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ABSTRACT

This survey performs a critical evaluation of the recent literature on monetary policy which emphasizes the theory of games as a natural characterization of centralized policy making. The dominant theme is the credibility hypothesis and its role in the success or otherwise of anti–inflationary policies. The principle concerns of the survey are as follows: (1) the interpretation of strategic interdependence between centralized policy makers and private economic agents; (2) the rules or institutional structure in the economy which determine the scope for discretionary opportunism on the part of policy makers; (3) the design of informal incentive mechanisms which may substitute for formal commitments; (4) strategic decision making under uncertainty and the incentives for players to conceal or misrepresent private information; and (5) the relationship between the monetary authority, the government and private agents, the degree of monetary independence and the political environment in which policy makers operate. Empirical research on the credibility hypothesis is fraught with important technical and conceptual problems. These, together with some first tests, are also discussed.

Keywords: Games, credibility, commitment, discretion, reputation, information.

CONTENTS

I. INTRODUCTION

Within the past decade there has been a significant shift in attitude by many western industrialized countries towards the objectives and conduct of national economic policy. The events of the 1970s—accelerating inflation and stagnant economic growth—motivated the view that inflation had created its own stubborn self–sustaining momentum which was either not amenable to the influences of conventional macroeconomic policy or else would yield to such influences only at unacceptable costs. This led to the development of a programme aimed at re–establishing control over prices whilst minimizing any adverse consequences of anti–inflationary policies on output and employment. Seen as a new monetary experiment, the essential ingredients included prudent financial management, abstinence from discretionary intervention, commitment to intermediate targets and, above all, prior announcement of these policies. Evidence of this programme, and its effects, can be found on the continents of Europe, North America and Latin America and provide further important lessons in anti–inflationary management. This paper is a survey of recent theoretical developments in monetary policy which, among other issues, attempt to explain one rationale for this programme and the likely consequences thereof.

To the extent that the new programme of monetary (and fiscal) reform was deliberately made public (and impressed upon citizens as an overriding commitment of governments) in advance of its execution reflects a prevailing opinion that economic policies are more effective if they are credible to private economic agents. This view, emphasized forcefully by William Fellner (1976, 1979), may be seen as being mainly due to the assimilation of the rational expectations hypothesis into mainstream macroeconomics. (Excellent comprehensive and critical surveys of rational expectations can be found in David Begg 1982; Roman Frydman and Edmund Phelps 1983; Patrick Minford and David Peel 1983; Steven Sheffrin 1983.) Rational expectations models are inherently forward–looking in the sense that current decisions depend not only upon the current and past states of the environment, but also upon

the entire expected future profile of events, including anticipated economic policy. The hypothesis asserts that private agents form these expectations by making optimal use of all relevant information.

Given this, the argument that figures prominently in contemporary discussions of deflationary management—namely that greater credibility of an anti–inflationary policy reduces the costs of disinflation—is persuasive. During the 1970s, two dominant views on the appropriate design of an anti–inflationary programme emerged. One of these—gradualism—urged the adoption of a programme which implied a steady predictable reduction in the rate of inflation. The other—immediacy—argued for a more radical policy package aimed at cutting inflation much more abruptly. These different policy recommendations reflected different views on the speed of market adjustment and the different costs associated with deflation.[1] Whatever their relative merits, however, the success of either type of policy in reducing inflation at little or no cost to output and employment relies on the policy being credible. Regardless of how well–articulated the programme is and how frequently it is publicly announced, a lack of credibility (for whatever reason) would inhibit a sufficient fall in inflationary expectations to prevent the economy from being thrown into a recession. Just as the success of gradualism requires a belief on the part of private agents in the policy maker's conviction to the announced contractionary path, so too does the success of immediacy rely on a belief in a binding commitment to the abrupt shift in policy regime. Moreover, if one conceives of the actual inflationary process as depending upon the method of forming inflationary expectations, a credible disinflationary policy has the added bonus of contributing to the disinflation itself.

In spite of the potentially crucial role of credibility in determining the success of economic policies, it is as well to point out at this stage that the concept of credibility is not well–defined in economics and has received different interpretations by different authors. Perhaps the most general interpretation is the extent to which beliefs about the current and future course of economic policy are consistent with the programme originally announced by

1. Under the gradualist view, the existence of various institutional rigidities in the economy (in particular, long–term nominal wage contracts) implies that a gradual deflation should be followed in order to allow these rigidities to adapt smoothly to the changing economic environment and prevent a protracted recession. By contrast, the immediacy view regards the economy as being essentially free of any impediments to market adjustments and sees no reason why policy makers should not aim for a much quicker end to inflation.

policy makers. On the basis of this, one may speculate upon a number of factors which are likely to influence the credibility of policy announcements. These factors may be classified under the broad headings of technological (inherent), administrative (political) and strategic constraints. (For further discussion of some of the issues that follow, see Thomas Schelling 1982; John Taylor 1982.)

The technological constraints on establishing credibility include such factors as the reliability of the data upon which policy makers condition their decisions and forecasts; the feasibility and controllability of policy instruments; the feasibility of policy makers' objectives; and the accuracy and relevance of the economic theory which policy makers use.

Administrative or political constraints include the ability of an incumbent government to carry through any required legislation; whether in a democratic society an incumbent will have sufficient time to execute its programme; and whether an incumbent will be tempted to modify its programme in response to political pressure either from within itself or from the electorate.[2]

Whilst all of these factors are, to a lesser or greater degree, important for establishing credibility, the major thrust of the recent literature on monetary policy concerned with this issue has focused on the third category regarding strategic aspects. The essential idea here is the interdependence between the behavioural patterns of private individuals and centralized policy makers—in particular, the view of centralized policy making as being conducted in an environment inhabited by sophisticated forward–looking private agents who are attempting to predict the economic policy to be applied (and policy makers' understanding of this). The strategic view of policy making implicit in this lends itself naturally to a game–theoretic interpretation where the players in the game are the policy makers and private economic agents. The credibility issue emerges here because of an incentive for policy makers to pursue a strategic advantage and seek short–run gains by reneging on previously announced policies. Originating in the work of Finn Kydland and Edward Prescott (1977), this is often referred to as the time inconsistency of optimal policies, by which is meant that an optimal policy

2. It has been suggested that private agents might deliberately distrust government announcements as a political protest and as a means of making a government fail in its promises. Taylor (1982) argues further that a new programme should be superior to the programme it is replacing if it is to be credible.

computed at the beginning of a planning horizon does not remain optimal at a later date. This property of optimal policies does not depend upon conflicting objectives between players in the game, changes in preferences or idiosyncrasies in the information structure. What it does rely on is forward–looking behaviour by private agents and an inability of centralized policy makers to precommit themselves to announced policies.[3]

When the source of a credibility problem lies in time inconsistency (or, more provocatively, cheating) a number of potential resolutions suggest themselves. (All of these will be discussed at greater length later.) One possibility is to change the rules or institutional structure within an economy in order to limit the scope for discretionary opportunism on the part of policy makers. This may take several forms, including tying policy decisions to the constraints imposed by some external commitment (e.g., a gold standard or fixed exchange rate regime), the use of explicit legislation (e.g., a legally prescribed rule for money creation) or ensuring that policy making is under the auspices of an independent authority which does not possess the same motives or strategic advantages that would otherwise weaken credibility (e.g., the establishment of an independent central bank). Alternatively, policy makers may be able to demonstrate their commitment to an economic programme by not yielding to outside pressure for change or by deliberately engaging in confrontation with opponents on issues which need not be directly related to economic policy but which are symptomatic of policy makers' general attitude. Finally, if policy makers are either unwilling or unable to commit themselves, there may be more informal incentive schemes with which private agents can threaten them if they behave disobediently (e.g., the threat of industrial action or inflationary wage setting).

The recent literature on monetary policy credibility to be reviewed in this paper has concentrated almost exclusively on the types of strategic issues alluded to above. Two main questions which it addresses are how serious is the time inconsistency problem and how might this problem be resolved in the absence of precommitment. This paper also stresses, however, that the three categories identified above are not mutually exclusive and that a complete

3. See, however, Robert Strotz (1956) who identifies time inconsistency with changes in tastes. Some early insights into the time inconsistency issue can be found in Phelps (1967) and Phelps and Robert Pollack (1968).

evaluation of the credibility issue must also take into account the constraints imposed by technology and the political climate. In fact, in many cases, it is these aspects of policy making which seem to be at the heart of the issues being discussed and which raise the most interesting problems. In general, credibility of monetary policy will depend not just upon monetary policy alone but rather upon the perceived coherence of the overall macroeconomic programme, together with the intellectual and political consensus on the economic theory being used and the objectives and conduct of economic policy, all of which may be influenced by elements in all three categories. Time consistency and credibility are often used interchangeably but the latter is a much broader concept and encompasses much more than just the implications of game theory.

Credibility has often been talked about by policy makers but it is only recently that a precise language and formal paradigm for systematically organizing the concepts involved have been developed. It is difficult not to be impressed by the elegance of this new body of research and the importance of the issues that it addresses. It makes explicit the motives and constraints facing hypothetical policy makers. It emphasizes that policy making is not exogenous but depends upon private equilibrium behaviour and private agents' understanding of this. It has been instrumental in shaping the way in which economists approach problems of optimal policy design and in shaping contemporary macroeconomic policy. It seems to confirm some long– and widely–held suspicions among many economists. And it has occupied the attention of many distinguished authors. There is, of course, some risk in attempting to survey this research, especially given the staggering pace at which it has developed. Nevertheless, the literature has now reached a sufficient maturity that it is possible to identify some commonly recurring and important themes which, together with the foregoing remarks, provide ample motivation for reflecting upon it—its methodological approach, its focus of attention and its empirical significance.

Related discussions of the literature can be found in Blackburn (1987), Alex Cukierman (1985a), Stanley Fischer (1986), Seppo Honkapohja (1985) and Kenneth Rogoff (1987).[4] Like

4. See also David Currie (1985).

each of these, the emphasis in this paper is different, being much broader in its outlook. It is deliberately critical of the existing literature, pointing out important drawbacks and unresolved issues and using these shortcomings as a guide for directing future research. It also contains the first appraisal of some recent econometric work and empirical evidence on credibility. Overall, the survey should be of interest to both specialists and non–specialists in the fields of monetary policy and game theory, as well as to others who would like to acquire a good working knowledge of this exciting research programme in macroeconomics.

The plan of the survey is as follows. Section II reviews some important concepts of game theory and describes a simple model of monetary policy which has been used extensively in the literature. Section III considers the basic problem of credibility associated with an anti–inflationary monetary policy in one–shot and repeated games under the assumption of perfect foresight. Section IV examines the role of the information structure in detail, focusing on strategic decision making under uncertainty. Section V contains a discussion of centralized policy making and expands upon some themes introduced in earlier sections regarding the institutional and political influences upon monetary policy. Section VI evaluates some recent econometric work and empirical evidence on credibility. Section VII concludes.

II. GAME THEORY AS A FRAMEWORK FOR MONETARY POLICY

1. Basic Concepts and Preliminary Remarks

The simplest type of decision problem is when only one agent affects an outcome. In this case, one may say that no game exists or that the single individual is playing a game against nature. Whilst the decision problem may still be non–trivial (e.g., because of risk and uncertainty), it is greatly simplified by the absence of any strategic considerations. In games between intelligent individuals, the utility of each agent depends not only upon his own decision but also upon the decisions of all other agents. Games of particular interest, therefore, involve two or more participants, each of whom is concerned about the outcome

which depends upon the joint actions of everyone. The purpose of this section is not to provide an exhaustive account of game–theoretic concepts but rather to give a selective summary of the main themes which have been applied to macroeconomic policy. (For useful introductions to and advanced treatments of, game theory, see Michael Bacharach 1976; Tamer Basar and Geert Olsder 1982; James Friedman 1977.)

A game consists of a set of agents or players, a set of actions or strategies and a utility or payoff function for each player.[5] The overall game environment may be described in terms of a number of characteristics.

Games may be either cooperative or non–cooperative. By cooperative, one means a game in which players are able to commit themselves to binding agreements before executing their strategies; in non–cooperative games, the opportunity for precommitment is absent and players have unrestricted discretion in choosing their strategies. The distinction between commitment and discretion is an important one and has occupied much attention in the monetary policy literature. It defines the constraints within which policy makers must operate when formulating their optimal policies and indicates the influence of the institutional structure in an economy on the credibility of monetary policy. Moreover, monetary policy games fall within the class of nonzero sum games in which cooperation can actually improve the payoffs of all players so that the existence of non–cooperative behaviour must reflect factors which inhibit cooperation, the most obvious being the lack of binding commitments. (These types of games are to be distinguished from zero sum games which are games of pure conflict, there being no incentives to cooperate because one player's gain from this is another player's loss.[6])

Another important factor in characterizing a game is the time dimension. Single stage or one–shot games are played only once so that neither past nor future confrontations between players influence their current behaviour. In many cases, these types of games are far too simple (and implausible) for modelling convincingly the strategic interactions between players. Repeated games or supergames, however, consist of a repeated play of the one–shot game in which each player's choice of strategy is a function of the past behaviour of others so that all

5. The description of the game here is in normal form. An extensive form game involves move–by–move decisions which can be reduced to a normal form in which a player moves only once in terms of choosing a strategy.

6. Zero sum games are, of course, a special case of constant sum games.

players must take into account the future consequences of their current actions. At least in the context of monetary policy, this is a more natural characterization of the strategic environment in which policy makers operate and has received a great deal of attention in the literature. This literature has also considered the generalization which makes the game stochastic, involving random elements and the dependence of players' utilities on exogenous shocks.

In all of these cases, the outcome of the game depends crucially upon the information structure conditioning players' perceptions about the environment and the strategies to be played by opponents. In a full information game, each player knows the current state of the environment, as well as the motives and constraints facing his rivals, and is, therefore, able to predict accurately what strategies these rivals will play. Games involving uncertainty, however, conceive of players as being (at least partially) ignorant of the objectives of rivals or as having incomplete information about contemporaneous exogenous shocks. It will be argued below that the most interesting issues raised by the literature on monetary policy credibility (which are also the objects of most speculation) have arisen in the context of strategic decision making under uncertainty and the notion that policy makers are engaged in an informational game (as opposed to just a policy game).

