]^2 - p[m_t + w_t - \hat{y} - 2p_{t-1} - 2\pi^*]^2.
\]

Following any \( \tilde{a}_t \), an equilibrium \([w_t(\tilde{a}_t), m_t(\tilde{a}_t)]\) must satisfy:

\[
w_t(\tilde{a}_t) = m_t(\tilde{a}_t) - \hat{y}
\]

and

\[
m_t(\tilde{a}_t) = \begin{cases} 
\tilde{a}_t, & \text{or} \\
\left(\frac{1}{1+s}\right)[(1-s)w_t(\tilde{a}_t) + (2\theta + s - 1)\hat{y} + 2s(p_{t-1} + \pi)]. 
\end{cases}
\]

Now, \( m_t(\tilde{a}_t) = \tilde{a}_t \) is a best reply to \( w_t = \tilde{a}_t - \hat{y} \) if and only if

\[
-4[(1 - \theta)^2\hat{y}^2 - s(\tilde{a}_t - \hat{y} - p_{t-1} - \pi)^2] \leq -2(1 - \theta)\hat{y} + \hat{m} - \tilde{a}_t \leq -2(1 - \theta)\hat{y} - 2(p_{t-1} + \pi).
\]

where \( \hat{m} = (1 + s)^{-1}[(1 - s)\tilde{a}_t - 2(1 - s - \theta)\hat{y} + 2s(p_{t-1} + \pi)] \). Otherwise

\[
m_t(\tilde{a}_t) = m_t^{NE} = (1/s)[-(1 - s - \theta)\hat{y} + s(p_{t-1} + \pi)]
\]
and

\[ w_t(\hat{a}_t) = w_t^{NE} = (1/s)[-(1-\theta)\hat{y} + s(p_{t-1} + \pi)] \]

is the unique Nash equilibrium in the second stage game. (A1) holds if and only if \( \hat{a}_t \geq m_t^{NE} - \nu \sqrt{\xi} \), where \( \nu = (1/2s)\sqrt{1 + s} \). For any other values of \( \hat{a}_t \) the equilibrium that emerges is the Nash equilibrium of the one shot game. Thus, any subgame perfect equilibrium must satisfy

\[
m_t(\hat{a}_t) = \begin{cases} 
  m_t^{NE} & \text{for } a_t \notin [m_t^{NE} - \nu \sqrt{\xi}, m_t^{NE}] \\
  \hat{a}_t & \text{otherwise}
\end{cases}
\]

and

\[
w_t(\hat{a}_t) = \begin{cases} 
  w_t^{NE} & \text{for } a_t \notin [m_t^{NE} - \nu \sqrt{\xi}, m_t^{NE}] \\
  \hat{a}_t - \hat{y} & \text{otherwise}
\end{cases}
\]

Thus, given any announcement, the subgame perfect equilibrium values \((m_t, w_t)\) are determined as above.

A subgame perfect equilibrium is an announcement \(a_t^*\) and rules \(m_t^*(a_t)\) and \(w_t^*(a_t)\) such that \(m_t^*(a_t^*)\) and \(w_t^*(a_t^*)\) are an equilibrium in the second stage of the game, and \(a_t^*\) maximizes \(UF_t\) given \(m_t^*(a_t)\) and \(w_t^*(a_t)\). The unique maximizing value for \(a_t\) is thus

\[ a_t^* = m_t^{NE} - \nu \sqrt{\xi} \]

Notice that the second stage equilibrium conditions pin down the unique subgame perfect equilibrium for the game.