Important concepts to note concerning strategic behaviour are as follows. At the simplest level, strategies may be 'memory–less' by which is meant that current actions are independent of the history of the game. Typically, however, one would conceive of players as formulating their current strategies on the basis of observations on the past actions of others. This type of strategic behaviour is relevant for repeated games (alluded to above) and introduces inter–temporal links into an otherwise static model. As will become evident later, strategies involving memory may operate as threats, providing rewards and penalties to rivals for behaving in a particular way. A further important distinction is between pure and mixed (or randomizing) strategies. The former are strategies which are chosen with certainty whilst the latter are probabilistic. In the case of a mixed strategy, a player is faced with a set of alternative actions, each of which has a particular probability of being chosen. The motivation

for choosing a mixed strategy arises in games characterized by uncertainty where players have an incentive to conceal or misrepresent private information. As indicated above, this issue will figure prominently in the following discussion.

Each player in a game must choose a strategy which maximizes his own payoff subject to the 'rules of the game'. These 'rules of the game' may take many forms, some of which have been identified above, and are essential for determining the solution or equilibrium of a game which requires specifying how each player perceives the strategies of other players and how each player perceives the influence of his own choice of strategy on the strategies chosen by others. In terms of non–cooperative games, two further concepts worth noting are as follows.

A non–cooperative Nash game assumes equal status for all players, each of whom chooses his strategy treating as parametric the strategies of others. In a Nash equilibrium, to be elaborated upon below, each player's action is optimal regardless of others' actions. In contrast to this, a non–cooperative Stackelberg game possesses a definite hierarchical structure in the sense that some players (leaders) have the potential to impose their policies on others (followers). In choosing his best strategy, therefore, a leader will take into account the reaction function of followers which describe their optimal response to any given action to be undertaken by the leader. An equilibrium in this case relies on the ability to precommit to announced strategies. This is because of an incentive for a leader to improve his own payoff by reneging (cheating) on his promised action, an indication that the optimal policy in Stackelberg games is dynamically inconsistent. In the absence of binding commitments, since this incentive structure is understood by all players, the logical outcome is a reversion to a Nash equilibrium in which leaders relinquish their dominant role. This line of reasoning plays an important part in understanding the consequences of a non–credible anti–inflationary policy to be examined below.

Implicit in the foregoing discussion were certain requirements that a solution of a game must satisfy. At a minimum, an equilibrium requires that each player understands, and behaves according to, the 'rules of the game', that each player chooses a strategy which is feasible and that each player's perceptions about the strategies of other players are consistent with the actual strategies chosen by these players. In the absence of precommitment, the relevant equilibrium concept is the Nash equilibrium defined by the property that the strategy of each player, which is taken as given by other players, is actually optimal for that player and vice versa.[7] The attractiveness of this equilibrium concept lies in the fact that it ensures that optimal policies are time consistent, there being no incentives for any player to depart from his planned course of action.

Unfortunately, a unique equilibrium may not always exist. Indeed, a general criticism of game theory is that it often gives an embarrassment of riches, a problem which has been inherited by the monetary policy literature where, it will be argued later, the problem is especially acute. Much research has been devoted to searching for additional conditions which limit the number of possible solutions. One strong concept of equilibrium which has been used extensively is that of subgame perfection or perfect equilibrium (David Kreps and Robert Wilson 1982a; Reinhard Selten 1975). A perfect Nash equilibrium has the property that the optimal strategy for each and every player is his equilibrium strategy regardless of the previous strategies played by others. Subgame perfection, therefore, is relevant for repeated games and ensures that the equilibrium conditions are satisfied in every stage of the game. In fact, subgame perfection is sufficient (though not necessary) for time consistency and much of the literature on monetary policy credibility can be viewed as seeking a unique perfect equilibrium. What is especially important about this concept is that it reduces the multiplicity of solutions by focusing on only those equilibria which can be credibly expected to occur. In other words, it rules out equilibria which rely on non–credible threats.

7. Formally, let n=1,...,N denote a player, u^n denote the payoff to player n and s^n denote the strategy chosen by player n from the set of all possible strategies, S (i.e., $s^n \in S \; \forall n = 1,...,N$). Each player's payoff is a function of the strategies of all players, $u^n(s^1,...,s^N) \; \forall n = 1,...,N$. A Nash equilibrium is defined by the N–tuple $(s^{1*},...,s^{N*})$ such that $u^n(s^{1*},...,s^{n-1*},s^{n*},s^{n+1*},...,s^{N*}) \geq u^n(s^{1*},...,s^{n-1*},s^n,s^{n+1*},...,s^{N*})$ $\forall s^n \in S \; \forall n = 1,...,N$.

Having reviewed some important concepts of game theory, it is now appropriate to consider the analogy which has been drawn between strategic decision making and macroeconomic policy design. Traditional macroeconomics viewed optimal policy design as a game against nature. The new body of research models explicitly the interactions between centralized policy makers and intelligent private economic agents. To be more specific, it is common to regard players who are followers as individually weak, numerous and dispersed and to consider dominant players as large and powerful. Put this way, the interpretation of strategic decision making in macroeconomic policy involves a leader–follower game of two players—a dominant centralized policy making body and a private sector consisting of many spatially separated atomistic agents, each of whom, being aware of his own relative insignificance and having no perceptible influence on the actions of others, takes as given the behaviour of other participants in the game (including that of policy makers).

This view has some merit—in fact, it is almost taken for granted in the literature—but it is as well to point out here some possible objections.

The issue of most concern, perhaps, is the notion of a single well–defined strategy on the part of many atomistic agents who are precluded from acting collusively. This is to ignore disparities within the private sector, including economic, social and political factors, information sets and institutional constraints. In the presence of these, the problem of anticipating the actions of both policy makers and other individuals is non–trivial and the aggregation or convergence implicit in the existing literature is overly simplistic. This conclusion is strengthened when considering some of the more complex game structures that have been envisaged and which require the same high degree of sophistication on the part of every agent. These arguments, which provide ample scope for further research, are rarely addressed in the current research which, as indicated above (and as will be seen shortly) subsumes the multitude of private individual decisions into a single well–defined action on the part of what appears to be a monolithic private sector.[8]

8. To some extent, attempts have been made to pre–empt these sorts of comments by modelling the policy game as one between policy makers and a well–organised labour force (i.e., a large trade union). It will be argued later, however, that the interpretation of the credibility problem in this approach is often quite different from that which occupies the majority of the literature and that the empirical relevance of this approach is rather weak.

Another, related, source of controversy centres on the modelling of centralized policy making. One argument here is that private agents typically exert a much stronger influence upon economic policy than that which appears to be allowed under the strict leader–follower interpretation. Monetary and fiscal policies are not immune to business fluctuations but typically respond (often in a systematic way) to changes in the economic environment. After all this is just what optimal control theory predicts about optimal economic policies.[9] This argument, however, reflects a misconception of what is (and what is not) implied by the strategic assumptions adopted by the recent literature. There is nothing inconsistent with viewing economic policy as responding to aggregate private sector behaviour and, at the same time, assuming that, individually, each agent regards his own behaviour as immaterial to policy decisions. The strategic view of policy making in no way precludes a feedback from private behaviour to economic policy; what it does assume is that atomistic agents regard this feedback as being invariant with respect to their own individualistic decisions and, therefore, treat it as parametric when making these decisions. This is succinctly illustrated in that part of the broader literature on macroeconomic policy games which adopts a general dynamic optimal control framework for modeling the game aspects of optimal policy design (Willem Buiter 1980,1981; Daniel Cohen and Phillipe Michel 1985a,b; Currie and Paul Levine 1986; Marcus Miller and Mark Salmon 1984).[10]

A final point worth noting also centres on the modeling of centralized policy making. The issue here, however, is whether one should consider policy making as being under the auspices of a unified centralized policy making body (i.e., a single policy maker) having a single well–defined objective function or whether it should be viewed in terms of the interactions between separate independent policy making units, each of which has its own objectives which need not coincide with the objectives of others. Virtually all of the existing literature adopts the former approach and, therefore, eschews many important issues which arise in what might be termed the 'deep structure' of the centralized policy making process. Only recently have these issues been addressed explicitly, leading to considerations such as

9. In the language of optimal control theory, closed loop (feedback or contingent) policies are superior to open loop (non–contingent) policies in stochastic systems because they permit a response to new information about the state of the economy.

10. A review of this literature is given in Blackburn (1987). This argument is not to rule out entirely the possibility that private agents may play a more dominant role in economic policy making. Trade union games (see n. 8) imply precisely this possibility and there may also be circumstances under which an overwhelming shift of opinion at least alters the strategic relationships in the economy. But the approach taken in the majority of the literature cannot be criticized as being internally inconsistent or incompatible with observed responses of macroeconomic policy to private sector fluctuations.

intra–policy making gaming, the precise nature of policy makers' objectives, the relationship between these and private preferences and the institutional and political influences upon economic policy. All of these will be discussed at greater length later after the main characteristics and themes of the majority of the literature have been elicited.

2. A Model of Monetary Policy

The central theme of the recent research on monetary policy games is the output and employment costs of a disinflationary programme and the design of monetary policy to minimize these costs. Almost without exception, this literature exploits the simplistic elegance of a model originally formulated by Kydland and Prescott (1977) and developed further by Robert Barro and David Gordon (1983a,b). This model has been advanced as a useful framework for understanding persistent and recurrent episodes of inflation and monetary expansion, and for yielding important new insights which would only be obscured in more complicated models.

All versions of this model revolve around two key relationships: a utility function describing the preferences of a single centralized policy maker; and an aggregate supply function for output describing the constraint imposed by the structure of the economy. These relationships are summarized respectively as follows:

$$u_t = f(\Pi_t - \Pi^*) + g(x_t - x^*) \qquad (1)$$

$$x_t = x_n + \alpha(\Pi_t - \Pi_t^e) \qquad (2)$$

where Π_t is the actual rate of inflation, Π_t^e is the private sector's expected rate of inflation, x_t is aggregate output, x_n is the (exogenously given) natural rate of output and Π^* and x^* are the policy maker's desired values for inflation and output respectively. The terms $f(\cdot)$ and $g(\cdot)$ are functions with properties defined below and α is a positive constant. Time is measured discretely and is indexed by t=0,...,T with the time horizon assumed to be either finite or infinite depending upon the structure of the game. The important restrictions on preferences

are $f'(\cdot)$, $g'(\cdot) \gtreqless 0$ as $(\cdot) \lesseqgtr 0$, $f''(\cdot)$, $g''(\cdot) < 0$ and $f(0) = g(0) = 0$. Some authors have specialized the utility function further in ways which, together with other modifications of the model, will be mentioned when relevant at the appropriate juncture.

The first term in (1) represents the inflation objectives of the policy maker, reflecting rising costs associated with deviations of actual inflation from some target value. The costs of inflation are not always obvious, though several plausible candidates have been advanced. These include the administrative costs of posting new prices, the costs of economizing on money balances (i.e., 'shoe–leather' effects), the costs of modifying the tax structure to be inflation neutral and, more generally, the distributional consequences of inflation in the absence of full indexation (Barro and Gordon 1983a,b; Fischer and Franco Modigliani 1978; John Moore 1984). The motivation for a positive desired rate of inflation is less well–explained and some authors have preferred to set $\Pi^* = 0$. In cases where $\Pi^* > 0$, it is possible to find some rather off–handish remarks about the optimal rate of taxation on cash balances but where this rate comes from and what determines it are considerations which are brushed aside.

The most important element in (1) is the second term, representing the policy maker's output (or employment) objectives. Similar to the above, deviations of output from a target value are assumed to yield disutility but the reasons for this are more fully articulated here. The basic assumption is that various labour market distortions exist which impart an upward bias to the natural rate of unemployment (translated into a downward bias to potential output). These distortions are usually alleged to arise from the existence of taxes and transfers (in particular, income taxation and unemployment compensation), but could also reflect the presence of trade unions or minimum wage laws which prevent voluntary decisions over work and leisure (Barro and Gordon 1983a,b; Matthew Canzoneri 1985).[11] From the point of view of the policy maker, the resulting natural rates of output and employment are regarded (for reasons discussed below) as being too low. This ties down the policy maker's desired level of

11. The distinction between the source of externalities is not necessarily innocuous for some of the wider issues raised by credibility, taken up later.

output to a rather more precise expression, $x^* = kx_n$ where $k \geq 1$ is some constant. The crucial assumption is that $k > 1$, implying that some distortions are perceived to exist.

Some authors have generalized the model slightly by allowing the natural rate of output to be stochastic. Others have presented a simplified characterization of the above arguments by assuming that the policy maker merely desires more output per se, having no well–defined target value. (This is captured formally by setting $x^* = x_n$ and restricting $g(\cdot)$ to be linear, in which case $g'(\cdot) > 0$, $g''(\cdot) = 0$ and $g(0) = 0$.) Whichever formulation is adopted usually depends upon analytical convenience—a rather disturbing feature given the extreme simplicity of the model in the first place! The important element in both cases is the policy maker's dissatisfaction with the level of output that would prevail at the natural rate.

Given the preferences described above, the basic problem confronting the policy maker is how to raise output to its desired level (or at least above its potential level). The mechanism involved relies on the second key ingredient of the model summarized by the Phillips curve relationship in (2). According to this, unanticipated inflation has temporary positive effects on the distribution of output around its natural rate. This is consistent with two very different interpretations: a market clearing–price misperceptions model in which private agents, located in spatially separated markets and endowed with only incomplete information, confuse relative and aggregate price movements (Barro 1976; Robert Lucas 1972, 1975); and a model of long–term nominal wage contracts which are drawn up prior to the realization of inflation with employment determined ex post along labour's marginal productivity curve (Fischer 1977; Taylor 1979, 1980). The choice between these two alternative views has been largely a matter of personal preference, though some authors have indicated certain differences in their implications.[12] Nevertheless, by focusing on only one stylized relationship in which the two views are observationally equivalent, the model is too schematic to reveal any major differences between them. The central assumption is that the policy maker has scope to influence output by engineering inflationary surprises. The precise way in which these surprises are administered will be discussed shortly.

12. Clearly, the equilibrium approach does not fit in well with the notion of labour market distortions being created by powerful trade unions whilst a well–organized labour force might seem quite appropriate for a model of wage contracting.

An important assumption implicit in (2) is that the Phillips curve slope coefficient, α, is constant. This contradicts the conventional wisdom that this coefficient is non–invariant with respect to fluctuations in inflation. In rational expectations equilibrium models, this arises from a 'signal–extraction' problem which makes α a function of the variances of market–specific and economy–wide (aggregate nominal) disturbances. More generally, one would conceive of α as responding systematically to the incentives for private agents to re–contract and re–negotiate transactions in the face of inflation volatility. Either way, the impact of (unanticipated) inflation on output depends upon α which, in turn, depends upon the inflation process itself. By assuming that α is constant, the model assumes away this important element in the inflationary transmission mechanisms and exaggerates the potential for the policy maker to influence output by inflicting inflationary surprises.[13]

Consider now the determination of actual and expected rates of inflation in this model. It is assumed that Π_t is the choice (strategic) variable of the policy maker. This is clearly a heroic assumption but, for the most part, serves as a useful abstraction. It is also weakly justified by envisaging some monetary instrument which can be chosen to engineer a particular rate of inflation. In later versions of the model, this assumption is relaxed and implications drawn for the case in which inflation is only imperfectly controllable.

Of more concern is the interpretation of Π_t^e as the choice variable of the private sector. It is tempting to think of Π_t^e as a strategic variable but this is seriously misguided. Private sector behaviour in this model is to be understood in terms of a (rational) expectations formation mechanism. Each agent, having the same information as all other agents, having the same preferences as all other agents and treating as given the behaviour of all other agents, will employ a forecasting rule which is the same for all other agents. This requires no concerted action among individuals; rather, anyone who sets expectations differently will only be punishing himself. Notice, therefore, that this eschews all of the issues raised earlier in connection with intra–private sector behaviour. (It is also worth bearing in mind for future consideration that, in many cases, this approach admits the possibility of more than one

13. The assumption could be justified on the grounds of analytical tractibility and that it would be possible, at least in principle, to allow α to vary. It is essential, however, that some trade–off exists for the policy maker to perceive an opportunity to influence output. It may also be noted here that some authors have argued more generally about the benefits from unexpected inflation—specifically, the revenue from inflationary finance and the deflation of nominally denominated public debt which reduce the need for distortionary taxation. It is true to say, however, that these are treated as being of second–order importance to the output and employment effects of surprise inflation. Writing (2) explicitly also makes clear the questionable assumption that the output–inflation trade–off is policy invariant.

expected inflation rate consistent with rationality and, therefore, raises a question of how a decentralized economy happens to coordinate upon one particular equilibrium of a game.)

Whilst actual and expected rates of inflation reflect the different decisions made by the policy maker and private agents, it is important to appreciate that, in an equilibrium, they cannot be chosen independently. After all, Π_t^e is a rational expectation of Π_t so that, whilst $\Pi_t \neq \Pi_t^e$ is entirely possible (under uncertainty), Π_t^e must always be the best guess of Π_t conditional on available information. At the same time, any attempts by the policy maker to systematically manipulate both Π_t and Π_t^e independently (e.g., by making false promises about Π_t) will be ultimately self–defeating. The general point is, of course, one of the central tenets of rational expectations (and game) theory—namely that, in an equilibrium, Π_t and Π_t^e must be consistent, given the information set of each player.

The general decision problem confronting the policy maker may now be stated as follows. Substituting (1) into (2) and using $x^* = kx_n$ from above gives

$$u_t = f(\Pi_t - \Pi^*) + g(\alpha(\Pi_t - \Pi_t^e) - z) \qquad (3)$$

where $z = (k-1)x_n$. The planning horizon of the policy maker is t=0,...,T and the objective function is assumed to be a time–separable utility function derived from an expected discounted sum of the instantaneous utility functions in (3). The decision problem is

$$\max_{\{\Pi_t\}_{t=0}^{T}} \; v = E\{\sum_{t=0}^{T} (1+r)^{-t} u_t\} \qquad (4)$$

subject to the 'rules of the game', where r is a discount rate and $E\{\cdot\}$ is the conditional expectations operator. Many of these 'rules of the game' have been outlined in section II.1. An especially important factor worth bearing in mind for future consideration is the constraint that might be imposed by future inflationary expectations. (Whilst there is no obvious reason for the policy maker to have a positive rate of time preference, it is usual in the literature to make this assumption which is re.t ained here for the sake of generality. It will become apparent how some of the results are strengthened if one relaxes this assumption.)

Before ending this section, it is worthwhile reflecting further on two important aspects of the model.

The first of these is the model's extremely rudimentary nature, lacking any structural dynamics and hanging on a skeleton system of two stylized relationships. This is in sharp contrast to the models found in the public finance literature on time inconsistency and credibility where fiscal policy and private sector behaviour are more fully articulated (Fischer 1980; Brian Hillier and James Malcomson 1984; Kydland and Prescott 1980; Lucas and Nancy Stokey 1983; Mats Persson, Torsten Persson and Lars Svensson 1987; Stephen Turnovsky and William Brock 1980). It also contrasts with the recent research (alluded to earlier) on the application of optimal control and game theory to macroeconomic policy design in general dynamic economic systems. In many cases, however, the simplicity of the model has proved to be a positive advantage. It has made it possible to study a wide variety of game scenarios which would only raise severe technical problems in more complicated dynamic models requiring the less–developed apparatus of dynamic game theory. The attractiveness of this model lies precisely in its brevity, its apparent plausibility and its capacity to generate powerful results. Nevertheless, this simplistic elegance remains a rich source of criticism and often makes the model inappropriate for addressing some of the wider issues of credibility.

The second aspect worth mentioning concerns the interpretation of the role of the policy maker in the model. Some authors have tried to link the preferences in (1) with private preferences, casting the policy maker as a benevolent planner whose sole objective is to maximize an aggregate social welfare function. Others have sought to identify (1) with the outcome of various political undercurrents in centralized policy making (elaborated upon later) which shape the final objectives of policy makers in such a way that they may reflect little about social welfare. This paper will indicate a number of reasons why the former interpretation—the social welfare approach—is difficult to sustain.

One obvious objection to this approach which may be noted here is that the model is simply not detailed enough to make it possible to draw conclusions about social welfare.

There is nothing in the model which indicates the preferences and constraints facing private agents. Any alleged relationship between (1) and social welfare is simply an allegation—and an unconvincing one at that unless an explicit characterization of private optimizing behaviour can show otherwise. Some authors have conjectured that private agents merely resist making forecast errors but this leaves unresolved the questions of where (2) comes from and why, if (1) is truly a measure of social welfare, does it not make allowance for the disutility associated with forecast errors (Cukierman 1985a).

Similarly, if the externalities in the labour market originate in distortionary taxes and transfers, the fiscal aspects of the model need to be spelled out in much more detail. At the moment, the important parameter k (determining the policy maker's desired level of output) is entirely arbitrary but this reflects decisions about public expenditures and taxes which the policy maker is also supposed to choose optimally to maximize social welfare. There is some scope here for synthesizing the literature on monetary policy with the similar research in the field of public finance and it is possible to view some recent contributions as responding to this challenge. A cursory glance at the model at this stage, however, should leave one in little doubt about the weak foundations upon which the social welfare interpretation rests. The alternative view of (1)—the political approach—appears to contain more substance and will be discussed at length later.[14]

III. STRATEGIC DECISION MAKING UNDER FULL INFORMATION

1. Credibility and Commitment in a Single Stage Game

The basic problem of credibility associated with an anti–inflationary policy is neatly illustrated by applying a one–shot non–cooperative game to the simple monetary model described in the previous section. Two important features of this game are, first, the assumption that all players (the policy maker and private agents) are fully informed about both the state of the environment and the objectives of others and, second, that the policy maker's decision problem in (4) reduces to piecewise optimization. The reasons for the latter are the

14. One might wish to obtain a flavour of this approach here by envisaging two competing groups—advocates of anti–inflation and advocates of economic stimulation—struggling to influence economic policy and shaping the objectives in (1) which represents a compromise between these groups. The fact that so much controversy surrounds the interpretations of (1) is symptotic of the existing literature's rather cavalier treatment of the motives of policy makers and their relationship to private objectives which will recur throughout the following discussion.

absence of any inter–temporal linkages in the model and the nature of the one–shot game itself: not only are actual and expected rates of inflation independent of history, but they are also unconstrained by the the future as well so that each one is free to be chosen separately each period. The importance of these features will become apparent shortly.

There are two possible solutions to the one–shot game, depending upon the assumption made about the policy maker's ability to precommit himself to announced policies. If such commitment is feasible, then common knowledge of this will mean that $\Pi_t^e = \Pi_t$ automatically which is treated as a constraint in the optimization problem. Maximizing (3) with respect to Π_t then yields $\Pi_t = \Pi^*$ with associated utility $u_t = u^* = g(-z)$. Inflation is at its target value and output is at its natural rate.

In the absence of precommitment, however, the policy maker is not bound by any announcement but has the discretion to choose any rate of inflation he so desires. For any given Π_t^e, the utility maximizing choice of Π_t follows generally as the reaction function $\Pi_t = h(\Pi_t^e)$ where $h'(\cdot) > 0$ and $h(0) > 0$. (This function also depends implicitly upon the policy maker's target variables, Π^* and z, and is increasing in both of these.[15]) The equilibrium of the game in this case is determined by the requirement that private sector perceptions about the policy maker's inflation policy be realised. In particular, since private agents know the objectives and constraints facing the policy maker, they also understand that $\Pi_t = h(\Pi_t^e)$ solves the policy maker's optimization problem. Hence, $\Pi_t^e = \Pi_t = h(\Pi_t^e)$ which determines some rate of inflation $\Pi_t = \hat{\Pi}$ and yields a utility $u_t = \hat{u} = f(\hat{\Pi} - \Pi^*) + g(-z)$. Compared to the precommitment equilibrium, the important features to note are $\hat{\Pi} > \Pi^*$ and $\hat{u} < u^*$.

The basic insight of this analysis is that, in the absence of precommitment, the economy is thrown into an inferior Nash (or discretionary) equilibrium characterized by an inflationary bias with output still at its natural rate. The intuition underlying this is as follows. When the policy maker has unrestricted discretion, there is always an opportunity to fool private agents by inflicting inflationary surprises. The incentive to do this lies in the policy maker's preference for raising output above its natural rate. Rational agents, however,

15. For the case in which $g(\cdot)$ is linear, the optimal value of Π_t is independent of Π_t^e and equal to some constant depending upon the parameters in the utility function.

understand this incentive and take it into account when forming their inflationary expectations. As these expectations rise, so too must actual inflation and so too does the marginal disutility of inflation. When $\Pi_t^e = \hat{\Pi}$ there is no incentive to inflict surprises and the economy is stuck at the natural rate with excessive inflation.

This is an example of the time inconsistency problem introduced in section I. Whilst $\Pi_t = \Pi^*$ is optimal ex ante, it is not optimal ex post and consequently lacks credibility if the policy maker is free to re–optimize. The only sustainable equilibrium—the Nash equilibrium—is when policy announcements are ignored and the scope for engineering surprises is neutralized. One may be tempted to infer from this that the problem of time inconsistency is overstated: either the incentive to defect from the ex ante policy is irrelevant (under commitment) or else this policy does not solve the policy maker's optimization problem (under discretion). Both of these arguments, however, are incomplete. Even if formal restrictions on the policy maker's freedom are feasible, there is still the important question of what form these restrictions take. Several possibilities are discussed below. Similarly, in the absence of commitment, there may exist more informal incentive schemes which motivate the policy maker not to act opportunistically. This idea is explored in the next section.

An obvious resolution of the credibility problem is to change the rules or institutional structure within an economy in order to constrain the freedom of the policy maker to alter his decisions. Taylor (1983) conjectures that society has already found ways of doing this in many circumstances in the form of explicit legislation.[16] It is not clear, however, how one could devise similar schemes for tying the hands of a monetary authority which would be equally successful. One possibility that has been advanced is to legislate a fixed rule for monetary policy (e.g., a k% growth rule) but this may do more harm than good if it also restricts the scope for useful stabilization policy. (This idea is returned to in the context of stochastic games.) In addition, the fact that such legislation is not observed in actual economies seems to be an unequivocal indictment of its undesirability or impracticality.

16. A popularly cited example is the case of patent laws to protect the incentives for innovation, research and development.

A more general constraint on policy making might follow from some external commitment (e.g., a gold standard or fixed exchange rate regime) which imposes a discipline on policy makers and limits the scope for discretionary increases in inflation.[17] There is some evidence (discussed later) that this has played a major part in ensuring the credibility and success of past programmes aimed at eliminating hyperinflations (and some current inflations as well). Unfortunately, however, recent experience generally suggests that national policy makers are reluctant to surrender their sovereignty to the requirements of a fixed exchange rate regime and there is no reason to believe that this will change in the foreseeable future.

Failing any formal constitutional restrictions or external constraints on policy makers, there may still be scope to influence anti–inflationary monetary policy (and the credibility of this) in other ways. These proposals take the form of changing the institutional structure of centralized policy making in such a way that influences the objectives in (1). The issues that arise here are many and varied and will receive more attention later but the basic point can be stated simply as follows: if the source of a credibility problem lies in the natural propensity of democratically elected governments to resort to inflation, then private sector scepticism about an alleged commitment to an anti–inflationary monetary policy could be quelled by charging responsibility for monetary policy to an independent apolitical authority. Many of the arguments for central bank independence appeal to this line of reasoning and the proposal by Rogoff (1985) to appoint conservative policy makers –policy makers with a strong anti–inflationary bias– is also most appropriately seen within this context. What this does, of course, is to alter the parameters in the utility function (1) such that greater weight is attached to inflation prevention and less weight attached to economic stimulation. There is some evidence (discussed below) that inflation rates do tend to be lower on average in economies where the central bank has a greater degree of autonomy. As above, however, such schemes might also create a rigidity in monetary policy which weakens its stabilization properties.[18]

To the extent that the above proposals are aimed at influencing the objectives in (1), there can be little pretence that this reflects a well–defined social welfare function.

17. The problems raised by pursuing independent domestic monetary and exchange rate policies are illustrated succinctly in the recent literature on speculative currency attacks (Robert Flood and Peter Garber 1984; Maurice Obstfeld 1986a,b).

18. A greater degree of independence may also make a tighter monetary policy less credible if this conflicts with the implications of fiscal policy. This is discussed in some detail later.

Indeed, the idea put forward by Rogoff (1985) is that society can make itself better off by appointing a policy maker who places a greater weight on inflation prevention than itself does. This particular result, however, is unconvincing because it still relies on an arbitrary specification of society's preferences. To emphasize the general point made earlier, any attempt to use this type of model for welfare comparisons is objectionable on the grounds that the more primitive analytical objects of choice behaviour—individual preferences, budget sets and endowments—are simply not spelled out. This gives rise to several other difficulties which the social welfare approach must deal with here.

The first of these is rather subtle and concerns the idea that social welfare is actually improved when private agents are fooled. To put it in its starkest terms, suppose that the policy maker maximizes the utility of a representative individual. Under such circumstances, the notion of a problem of time inconsistency may appear rather vacuous—after all, the representative agent could merely plead ignorant and allow the benevolent policy maker to cheat him for his own good! The argument is really much deeper, however, because this view implies that the agent somehow ignores relevant information—and when this information is taken into account, he finds himself in the position of being worse off.[19]

A second issue concerns the idea that, if (1) is truly a measure of social welfare, the inflation and output objectives should reflect the preferences of private agents which are currently shrouded in mystery. In particular, any resistance to being fooled on the part of private agents should be incorporated explicitly into the social welfare function, in which case the inflationary bias in the economy might be eliminated altogether (Cukierman 1985b).

A final point worth bearing in mind is that all of the discussion so far rests on the crucial assumption made previously that $k > 1$ in the expression $x^* = kx_n$. If $k = 1$, the policy maker's target value for output is the natural rate. Since there are no gains from inflicting surprises, there is no time inconsistency problem and, therefore, no inflationary bias in the economy. This raises a much broader aspect to the credibility problem concerning ways of influencing the natural rate itself in order to avoid conflict with the policy maker's objectives.

19. Analyses of time inconsistency based on representative agent models include Guillermo Calvo (1978), Fischer (1980), Hillier and Malcomson (1984) and Kydland and Prescott (1980). The above arguments might be objected to on the grounds that they contradict the principle of methodological individualism (i.e., each agent prefers that others make forecast errors but this gives him no incentive to do so himself). But the point of contention arises in models for which a strategy of reneging unambiguously maximizes the utility of each and every agent. Everyone may know that the policy maker intends to renege but, if this improves their utility, they would be foolish to neutralize this policy by reverting to their Nash equilibrium behaviour.

Given that $k > 1$ reflects labour market distortions, the appropriate policy will depend upon the source of these distortions: in the case of taxes and transfers, fiscal reform is called for; in the case of trade unions, labour legislation is required. This is not necessarily an objection to the social welfare approach, though to the extent that the inflationary bias originates from an inappropriate fiscal policy, this approach is certainly incomplete. Needless to say, unless otherwise stated, it is implicitly assumed in the remainder of the paper that $k > 1$.

Suppose now that a suitable re–structuring of the institutional framework for binding a policy maker to his promises is not feasible. The question which naturally arises is whether there exists more informal incentive mechanisms which may substitute for formal commitments. The following section examines this possibility.

2. Repeated Games and Reputation

The credibility problem in anti–inflationary monetary policy, identified above, is an irrevocable consequence of a one–shot full information non–cooperative hierarchical game without precommitment. Important recent work, however, has borrowed themes developed by Friedman (1971) and explored the implications of a game which is repeated (i.e., a supergame). It will be recalled from section II.1 that an important ingredient of a repeated game is that strategic behaviour involves 'memory' which makes the piecewise optimization used previously no longer applicable. An equilibrium is now sustained by reputational forces operating through threat strategies which punish a rival for bad behaviour. By considering only credible threats—threats announced ex ante which are optimal to execute ex post—the reputational equilibrium also satisfies the conditions of subgame perfection. Above all, a well–known folk theorem states that the cooperative (precommitment) equilibrium of a one–shot game can be sustained as a non–cooperative Nash equilibrium in a repeated game provided that the rate of discount is not 'too high'.

A simple 'tit–for–tat' rule that one might envisage is that each player treats others as he would like to be treated himself and responds to bad behaviour on the part of others in a

likewise manner. This simple idea (appropriately interpreted) can be incorporated into a repeated monetary policy game by specifying a trigger mechanism describing how private sector inflationary expectations are revised (rationally) in response to the actual inflationary strategy played by the policy maker (Barro and Gordon 1983a,b; Rogoff 1987). One such trigger mechanism might be the following: private agents hold down their current inflationary expectations ($\Pi^e_t = \Pi^*$) if actual inflation has been held down previously ($\Pi_{t-1} = \Pi^*$) and raise their inflationary expectations ($\Pi^e_t > \Pi^*$) if actual inflation has been raised ($\Pi_{t-1} > \Pi^*$). What this means is that the policy maker must take account of the future consequences of his current actions—in particular, he must weigh up the current gains from cheating with the subsequent loss of reputation reflected in higher expected inflation.

Whether such incentive schemes are successful in preventing the policy maker from cheating depends upon the severity of the punishment that they inflict. This is determined by both the absolute value of the penalty and the length of time over which the penalty is incurred. As indicated above, there is also a more general factor which influences the success of these schemes—namely the policy maker's rate of time preference. The reason for this is simply that the penalty for cheating is incurred in the future and matters less, therefore, if the future is more heavily discounted.

The notion that private agents might be able to coerce a policy maker to behave obediently is an important insight, offering some consolation to those who fear the strategic advantages that a centralized policy maker might have in the absence of binding commitments. Moreover, this does not rely upon any collaboration among private agents, which is precluded in this model (and in the non–cooperative game) by assumption. In fact, the notion of a threat, with its tacit requirement of coalitions, is rather misleading and a more appropriate concept is that of temptation which entertains the idea that the incentive (temptation) for a player to cheat induces others to adopt a safe position (Friedman 1971). In the present context, this merely amounts to private agents losing faith in the policy maker's anti–inflationary commitment and the problem may be seen more in terms of deterring, than

punishing, policy maker disobedience.

Unfortunately, there are many types of trigger mechanisms which are equally successful and there is no particular reason for choosing one in preference to another.[20] This problem of multiple equilibria, inherited from game theory, may be regarded as being especially acute in the case of monetary policy games. There is an important unresolved question in this literature of how a decentralized economy, comprising many atomistic agents who are precluded from acting collusively, happens to coordinate upon one particular equilibrium. At the moment, this is left to chance and the conclusions of the literature rest upon an arbitrary choice of outcome which appears to be the result of a fluke.

Another (and possibly more) serious criticism of these types of games (including the one–shot game as well) lies in the assumption of full information. This necessitates the assumption of an infinite horizon in order to avoid the 'chain store paradox'—a situation in which the game unravels backwards and the discretionary equilibrium obtains for all periods (Selten 1978).[21] This may not be too objectionable, however, since policy makers will usually have a vested interest in the legacy that they leave either to themselves or to their successors after their current term of office has expired.

A more important criticism of the full information assumption is the constraint that it imposes upon the interpretation of the concepts of credibility and reputation. In short, this assumption makes the game quite trivial because the preferences (and, therefore,the dominant strategies) of players are known so that there is little or no scope for the policy maker to manipulate private sector expectations (and the economy is effectively stuck with a vertical Phillips curve). What one typically has in mind when considering credibility and reputation is the potential for a policy maker to lead private sector beliefs astray and manouver them into a position which can eventually be exploited. This idea draws attention to the informational characteristics of a game and strategic decision making under uncertainty. As will be seen shortly, such considerations have undoubtedly yielded the major insights (as well as the major points of controversy) in the recent credibility literature, focusing on informational games (as

20. For example, Barro and Gordon (1983b) consider the following mechanism: agents expect low inflation currently ($\Pi^e_t = \Pi^*$) if expectations were correct last period ($\Pi^e_{t-1} = \Pi_{t-1}$) and raise expectations ($\Pi^e_t = \hat{\Pi}$) in the event that expectational errors occurred ($\Pi^e_{t-1} \neq \Pi_{t-1}$). Rogoff (1987) gives several other examples in an extended discussion of repeated monetary policy games.

21. This occurs because, in a finite horizon game, the policy maker will always raise inflation in the final period, having no incentive to invest further in goodwill. Rational agents, however, understand this and raise their inflationary expectations also. This motivates the policy maker to seek gains by inflating in the penultimate period. But inflationary expectations will then be raised in this period as well and so on and so forth until the upshot is the inferior single stage Nash equilibrium in all periods.

opposed to just policy games) in which there may exist strong incentives for players to conceal or misrepresent private information. The basic message of this research is the crucial role of the information structure in determining the equilibrium properties of a monetary policy game.[22]

IV. DECEPTION, SECRECY AND THE ROLE OF PRIVATE INFORMATION

1. Intrinsic Uncertainty

In discussing the informational aspects of strategic decision making, it is convenient to distinguish between two types of uncertainty. The first—intrinsic uncertainty—concerns players' ignorance about the characteristics (usually preferences) of other players in the game and is considered immediately below. The second—extrinsic uncertainty—focuses on imperfect information about stochastic shocks impinging upon the game environment and is treated in the next section. For the most part, this distinction is an accurate reflection of the current state of the literature. The two types of uncertainty are not, however, necessarily mutually exclusive and a later discussion in the paper addresses some recent contributions which blend them together.

Monetary models incorporating intrinsic uncertainty borrow heavily from the work of Kreps and Wilson (1982a,b) and Paul Milgrom and John Roberts (1982a,b) on sequential equilibria in repeated games and optimal (Bayesian) learning. As indicated above, the central assumption is that players have only imperfect information about the character of rivals (usually interpreted as the characteristics of rivals' utility functions). The main implication of this is the potential for those with superior information to conceal their identity for some time in order to build up a reputation and induce a set of beliefs on the part of others which can be exploited at a later date. It will be recalled from section II.1 that such behaviour might involve randomization or mixed strategies (i.e., strategies which are chosen probabilistically rather than with certainty). The risk facing ignorant players, therefore, is the possibility that they are playing against a wolf in sheep's clothing, a possibility which may be either confirmed

22. These issues have recently been explored in the context of international monetary policy by Blackburn (1988a,b).

or refuted by watching the behaviour of this animal as the game unfolds.

Consider now the following scenario in monetary policy (David Backus and John Driffill 1985a; Barro 1986). There are two types of policy maker who differ according to their inflationary intentions—a type–1 (hard or strong) who always holds inflation down ($\Pi_t = \Pi^*$, say) and a type–2 (soft or weak) who is tempted to create surprise inflation ($\Pi_t > \Pi^*$, say). Private agents know that the policy maker may be either of these types but they are ignorant of which type they are actually facing. Under such circumstances, there is an incentive for a type–2 to masquerade as a type–1. The reason is that, since only a type–2 has a preference for engineering surprises, observation of high inflation immediately blows his disguise and the discretionary equilibrium obtains for the rest of the game. By posing as a type–1 and playing low inflation, however, a type–2 is able to hold down inflationary expectations until such time when it pays to raise inflation. The problem confronting private agents, therefore, is to extract information about the identity of a policy maker from observations of actual inflation which may reflect the dissembling actions of an imposter.

Credibility (or reputation) is now understood to be a well–defined (time–dependent) state variable, measuring the private sector's subjective probabilistic belief that the policy maker is a type–1 and being updated according to an optimal learning rule.[23] The resulting (perfect) equilibrium of this type of game is in sharp contrast to those considered previously, admitting the possibility of fluctuations in inflation and output which depend upon several important factors (notably, the time horizon, the rate of discount and the stock of reputation). A typical description of these events is as follows. For some period at the beginning of the game, a sufficiently good reputation induces a type–2 policy maker to hold down inflation, mimicking the precommitment equilibrium with no change in reputation. At some juncture, this policy maker becomes indifferent between masquerading as a type–1 and raising inflation, yielding a period of randomization in which there is a probability of choosing either low or high inflation, inflationary expectations are raised and the economy experiences a recession if actual inflation is held down. Finally, as the end of the game approaches, the type–2 policy

23. More formally, if p_t = prob(type–1|$\Pi_{t-i} = \Pi^*$; i=1,...,t) so that $1-p_t$ = prob(type–2|$\Pi_{t-i} = \Pi^*$; i = 1,...,t) and q_t = prob($\Pi_t = \Pi^*$|type–2) so that $1-q_t$ = prob($\Pi_t > \Pi^*$|type–2), then prob($\Pi_t = \Pi^*|\Pi_{t-i} = \Pi^*$; i=1,...,t) = $p_t + (1-p_t)q_t$ and p_t is revised according to Bayes' rule, $p_{t+1} = p_t/(p_t + (1-p_t)q_t)$.

maker raises inflation with certainty, in which case reputation is blown and the discretionary equilibrium obtains thereafter.

It is difficult to over–emphasize the major step forward in understanding and analysing problems of credibility that this framework represents. Apart from rationalising an equilibrium involving periods of high and low inflation (and unemployment), it makes a bold attempt at formalising the concept of reputation, its evolution over time and the way it influences policy behaviour, as well as marking the beginnings of a new body of research concerned with secrecy in centralized policy making. In spite of all this, however, it is susceptible to a number of objections, some of which remain unresolved.

One obvious drawback of this type of framework lies in the fact that the equilibrium properties of the game depend critically upon a particular initial set of private sector beliefs. These priors have a major influence on the evolution of players' actions but where they come from and what determines them are questions which remain unanswered.

More important, however, is the assumption of a discrete number of policy maker types (i.e., two) which is responsible for two other unappealing features: the first is that it is impossible for a policy maker to re–capture a lost reputation; the second is that the (type–2) policy maker chooses a randomizing strategy for determining his inflation policy. The former of these appears too extreme since private agents are surely willing to forgive (or forget) at least one misdemeanor on the part of the policy maker (and probably more). The latter is simply inconceivable since it implies that centralized policy making is nothing more than a collection of chance events: consider a policy maker tossing a coin and picking either a low or high inflationary policy depending upon whether the coin turns up heads or tails!

It is possible that some of these problems are specific to the precise modeling strategy employed and could (at least partly) be resolved by some appropriate re–specification.[24] A more general objection to this framework, however, is that credibility problems start to bite only towards the end of a policy maker's lifetime and do not confront a new, untested policy maker. But it is possible to argue that credibility is really a teething problem which could be

24. Rogoff (1987), using a model in which there is a continuum of policy maker types (distinguished according to the cost incurred by each upon breaking a commitment), has recently derived an equilibrium in pure strategies with broadly the same characteristics as those described above.

eliminated by establishing a reputation. This links in with the fact that, at the moment, there is no escaping the considerable costs that a high inflation (type–2) policy maker imposes on the economy. This is true, even though the possible presence of a low inflation type (type–1) disciplines a type–2 (by motivating him to imitate a type–1) and, more importantly, even if the policy maker actually turns out to be a type–1 (a case of bad reputation carrying over to the innocent). Whatever the circumstances, private agents are burdened with a prolonged period of uncertainty which may see the economy stuck in a protracted recession.[25]

All of this indicates a strong incentive for a low inflation policy maker to eliminate this uncertainty as soon as possible by signalling his true identity, an idea which has recently been explored by Driffill (1987) and John Vickers (1986) who show that, in general, the ability of a policy maker to reveal private information about his character through his inflationary policy depends upon the extent to which the preferences of different policy maker types diverge. This means that the economy may be characterized by either of two types of equilibrium. The first—a separating equilibrium—involves the low inflation policy maker successfully revealing his identity. This is achieved by setting a sufficiently low rate of inflation which a type–2 never finds profitable to mimic so that observation of this inflation rate is a sure sign of a type–1. Under such circumstances, the economy experiences an early recession in return for future certainty and and a costless low inflation equilibrium. The second type of equilibrium—a pooling equilibrium— obtains when the low inflation policy maker is incapable of signalling his identity and private sector ignorance is sustained. This pooling equilibrium is, therefore, the relevant concept for the learning paradigm and turns out to be more likely for relatively dissimilar policy maker types. The reason is that a greater divergence between preferences implies greater potential gains for a type–2 policy maker if he can successfully mislead the private sector into believing he is a type–1. Hence, it is more difficult for a type–1 to select a rate of inflation which the imposter has no incentive to play also.[26]

25. Torben Andersen and Ole Risager (1987a,b) have recently considered a model in which private agents may attach a non–zero probability that a type–2 policy maker will start out by generating high inflation so that a recession may emerge at the beginning of a game and not just during the period of randomization.

26. It could also be argued that pooling is more likely as the time horizon increases since the more inflationary policy maker then has a greater incentive to mimic the lower inflationary policy maker early on in the game.

Signalling in monetary policy is an appealing notion but a policy maker could also indicate his character in many ways other than that described above (which allows the policy maker to signal only by the actual inflationary strategy that he follows). Deliberate confrontation with opponents can often be a powerful and more general means for demonstrating both views on particular issues as well as an overall attitude towards economic policy. Added to this might be a policy maker's stand and action on other matters which are symptomatic of his general disposition towards economic objectives. There may even be such an overwhelmingly obvious ideological commitment on the part of the policy maker that private agents can be left in little doubt about the implications for economic policy.[27]

One should also note that it makes a considerable difference as to how one interprets the distinction between different policy maker types. One view is that these policy makers have different utility functions which place different weights on inflation prevention versus economic stimulation or which involve different target values for inflation and output. Another view is that these policy makers differ according to the extent to which each is willing or able to commit himself. The signalling game described above makes sense only under the former interpretation since a policy maker who is committed to a particular inflation policy is, by definition, unable to manipulate inflation for the purposes of signalling.

The ability of a player to signal his own identity is usually only half of the incentive problems relating to information disclosure which underlie a game involving learning. For uncertainty to persist it must also be true that others in the game are unable to coerce this player into revealing his private information. The short answer to this in the case of monetary policy is that information disclosure is a matter which lies outside the sphere of influence of atomistic private agents. All that any single individual can do is to make informed guesses about the identity of a policy maker; the notion that this policy maker might somehow be unmasked by the collective action of agents is simply a moot point.

Yet this is not so easy to dismiss if one conceives of the private sector in terms of a well–organized labour force (as some authors have done). Under such circumstances, the

27. A case in point here is the Conservative government in the U.K.—one of the most strongly ideologically committed parties in recent British political history which should have sent a clear signal to the public about its anti–inflationary commitment. The fact that unemployment increased by almost unprecedented proportions, therefore, is some cause for concern and will be returned to later when considering the empirical evidence on credibility.

policy maker might well be forced to reveal his true colours by a more powerful strategy on the part of what now becomes a single rival (i.e., a large trade union for which inflationary expectations are understood to represent a nominal wage strategy). This intriguing idea invites comparison with principal–agent type problems in which one is seeking an equilibrium which is incentive compatible. The attractiveness of this concept is that it automatically precludes equilibria in which players can profit from misrepresenting private information and, therefore, focuses on mechanisms which are designed specifically to eliminate idiosyncrasies in the information structure.

The application of this to monetary policy can be found in Andersen (1987) and derives generally from the private sector's perception of its newly acquired power to influence the inflationary strategy of a policy maker through his reaction function, $\Pi_t = h(\Pi_t^e)$. The basic idea is that the private sector, faced with a potentially noisy announcement about a policy maker's preferences, chooses its inflationary expectations conditional on this announcement and the probability that it is misleading. By virtue of the reaction function, therefore, actual inflation becomes a function of the private sector's optimal response to any announcement which takes into account the incentives for a policy maker to misrepresent private information. In this way, it may be possible for the private sector to set expectations judiciously such that the actual inflationary strategy which is optimal for a policy maker is one which follows from a truthful announcement in the first place. As for the signalling game described above, whether private information is revealed will depend, in general, upon the degree of divergence between the preferences of policy maker types so that an equilibrium may be characterized by either separation (information disclosure) or pooling (sustained ignorance).[28]

It is worth emphasizing that all of this makes sense only if one is prepared to abandon the assumption of an atomistic private sector. But once this step is made, there is a danger of making quite arbitrary assumptions about which of two powerful players—the policy maker or the trade union—is more able to commit itself and which of them has superior information about their preferences. In most cases, the policy maker is assumed to retain a dominant role

28. The point is, perhaps, best illustrated with the aid of a specific example. Suppose that a type–2 policy maker has a higher inflation target than a type–1. By claiming to be a type–1 and holding down inflation expectations, a type–2 faces the prospect of greater output gains. At the same time, however, actual inflation moves further away from this policy maker's relatively high inflation target by virtue of the relationship $\Pi_t = h(\Pi^e_t)$. By an appropriate choice of Π^e_t, the private sector can make the 'inflation loss' outweigh the 'output gain' so that the type–2 has no incentive to claim to be a type–1 to begin with. Notice that, in contrast to the signalling game, separation is more likely here for relatively dissimilar policy maker types since the lower the inflation target of a type–1, the lower will be inflationary expectations if a type–2 claims to be a type–1 and the more easy it is to make the 'inflation loss' outweigh the 'output gain'.

and the source of a credibility problem lies in his inability to precommit (Blackburn and Christensen 1987; Henrik Horn and Torsten Persson 1985; Guido Tabellini 1986).[29] This might be justified by appealing to the existence of long–term nominal wage contracts—for then, the trade union must commit itself to a (possibly flexible) wage sequence conditional on the policy maker's announcement about his future inflationary strategy whilst the policy maker faces no such constraint on his discretion. If so, however, any attempt by the policy maker to act opportunistically would presumably be reflected not only in a change in private sector beliefs but also in a change in the structure of the wage agreement itself (Blackburn and Christensen 1987).

Conversely, in the event that neither player is bound by any commitment and both are unsure about whether the other will exploit this (two–sided uncertainty), a case of Stackelberg warfare or a 'game of chicken' develops in which each player constantly tests the nerve of its rival to continue investing in a reputation (Backus and Driffill 1985b). To the extent that this involves the trade union demonstrating its strength by setting high nominal wages, however, the problem of credibility focuses more on whether a policy maker will accommodate inflationary wage setting rather than on whether a policy maker intends to ride the Phillips curve.[30]

These few brief remarks should indicate how monetary policy games involving an atomistic private sector may require careful re–interpretation when this is replaced with the assumption of a well–organized labour force. It should be made quite clear, however, that the trade union approach can only have limited appeal. To be sure, whilst a well–organized labour force is a stylized feature of most industrialised countries—especially Western Europe, North America and Japan—what matters is the degree of centralized wage bargaining and, with the possible exception of Scandinavian countries, this is typically not very high. (In addition, less than fifty per–cent of the labour force is unionized in many countries.) Thus, the remainder of the paper continues to discuss monetary policy games against a backdrop of atomistic private agents.

29. These models adopt the monopoly union approach to wage determination in which the trade union chooses nominal wages and profit maximizing firms choose the level of employment. The maximand of the trade union is typically some arbitrary function of the real wage bill or deviations of real wages and employment from target values.

30. Though not explicitly stated, this analysis implicitly assumes a well–organised labour force since the action required by the private sector to maintain and improve its reputation does not conform to individual rationality.

2. Extrinsic Uncertainty

Extrinsic uncertainty—defined earlier as the case in which the economy is subject to potentially unobservable contemporaneous exogenous shocks—means that the policy maker and private agents are engaged in a stochastic game. As in the case of intrinsic uncertainty, idiosyncrasies in the information structure may motivate players to conceal private information but additional issues arise in a stochastic setting even when the policy maker's preferences are public knowledge. The main theme which has occupied attention is the design of optimal stabilization policy in a strategic environment.

One issue which re–emerges here is the proposal to appoint a conservative policy maker (i.e., a policy maker who has a strong dislike for inflation) as a means of alleviating the potential inflationary bias in an economy. The most persuasive case for flexibility in policy making, however, is that it gives scope for the policy maker to respond to unforeseen contingencies. This means that there is generally a trade–off between conservatism and flexibility in policy design (Rogoff 1985). The gain from conservatism is its (partial) substitution for commitment which ties down actual and expected rates of inflation to lower equilibrium values. The cost is that it imparts a degree of rigidity to monetary policy which prevents an effective response to exogenous shocks and weakens the capacity to stabilize the economy. In other words, there is something to be said for having a policy maker who is not 'too' conservative.[31]

Of more interest, however, are the issues which arise from the existence of informational asymmetries. It has been argued that a symmetric information structure makes the resolution of credibility problems—whether through informal incentive schemes or a more formal apparatus—overly simple (Canzoneri 1985). Given what has been said about problems of multiple equilibria and the difficulties of tying the hands of a centralized policy maker (together with the above remarks concerning the restrictions imposed upon stabilization policy), this position is probably too extreme. Nevertheless, there is some truth in the statement that the non–cooperative (discretionary) solution is more difficult to improve upon

31. Presumably, this also means that inflationary shocks would induce a more flexible response from a more conservative policy maker. The argument that a policy maker will respond insufficiently to exogenous shocks may be seen as one element of a more a general objection that such a policy maker may become over–preoccupied with his own objectives (e.g., the pursuit of intermediate monetary targets) at the expense of the ultimate goals of economic policy and the possibility that monetary policy will then be pushed either too far, too soon, or too little, too late. It might be possible to weaken the trade–off between conservatism and flexibility by appointing a policy maker who aims for low inflation only on average, allowing the actual rate to vary under certain circumstances.

when players have access to private information about the source of stochastic perturbation. The idea behind this is as follows.

Suppose, as before, that the policy maker chooses the rate of growth of the money supply to control the rate of inflation. Suppose also, however, that these two variables are no longer deterministically related owing to the presence of stochastic disturbances (e.g., random disturbances to money demand). Now make the crucial assumption that the policy maker has private information about these shocks. Then an immediate dilemma confronts private agents. The optimal monetary growth policy, μ_t say, is comprised of two components: a strategic (deterministic) element, μ_d, the value of which depends upon whether the policy maker is operating under commitment or discretion; and a stabilization (stochastic) element, μ_s,reflecting an optimal feedback on contemporaneous disturbances. Private agents observe only the joint signal, $\mu_t = \mu_d + \mu_s$, and this is an insufficient statistic to allow them to decompose a change in policy into its strategic and stabilization components. This implies the possibility for a policy maker to disguise a strategic ride on the Phillips curve as an optimal response to an exogenous shock—in particular, a policy maker is able to announce a forecast of this disturbance and make a cheating strategy observationally equivalent to the policy that would occur under precommitment. Under such circumstances, an apparent adherence to an announced policy is not verification of the policy maker's honesty since it is possible to exploit the ignorance of the private sector and publish spurious information.

The corollary of this, of course, is that even a policy maker who is truly averse to cheating may suffer from periodic bouts of pessimistic inflationary expectations if private agents misinterpret a genuine attempt at stabilization as an attempt to act opportunistically. Being aware of this, private agents would be foolish to adopt the simple trigger mechanisms outlined in section III.2 but rather must seek an alternative reputation–based resolution. Borrowing an idea of Edward Green and Robert Porter (1984), this might involve the private sector establishing confidence intervals for monetary policy, observations that lie outside of which trigger the feeling of opportunism. A judicious choice of confidence interval will

ensure that the policy maker has no incentive to raise inflation other than for stabilization purposes but, even though there is no cheating in the equilibrium, periodic forecast errors may still arise. This is an improvement upon the simple reputational equilibrium originally formulated by Barro and Gordon (1983b) which is 'too stable' in the sense that it never admits inflation fluctuations.

The issues raised above have some implications for the problems studied previously in the context of intrinsic uncertainty. Consider again the learning paradigm in which private agents, having no sure signal of a policy maker's identity, update their beliefs about whether the policy maker is a low inflationary type (type–1) or a high inflationary type (type–2). In the event that a control error drives a wedge between a policy maker's desired inflationary strategy and the actual rate of inflation which is realised, it is possible to conjecture that the reputational forces which discipline a type–2 to play low inflation are weakened. The reason is that this player is able to raise inflation without blowing his reputation since there is always a probability that the inflationary burst was the result of a control error on the part of a type–1 (Driffill 1987).

The problems raised in this section are germaine to the issue of credibility whenever a policy maker has an informational advantage about the stochastic properties of the economy and is free to act in a discretionary manner.[32] In spite of this, however, there is an important question concerning the plausibility of information asymmetries in this case. Even if one conceives of centralized policy makers as having quicker access to data than private agents (itself a questionable assumption), the fact remains that, sooner or later, private information about exogenous shocks will become publicly available, at which time private agents are able to figure out whether a past change in policy was the result of deviant behaviour. It seems that the significance of differential information here is likely to take on importance only towards the end of a planning horizon which gives less time for private information to be disseminated. To this extent, the issues that have been raised are probably more apparent than real.[33]

32. Andersen (1986) has examined the precise incentive problems relating to information disclosure in a stochastic setting in a similar spirit to the analysis outlined previously in the context of intrinsic uncertainty using incentive compatibility requirements (Andersen 1987).

33. It is worth noting that the existing models of extrinsic uncertainty assume an information lag for private agents on money stock data but this is typically minimal (e.g., barely over a week in the U.S.).

To conclude this discussion of monetary policy games under uncertainty, it is worthwhile reflecting a little more generally on some of the main themes that have emerged.

Most generally, one cannot escape the fact that the conclusions are extremely sensitive to apparently minor modifications in the information structure. One has the uneasy feeling that almost anything can happen—and invariably does—once the security of full information is departed from and, to this extent, the literature is still in a state of some flux. This is important, not least because it is precisely within the context of imperfect information that the most interesting issues arise and which seem to come closest to what one typically has in mind when considering problems of credibility and reputation.

Moreover, there is still a serious question to be raised over the generality of results obtained from a model which admits the derivation of analytical expressions but which is extremely (almost embarrassingly) simple. Additional assumptions (on top of the existing battery) are often required to avoid severe problems of tractability and one wonders just how much more the model can be stripped before it ceases to function as a useful characterization, and becomes a mere caricature, of monetary policy.

In defense of this recent body of research, one should appreciate that it is a far cry from the (even more simplistic) early generation of monetary policy games and that it has gone some way towards identifying the crucial role of the information structure in determining the properties of an equilibrium. The role of information in monetary policy has, of course, been recognized in the past but the recent game–theoretic approach offers a more precise formal framework for systematically investigating this thorny area within the context of explicit optimizing behaviour and strategic decision making. In doing so, it focuses attention on particular issues and lays bare the assumptions that one is (either implicitly or explicitly) making. The most important theme which recurs throughout is one that will continue to figure prominently in the discussion that follows—namely, the strong incentives for a better informed policy maker to conceal or misrepresent private information. This literature demonstrates vividly how a certain amount of ambiguity in monetary policy may arise from

maximizing behaviour and why private agents may have to devote a non–trivial amount of resources to scrutinizing the actions of centralized policy makers—what has been called 'Fed watching'. A framework which endogenises these costs would be a useful contribution to this research.

A final point worth noting is that the idea of there being more than one type of policy maker is surely the final nail in the social welfare advocates' coffin. Not only would this seem to imply the existence of more than one social welfare function, but (in the case of intrinsic uncertainty) it would also entertain the notion that the policy maker knows more about the social welfare function than do private agents. Together with the other criticisms raised earlier, the game aspects of monetary policy are more appropriately seen within a broader institutional and political context which is discussed below.

V. CENTRALIZED POLICY MAKING AND THE NEW POLITICS OF MONETARY POLICY

1. Monetary Independence and the Coordination of Monetary and Fiscal Policies

To this point, the discussion has followed virtually all of the literature on monetary policy games in the sense that the policy maker has been treated as a single entity—a sole authority charged with the responsibility for choosing monetary policy in order to maximize a single well–defined objective function. This section marks the beginnings of a more detailed inquiry into what might be termed the 'deep structure' of centralized policy making and argues that, in many cases, the foregoing characterization of monetary policy is neither plausible nor (more importantly) innocuous. The issues which arise often seem to be at the heart of the recent credibility literature but have largely been ignored by this and, in many ways, offer the most interesting avenues for further research.

The notion that any single institution or individual is predominantly responsible for steering an economy may be a convenient abstraction in some instances but seriously misleading in others. Public expenditures and the tax structure, which form the fiscal arm of

macroeconomic policy, will normally be under the close supervision of the democratically elected government but the other extremity—monetary policy—might be the responsibility of a quite separate authority. The degree of this monetary autonomy (or central bank independence) differs markedly across countries and has important implications for the conduct of monetary policy and the credibility of an overall anti–inflationary macroeconomic package.[34]

A commonly held view (alluded to in section III.1) is that a greater degree of central bank independence is conducive to a greater degree of credibility (and a lower equilibrium rate of inflation) because it weakens the leverage that a democratically elected government has on monetary policy for satisfying its natural thirst for economic stimulation. The ideas behind this, and the implications thereof, are discussed in some detail in the next section but it is worth commenting first on a very different view of the consequences of monetary autonomy. According to this, monetary independence fuels coordination problems with fiscal policy which make an overall macroeconomic programme less coherent and subject to greater speculation. In short, the credibility of monetary policy does not depend upon monetary policy alone but rather upon the macroeconomic programme in its entirety.

Once monetary and fiscal management are no longer regarded as being under the auspices of a single policy maker, there exists the real possibility of a struggle (a 'game of chicken' or Stackelberg warfare) between two powerful players—an independent central bank and a fiscal authority—over economic policy (Alan Blinder 1982; Mark Loewy 1983; Thomas Sargent 1986).[35] The fiscal authority, in setting expenditures and taxes, is responsible for the creation of public debt whilst the central bank, by choosing monetary policy (open market operations), determines the composition of this debt. The source of coordination (and credibility) problems lies in the interaction between these policy makers summarized by the government's budget constraint. In particular, the requirement that the government remains solvent over its lifetime (excluding the possibility of debt repudiation) imposes severe restrictions upon the viability of a non–inflationary financial policy.[36]

34. In a recent study of twelve industrialised countries, Michael Parkin and Robin Bade (1985) examine the degree of central bank independence according to three criteria: the relationship between the central bank and government in the formulation and conduct of monetary policy; the procedure for appointing and removing members on the central bank's policy board; and the financial and budgetary relationships between the central bank and government. On the basis of these, Japan, Switzerland, the U.S. and West Germany are identified as those countries with the highest degree of central bank independence and Australia, Belgium, Canada, France, Italy, the Netherlands, Sweden and the U.K. as those countries with the lowest degree of central bank independence.

35. This view is also illustrated vividly in two recent articles in *The Economist* (1987, vol. 1987, nos. 2525, 2527) on the division of control in macroeconomic policy in the U.S. and West Germany. Some of the issues that follow can also be found in Andersen and Friedrich Schneider (1986) and Tabellini (1985a,b, 1987).

36. Formally, the solvency condition is obtained by integrating the budget constraint forward in time such that the present value of real lifetime government expenditures plus initial net indebtedness is accounted for by the present value of real lifetime taxes, including the inflation tax, plus monetary base expansion. The problems raised in the following discussion have been neatly illustrated by John Bryant and Neil Wallace (1980) and Thomas Sargent and Wallace (1981).

To be sure about this , consider a financial policy designed to (at least partially) avert the inflationary pressures associated with the monetization of fiscal deficits. This policy involves the issue of interest–bearing government debt which stores up future outlays in the form of debt–servicing. To avoid (or reduce) any future monetization and, at the same time, ensure solvency, the government must eventually run an appropriate stream of budget surpluses. In the absence of such a fundamental fiscal correction, however, the solvency condition can only be satisfied by resorting to seigniorage. Rational agents who understand all of this, therefore, are sent clear signals about the inflationary consequences of debt–financing if there is no prospect of a future reversal in fiscal policy.

In the light of this, there are some clear implications of a game between independent monetary and fiscal authorities. Suppose that the central bank promises to pursue a tight money policy whilst the fiscal authority sets taxes and expenditures in such a way that implies a stream of large budget deficits. (The obvious conflict between these policies can be understood as reflecting a conflict in objectives between the monetary and fiscal authorities regarding inflation prevention and economic stimulation.[37]) By both playing tough and sticking to their respective policies, these policy makers create a composite macroeconomic programme which is not credible because it is simply not feasible. One of them has to 'give in' and it matters considerably for inflation which of them does so: if the monetary authority remains strong, concessions must be made on the fiscal side and the economy is kept under a tight monetary rein; if the fiscal authority remains strong, monetary policy must 'give way' and the economy is thrown into a financial regime of monetization. Such coordination problems generate uncertainty for private agents and invite speculation over how and when the conflict between policy makers will be resolved. They will figure extensively later on when considering the empirical evidence on credibility.

In anticipation of that discussion, however, it is worth mentioning here that similar problems may arise from sources quite apart from any strategic considerations. A lack of coherence in macroeconomic policy may reflect merely the technical difficulties associated

37. In particular, the central bank may have a relatively lower target rate of inflation or may assign a relatively higher (lower) weight to inflation prevention (economic stimulation). Some reasons for why this might be so are conjectured in the next section.

with coordinating the actions of different policy makers or even bad planning on the part of a single policy maker.[38] Whatever the reason, the important point is that an unforeseeable reversal in fiscal deficits renders any announced commitment to an anti–inflationary monetary policy susceptible to severe problems of credibility.

In considering fiscal policy explicitly, one should also note the potential that exists for improving the basic monetary model (described in section II.2) which has been used extensively in the credibility literature. It will be recalled that the source of credibility problems in this model lies in the existence of labour market distortions which motivates a policy maker to raise output above the natural rate by inflicting inflationary surprises. These distortions are taken as given but, to the extent that they arise from a particular tax and transfer structure, they can be influenced by fiscal policy.[39] Alberto Alesina and Tabellini (1985) have constructed a game–theoretic model of monetary and fiscal policy making in which inflation, public expenditures and the level of distortionary taxation are all determined simultaneously from the strategic interactions between divorced policy makers who possess conflicting objectives over inflation, employment and expenditures. The main insight is the ambiguity of the net benefits from central bank precommitment. The reason is that lower inflation reduces the revenue from inflationary finance and forces the fiscal authority to resort to a higher level of distortionary taxation. This may also be seen as another qualification to the argument for appointing a conservative monetary policy maker.

2. Monetary Politics

It has been hinted on several occasions up to this point that certain elements of the literature on monetary policy credibility may be interpreted in a way that imputes a strong political flavour to the objectives and constraints facing centralized policy makers. The notion that macroeconomic policy in general, and monetary policy in particular, may be influenced (at least to some extent) by the political process in democratic societies is, of course, by no means new. Traditional macroeconomics was quite specific about the incentives that exist for

38. See n. 35.

39. On the other hand, to the extent that the distortions reflect the presence of trade unions or minimum wage laws, they can be influenced by labour market legislation.

democratically elected governments to deliberately manipulate economic policy for electoral gains. The most well–articulated version of this was developed by William Nordhaus (1975) who showed that incumbent governments have a vested interest in creating cycles in the economy which are synchronized with the dates of election. This framework, and subsequent developments of it, rested on a set of highly questionable assumptions which amounted to a naive and implausible description of government and voter behaviour. Such criticisms were endorsed, and others revealed, when the theory—what might be termed the 'old politics of monetary policy'—was confronted with empirical evidence.[40]

To the extent that some of the research on credibility can be given a political interpretation and forms the basis of some recent inquiries which deal explicitly with the political fabric of monetary policy, there are the seeds of a new approach to monetary politics. One aspect of this addresses similar issues to those raised above but does so within a strategic context which is less susceptible to the problems associated with the traditional approach. One may, in fact, have already been tempted to interpret the reputational model involving learning (described in section IV.1) in precisely this way: defining the final period of the game as the date of an election, this model predicts that a (type–2) policy maker will raise inflation (in order to seek employment gains) towards this date, resembling the pre–election booms of electoral cycles. Consider, however, the following points which should convince one that this interpretation is seriously misguided.

Policy makers in the reputation building model do not inflate for electoral gains; on the contrary, they throw away their reputation by inflating. But politically motivated policy makers will surely have a vested interest in post–election events and the effect of their current behaviour on the opportunities available to themselves or their successors. Moreover, by truncating the game arbitrarily, one is ignoring the credibility issues which might naturally arise from the electoral process when the pre– and post–election decision problems confronting policy makers may be quite different. In addition, there is still no modelling of voter's preferences about alternative types of policy makers, how these may affect policy

40. The key assumptions were that the popularity of a government with the electorate is a function of a few key economic variables (usually inflation and employment), that the sole aim of a government is to seek re–election, that there is a short–run inflation–unemployment trade–off and that private agents (voters) are myopic. These assumptions imply that the government would maximize its popularity by following post–election restrictive (anti–inflationary) policies with a U–turn designed to reduce unemployment towards the date of the next election. The short–sightedness of the electorate ensured that they would not foresee the inevitable inflationary consequences of this policy.

choices and how they may be influenced by announced post–election programmes which will knowingly not be executed. Finally, for many democratic societies, it is simply not true that the timing of an election is a well–defined mandatory date; rather, incumbent administrations often have some discretion in choosing the date at which they wish to go to the country so that the final period of office becomes endogenous and uncertain.

Given that the issues raised above must (at least partly) be addressed if one is to model convincingly the role of the electoral process in monetary policy, they represent both a formidable and exciting challenge for future research. The raw beginnings of this may be seen in the recent contributions of Alesina (1987a,b), Alesina and Cukierman (1988), Alesina and Stephen Spear (1987), Alesina and Tabellini (1987) and Rogoff and Anne Silbert (1988). Whilst many of these are not directly concerned with monetary policy, some general points of interest are worth noting.

First and foremost, of course, is the assumption of rational voters who understand the electioneering incentives of democratically elected governments. Hence, any electoral cycles which occur must be interpreted quite differently from those in traditional models of political business cycles which rely on a gullible electorate.

Second, these traditional models rest on the assumption that the sole aim of political parties is to seek election, an irrevocable consequence of which is that the policies of different parties will converge towards the date of an election in an attempt to capture the median (floating) voters. In constrast to this, the new approach adopts a more plausible partisan view of economic policy, implying that different political parties have different preferences which reflect the opinions of a 'core' set of voters to which each party appeals.[41] This means that each party generally faces a trade–off between its most preferred (ideological) policy and the policy which maximizes its chances of election. It also implies that, if voters are perfectly informed about the objectives of different parties, any pre–electoral policy announcements other than those which reflect a party's true preferences will not be credible since, once in office, each party will knowingly choose its ideological policy. In short, each party is locked

41. Evidence to support the view that political parties differ according to the weights that each places on inflation and unemployment can be found in Alesina and Jeffrey Sachs (1988), Nathaniel Beck (1982a) and Thomas Havrilesky (1988). Forerunners of this 'ideology' model of the political business cycle are those of Olivier Blanchard (1985) and Minford and Peel (1982).

into its idelogical position and any policy convergence or electioneering behaviour must reflect factors not already accounted for.

One idea which has been explored here centres on the incentives that may exist for political parties to coordinate upon a common policy in order to eliminate electoral cycles arising from uncertainty about which party will be elected. Whilst each party has an incentive to unilaterally defect from this policy once elected, reputational mechanisms of the sort discussed in section III.2 (in this case, the threat of non–cooperation at the next election should the currently elected party choose to defect) might neutralize this incentive. Notice, therefore, that policy convergence here is a response to, not a cause of, electoral cycles.

Policy convergence may, however, arise from electioneering strategies if one admits the existence of intrinsic uncertainty. Thus, in the context of monetary policy, whilst voters may know that one party is anti–inflationary, they may be uncertain about the precise inflationary objectives of a rival party which could exploit this ignorance and move its policies closer to the former. This suggests once more that incentives may exist to conceal information about preferences, though these incentives now contain a distinct political flavour. Moreover, it has also been suggested that an incumbent government seeking to influence its popularity prior to an election may deliberately adopt an imprecise control technology for its policy instruments to make it more difficult for voters to identify its preferences from its actions. This idea will be returned to shortly in a slightly different context of political monetary policy.

In addition to the above, it is also possible to identify the beginnings of what might be another important research programme on a set of issues other than just the electioneering strategies of democratically elected governments. These issues are, in many respects, closer to some of those raised in the credibility and reputational models discussed previously and truly distinguish the 'new' from the 'old' politics of monetary policy.

The key ingredient of this research developed informally in the political science literature and elsewhere, is the view of monetary policy as the outcome of a process in which competing groups use their official authority (and, failing this, their economic and political

muscle) to influence central bank decision making (Beck 1982b; Jeremy Clifford 1965; Robert Hetzel 1985; John Woolley 1984). These groups–predominantly central bank officials, professional economic advisors, the financial community and representatives of the democratically elected government—typically have different preferences over a number of issues (in particular, inflation and unemployment) which are only partly reconciled by the existing power relationships between them. Conflicts of interest may arise from a number of sources, the most obvious, perhaps, being the distributional consequences of alternative policies, the degree of myopia in economic planning and the extent to which each group is accountable for its actions.

Thus, it has frequently been alleged that, among these groups, governments especially have a natural propensity to resort to monetary expansion. This may reflect the potential short–run electoral gains from economic stimulation, the incentives to reduce debt–service payments, the temptation to impose the (hidden) inflation tax and, to the extent that different members of society are affected differently by inflation and unemployment, the particular ideological position of the government. The relative importance of each of these factors is also likely to shift and may be a constant source of intra–governmental debate as well so that a government's disposition towards monetary policy is unlikely to remain unaltered.

In contrast to this, central bankers have typically been regarded as having a positive bias against monetary expansion and as willing to implement monetary policies tied to much longer–run considerations, even if these are politically costly for the government in the short–run. This may be due, in part, to a greater degree of objectivity on matters relating to economic policy associated with an apolitical institution. It may also reflect the natural desire for monetary stability and low inflation on the part of the financial community from which the central bank derives much of its power—a power which can be taken away quite easily should it behave irresponsibly. Whatever the reason, this conservative view of central bankers does have some empirical support. In a recent study of twelve industrialized countries, Parkin and Bade (1985) identify lower average rates of inflation in those countries (Japan, Switzerland,

the U.S. and West Germany) in which the central bank has a relatively high degree of autonomy than in those (Australia, Belgium, Canada, France, Italy, the Netherlands, Sweden and the U.K.) in which the central bank is more subservient to the central government.[42] To this extent, therefore, the aforementioned proposal to reduce the potential inflationary bias in an economy by establishing an independent monetary authority has some merit. (Given that fiscal policy is under the close supervision of the government and may be used as a substitute for monetary policy in economic stimulation, the above arguments can also be used to explain why independent monetary and fiscal authorities may adopt policies which generate the types of coordination problems discussed in the previous section.)

The main implication of the foregoing discussion (which is a representative snapshot of the considerable literature on the subject) is that the objectives of monetary policy are often likely to be in a state of some flux, reflecting a constant struggle between different groups in the centralized policy making process to impose their views on economic management. In particular, monetary policy decisions are to be seen in terms of a compromise between advocates of anti–inflation and economic stimulation, whose relative importance in shaping the final preferences of the central bank may shift repeatedly.[43]

This view of monetary policy is applicable whether one considers the central bank as merely a technical arm of the government or as a more independent monetary institution. Whilst a degree of monetary autonomy may well dilute the controversy over what is considered to be a tight or easy money policy, there is a large body of literature on the relationship between central banks and central governments which points out that monetary policy can never be completely divorced from governmental influence (Beck 1982b; Clifford 1965; Hetzel 1985; Robert Weintraub 1978; Woolley 1984). Most fundamental is that an autonomous central bank necessarily relies on the government for its autonomy: it is the government which establishes the central bank's independence in the first place and which can restructure (or abolish) it should it refuse to compromise its position (at least partly) on matters over which the government fundamentally disagrees. It follows that central banks which are

42. See n. 34.

43. At one extreme, one might conclude from this that the notion of any well–defined objective function for the monetary authority is simply vacuous and, therefore, the idea of an optimal monetary policy meaningless. This view emerges repeatedly in the 1978 *Official Committee Report on Policy Optimization* in the U.K. which emphasizes that governments, especially, frequently do not know exactly what they want and, even when they do know, are often reluctant to reveal their preferences.

deemed to be independent of governments must, nevertheless, be willing to make some concessions if they are to preserve their apparent autonomy.[44]

A consequence of all this is that (subject to some qualifications stated below) it is possible to rationalize more persuasively the notion of imperfectly understood monetary objectives on the part of private agents which has occupied a great deal of the previous discussion. But there is also a further implication—namely that it is quite possible now for a monetary authority itself to know its current preferences but to be ignorant about its future preferences because of the changing social, institutional and political environment in which it operates.

This intriguing idea has received formal treatment in a series of papers by Cukierman and Allan Meltzer (1986a,b,c) who model the arguments presented above in terms of a stochastic process for the parameters in the utility function (1)—specifically, a serially correlated process describing the evolution of the weight attached to inflation prevention versus economic stimulation. (Hence, this model may be seen as blending together both intrinsic and extrinsic uncertainty.) Whilst the central bank does not know its future preferences, it must attempt to predict these because of the effect of its current behaviour on future private sector inflationary expectations and, therefore, the constraints that face successive administrations. Private agents, in turn, are ignorant of the central bank's current objectives and draw inferences about them from observations of past inflation, inferences which are noisy because of the additional complication that inflation can be controlled only imperfectly and reflects both persistent shifts in the policy maker's preferences as well as transitory control errors. This also means that it is rational for private agents to adjust their inflationary expectations with some sluggishness in response to changes in actual inflation.[45]

The concept of credibility here is completely different from that offered earlier in connection with reputation building and learning (Backus and Driffill 1985a; Barro 1986). In the present context, credibility is understood to mean the speed with which private agents realise that a shift in the policy maker's preferences has taken place and is represented by a

44. There is, of course, a problem raised by the existence of independent policy makers over the blurring of the onus of responsibility for economic performance which may motivate each policy maker to devote considerable efforts to justify particular actions, to seeking praise when events turn out well and to denying responsibility when they do not. It has been suggested that central banks and democratically elected governments have already hit upon a mutually beneficial arrangement on these matters: in short, the central bank deliberately shields the government from blame by acting as scapegoat in return for its independence (Edward Kane 1980, 1982; Woolley 1984). Put this way, some authors have found it curious how one could justify monetary independence as being in the best interests of society without implying a rather distressing and debilitating distrust of the democratic system.

45. The original formulation of this model is in terms of monetary growth rates rather than inflation rates. Since there is still assumed to be a unique relationship between these variables, however, it is convenient to keep the discussion in line with the rest of the paper and consider the policy maker as choosing a planned rate of inflation.

parameter (as opposed to a state variable measuring the probability that the policy maker is of a particular type). Credibility is higher, the greater the precision of inflation control, in which case a disinflation policy is less costly if the policy maker has a tighter grip on policy instruments.

Moreover, as indicated earlier, the control technology need not be entirely exogenous and the precision of control may be seen as a matter of choice for the policy maker. Under such circumstances, a strong preference for economic stimulation will motivate the choice of a more noisy control procedure in order to delay private sector recognition of a change in preferences. In short, a certain amount of ambiguity about preferences may be beneficial because of the greater flexibility this gives in the timing of surprises. Hence, the motivation for adopting an imprecise control technology is quite diferrent here from that revealed above in connection with the electioneering strategies of political parties.

Several other results emerge from this analysis but the basic message is by now a familiar one—namely that policy makers have strong incentives to conceal private information about their objectives.[46] This confirms the suspicions held by many observers of central bank practice who have frequently pointed out the dissembling aspects of monetary management and the mystique and secrecy which constantly surround central banking (Keith Acheson and John Chant 1973; Karl Brunner 1981; Marvin Goodfriend 1986; Raymond Lombra and Michael Moran 1980; Richard Sayers 1957). The particular formalisation of these issues adopted above, however, does not rule out scope for further improvement.

Thus, in addition to the results already mentioned, the analysis also predicts that when policy makers become less concerned with inflation prevention (e.g., the 1960s and early 1970s), the sluggishness in expectations adjustment permits scope for monetary expansions to raise employment; conversely, periods characterized by conservative policy makers (e.g., the 1980s) are likely to exhibit overly pessimistic inflationary expectations and unemployment costs (and, presumably, a tightening of control procedures). But this is only one aspect of the story. Shifts in the preferences of centralized policy makers are often associated with shifts of

46. One other issue worth mentioning is the distinction which is made between average and marginal credibility. Considering the case in which inflationary expectations are conditioned, in part, by a (possibly noisy) announcement about the policy maker's future inflation target, average credibility is defined as the (absolute) difference between the announced and expected rates of inflation whilst marginal credibility is defined as the effect of a unit change in the announced inflation rate on expected inflation. It turns out that average (marginal) credibility is lower, the lower equiproportionally are the precision of inflation announcements and control, the lower is the variance of the policy maker's preferences and the lower (higher) is the degree of persistence in changes in preferences. Thus, a new inflation policy will not be immediately credible if announcements are very noisy and if control is very loose.

opinion in the academic community on the appropriate economic theory and corresponding changes in the operating procedures of monetary policy itself. Thus, the predominant concern with full employment objectives in the 1960s was accompanied by a characteristically neo–Keynesian flavour in macroeconomics and the use of interest rates as the primary monetary instrument. Compare this with the growing concern over inflation and a sustained momentum in the monetarist research programme throughout the 1970s which culminated in the widespread shift towards monetary targets in the 1980s (and the focus on bank reserves as the main control variable).

More important still, however, is the precise modelling of changes in preferences as a simple stochastic process which eschews considerations (addressed earlier) of what causes these changes in the first place. In doing so, it overlooks an important point—namely that shifts in the objectives of monetary policy are unlikely to arise from the influence exerted by any single individual or group in the policy making process but rather are likely to reflect an overwhelming shift of opinion among several of them (Woolley 1984). If this is the case, however, any swings in monetary objectives would surely be more evident to the public than the above analysis implies.

This leads to the related point that changes in preferences, far from being a purely exogenous source of economic fluctuations, will typically reflect changes in the economic environment and become endogenous themselves. Consider, again, the rising inflation during the 1970s which would have been a leading indicator of the subsequent shift towards anti–inflation objectives.

There is a clear indication here of the need to specify more fully the channels of influence upon monetary policy and the way in which these might interact to promote a level of secrecy in central banking which many commentators have frequently observed. To the extent that one conceives of a central bank as having a strong degree of autonomy, one particular line of inquiry which immediately suggests itself is the following.

It has already been argued why independence is not a guarantee of freedom from political pressure and why one would normally expect to find some governmental influence upon central bank decision making. But there is also another argument which states that an independent monetary authority will itself evolve into a political animal (Acheson and Chant 1972, 1973). In doing so, it will seek to develop an impenetrable set of rules, regulations and practices in monetary policy in order to protect itself from outside interference and to give itself the opportunity to publish selective pieces of information which magnify its successes and minimize its failures. This view of central banking lends itself naturally to a theory of bureaucracy in which the central bank is seen as being primarily concerned with its own self–esteem and self–preservation. These objectives are best served by securing immunity from critical investigation which invites the use of covert methods of operation and surrounding monetary management in a cloak of secrecy.

Central banks are, of course, often quick to respond to these charges by appealing to a number of arguments which purport to show secrecy in a favourable light. Many of these arguments (which are not gone into detail here) can be found in the enlightening discussion by Goodfriend (1986) on a law suit that was brought against the
Federal Reserve in 1975 for contravening the Freedom of Information Act! This also illustrates vividly that, however one interprets the origins of the secrecy and mystique surrounding central banking, the fact that they are evidently manufactured as an integral part of central bank operations suggests a pressing line of inquiry into their precise social benefits and costs. Depending upon the outcome of this, attention may then turn towards ways which make the dissembling activities of monetary authorities more or less visible. It is likely that the game–theoretic framework will remain instrumental in these ventures.

VI. EMPIRICAL EVIDENCE OF THE CREDIBILITY HYPOTHESIS

The preceding sections have sought to elicit in some detail the many issues which have been raised in the recent theoretical literature on monetary policy games. To date, there has

been very little empirical work in this area but if the models of credibility and reputation are to provide a useful addition to existing explanations of phenomena, they must be capable of giving 'better' explanations of the same phenomena or of giving explanations of previously unexplained events. This section applies some of the important concepts that have been developed above to selected historical episodes of inflationary management and reviews the first few econometric tests of the credibility hypothesis that have recently been attempted.

It is important, first, to be aware of some fundamental problems that immediately arise in attempting to identify the existence of credibility and reputation effects.

In addition to the usual problems created by expectations variables, there are other non–tangible concepts which raise new difficulties. One approach is to obtain some proxy for these variables (i.e., credibility and reputation), in which case any results are subject to the appropriateness of this proxy. Failing this, more indirect tests may be devised which are then more susceptible to differences in interpretation.

The theoretical literature also indicates that credibility is likely to be time–dependent, having both impact and subsequent effects. Lucas (1976) demonstrated the inherent instability of reduced form relationships under perceived changes in policy regime. If credibility also evolves over time, there is a real problem of ensuring an adequate data set which is capable of picking up the effects. These observations are related to the distinction made by Buiter and Miller (1983) between announcement effects—the immediate effects of an announced regime change—and result effects—the effects after proposed plans have been realised. The main implication of all this is that reputational factors are likely to be reflected in time–varying coefficients of an estimated relationship which must be distinguished from ordinary parameter instability.

Finally, the theoretical models, with their emphasis on stylization and analytical tractability, are far too schematic and simple to be of use in empirical work. They often concentrate on only a few economic variables (usually inflation and unemployment) but these

may not be the most suitable variables upon which to form empirical tests. Alternative frameworks which are capable of capturing the essential strategic features may be better but these may be far–removed from the first generation of credibility models, especially if the search for the best parsimonious representation is at the cost of economic (and game) theory.

Bearing these considerations, the few empirical studies and formal econometric investigations that have been conducted may be summarized as follows.

One main implication of the theoretical literature is that a credible disinflation policy should not be associated with large unemployment costs. In looking for credibility effects, therefore, one line of inquiry has focused upon the inflation–unemployment trade–offs experienced by countries in which an anti–inflationary programme has been in operation. Before discussing some contemporary evidence on this, it is important to be aware that, according to this criterion, certain historical episodes of hyperinflation already appear to offer strong support for the credibility hypothesis.

Sargent (1981) has documented the events leading up to and ending the severe inflations in Austria, Germany, Hungary and Poland in the 1920s. In each case, four important characteristics were evident: enormous and persistent monetized fiscal deficits which fuelled the inflation; drastic monetary and fiscal reforms which ended the inflation; a striking immediacy with which prices were stabilized; and a trivial effect upon unemployment in spite of this. The common programme of reform aimed at eliminating all of the hyperinflations hinged on three key ingredients (largely under the direction of the Council of the League of Nations): a return to the gold standard, a commitment by governments to balanced budgets and the establishment of independent central banks. The latter would monitor and supervise the progress of the deflationary package and would be legally obliged to refuse governments additional advances of unsecured credit. The theoretical justifications for each of these policies have been discussed previously. Collectively, they amounted to a well–coordinated battery of constraints on the freedom of governments to resort to inflationary finance and a coherent anti–inflationary macroeconomic programme.

These episodes of hyperinflation provide important lessons in the design of a credible disinflationary package and in interpreting some more recent experiences of both similar and less severe inflations. In fact, it is possible to argue that such hyperinflations offer the best raw material for examining the credibility hypothesis. A note of caution, however, needs to be injected here. It is also possible to argue that so spectacular are these episodes and so draconian must the deflationary measures be to end them that they have few implications for eliminating more moderate inflations. The basic idea behind this is that a severe inflation provides strong incentives for agents to re–contract and re–negotiate transactions which destroys the momentum in inflation and weakens its real effects. To the extent that such incentives are less evident under milder inflations, the problems of designing a costless anti–inflationary policy in these cases may be more real than apparent.

Recent empirical studies of inflation–unemployment trade–offs which focus explicitly upon the credibility issue have been performed for Denmark, the U.K. and the U.S. All of these countries experienced significant policy regime changes in the late 1970s or early 1980s which reflected a strong shift towards anti–inflationary objectives.

In Denmark, these changes were associated with the election of the Conservative government in 1982 which announced plans to reduce budget deficits, to influence centralized wage negotiations, and to fix the exchange rate. The most significant change was the latter—an announced targeting of the Danish kroner within E.M.S margins which was in sharp contrast to the repeated devaluations of the currency during the 1970s.

The 1979 election in the U.K. also returned a Conservative party to office against a backdrop of over a decade of stop–go U–turns in macroeconomic policy. This government made it clear that such policies would not continue and that a programme of monetary and fiscal reform (under flexible exchange rates) aimed at eliminating the inflationary legacy of the 1970s was to be implemented. The cornerstone of this was the Medium Term Financial Strategy—a gradualist plan involving the pre–announced tightening of monetary and fiscal policies.

A similar programme of monetary restraint characterized the deflationary package of the Republican administration in the U.S., also elected to office in 1979. Most evident was a general change in policy away from inflationary accommodation which had been evident for two decades previously. This was accompanied with what was seen as an important change in operating procedures—namely a shift from interest rate to money stock targets. This change in emphasis was seen, in part, as a deliberate attempt to gain public confidence in the planned monetary contractions and to endorse the administration's anti–inflationary commitment.

All of these programmes have, to a lesser or greater degree, certain elements in common–notably an alleged commitment to some nominal target, a relinquishment of discretionary interventionist powers, an alleged prudent financial policy and, above all, prior announcement of these policies. Especially in the U.K. and the U.S., the emphasis that was placed on the announcement effects of policies was unprecedented and indicated an overwhelming desire to break the 'inflation psychology' of the public.

At first glance, casual inspection of the data may leave one in little doubt that the above policies have not, in general, commanded credibility. With the possible exception of Denmark (where the Conservative government appears to have been quite successful in reducing inflation without any obvious increase in unemployment) deflation has been associated with considerable unemployment costs. Between 1979 and 1983, inflation fell from 13.4% to 4.6% in the U.K. and from 11.3% to 3.2% in the U.S.; at the same time, unemployment in the U.K. increased from 5.1% to 12.4% and, in the U.S., from 5.8% to 9.6%. From the perspective of the credibility and reputation framework, these events appear extremely odd, especially given the rhetoric which surrounded the anti–inflationary policies and the typically strong ideological commitment of governments in both countries. Either the credibility model is wrong or something fundamental was preventing the public from believing the anti–inflationary programme. It is possible to make a persuasive case for the latter view.

In spite of the frequently announced commitment to reducing money growth rates, both the U.K. and U.S. governments were running large budget deficits with little or no prospect of

a reversal in these. From the discussion in section V.1, this made the overall macroeconomic programme non–feasible. For the U.S., this has been interpreted as reflecting a struggle between the Federal Reserve and Congress over macroeconomic policy which can be likened to the 'game of chicken' alluded to previously. For the U.K., however, this interpretation is unconvincing because the Bank of England is, in no way, an independent monetary institution. Rather, one is led to the disappointing conclusion that the coordination problems in this case were the result of nothing more than bad planning. In both cases, the point is that the prospect of high fiscal deficits into the indefinite future and the anticipation of future monetization would have been sufficient to prevent inflationary expectations falling.[47]

Snapshot empiricism cannot, of course, give the complete picture, especially in the case of something as subtle as credibility. As indicated earlier, however, there are very few formal (econometric) tests of the credibility hypothesis and those that have been performed are rather weak. Rather than attempting to offer any detailed technical guidance in this area, the following discussion concentrates on the results and drawbacks of these existing studies in order that the current state of the literature is clearly understood.

The most commonly used technique in testing for credibility effects is the prediction error method. When applied to the Phillips curve, the relevant hypothesis is that a credibility effect can be sustained if an estimated Phillips curve for one policy regime over–predicts the rate of inflation for a subsequent policy regime which has lower actual inflation (i.e., there are negative forecast residuals). The logic of this is that the estimated relationship does not take account of the regime change and, therefore, ignores the effect this has on expectations. Blanchard (1984) for the U.S., Christensen (1987a) for Denmark and Jonathan Slow (1987) for the UK obtain mixed results here indicating, at best, muted evidence in favour of a belated credibility effect. Similar conclusions are found when the test is applied to the term structure of interest rates (Blanchard 1984; Slow 1987), whilst more favourable results appear in Christensen (1987b) who derives a reduced term interest rate equation from a simple macroeconomic model.

47. There is also another persuasive argument for the U.K. The large budget deficits were being financed by the issue of non–indexed debt paying extraordinarily high nominal interest rates. Hence, if actual inflation fell, the government would face an enormous increase in the real value of the burden of this debt and, therefore, was seen to have strong incentives to default by raising inflation.

The generally poor quality of these results can be attributed to two sources – the particular models to which the test is applied and the nature of the test itself.

On the first of these problems, it is possible to argue that relationships such as the Phillips curve, including as they do variables which typically adjust only sluggishly, are not well–suited for testing the forward–looking aspects of rational forecasting which are endemic to the credibility hypothesis. A change in inflationary expectations due to an announced change in future policy may be reflected in actual inflation only after some time and the data may be incapable of picking this up. A more appropriate approach would be to focus on variables which are inherently forward–looking (non–predetermined), being free to respond to (both actual and perceived) changes in the environment and unconstrained by institutional rigidities. Asset prices seem to fit this criteria which leads to the tests based on interest rate equations.

The problem with the term structure model is that the results are extremely difficult to interpret because of the ambiguous effect of tight money and low inflationary expectations on long–term nominal interest rates. Given that a long rate is written as a weighted average of current and expected future short rates, the upward pressure on the long rate, arising from the effect of tight money on the current short rate, may be swamped by the expectation of lower future inflation and lower future short rates. This is more likely as prices become more flexible so that any conclusions regarding the existence of credibility effects must pre–suppose something about the degree of price strickness. This problem is avoided in the approach adopted by Christensen (1987b) since all three elements in the Danish regime change (exchange rate stability, lower budget deficits and incomes policy) would, if credible, reduce nominal interest rates unambiguously. This study offers the strongest support for the credibility hypothesis.

Turning to the second of the above drawbacks, all of these investigations suffer from the same general problem associated with the prediction error method – namely that it hinges on a rather tenuous comparison between two distinct policy regimes. One aspect of this is that

the test is only as good as one's confidence in the equation estimated to the data for the earlier regime. Another is that any observed errors may explain almost anything not modelled explicitly within the regression model. Only in the case where the systematic behaviour of these errors is due solely to the missing 'credibility variable' will this method be suitable for testing credibility. In view of this, it is clearly important that other indirect tests are developed which are less susceptible to problems of interpretation.

On more direct tests of the credibility hypothesis, only two fully articulated attempts have been made. In both cases, a variable representing credibility is defined explicitly, though the methodological approach in each is quite different.

Christensen (1988) takes up the point raised above that the prediction error method merely subsumes credibility into an error term. By decomposing a specific form for the error process into a 'credibility variable' and a residual, however, a more direct test of credibility is proposed for Denmark. This 'credibility variable' is measured as the variation of the exchange rate around E.M.S. margins and turns out to be significant (up to three lags) for explaining interest rate variations.

The most ambitious approach to date, however, is by Marianne Baxter (1984) who adopts a framework which is important in two main respects: first, it is used to examine some contemporary hyperinflations in Latin American countries–specifically, Argentina and Chile (as opposed to the relatively moderate inflations in western Europe and North America); and second, it is closest to the spirit of the theoretical models of credibility and reputation.

The severe inflations experienced by Argentina and Chile towards the late 1970s reflected large fiscal deficits financed by monetization. In each case, a programme of reform was announced which consisted of monetary and fiscal tightening and, most important, a crawling peg which implied successive decreasing rates of devaluation of the exchange rate. To examine the credibility of these programmes, an explicit Bayesian approach is used in which credibility is defined as the public's subjective probabilistic belief that a given policy regime change has been maintained. The results of the analysis are quite clear: the policy

reform in Chile was a partial success whilst that in Argentina was an unmitigated failure.

These seemingly paradoxical results can be explained by two facts. The first was the series of unscheduled devaluations in Argentina which was not evident in Chile. The second was the monetary–fiscal mix in Argentina which, in contrast to that in Chile, implied an explosive path for the real value of interest–bearing government debt unless the government resorted to monetization. Taken together, it is hardly surprising that the Argentinean citizens would have had little confidence in their government's commitment to the policy reform.

It is tempting to regard the foregoing empirical evidence on credibility as a rather damning critique of the prolific theoretical literature. There are, however, some grounds for a less pessimistic view.

It is true that the evidence to date does not offer any overwhelming support for the hypothesis but this empirical literature is very much in its infancy, feeling its way into an area which is fraught with substantive technical and conceptual problems. The first tests have been successful in identifying some of these difficulties and a closer inspection of the evidence reveals a strikingly consistent pattern which is compatible with some important predictions of the theoretical literature. What appears to emerge (regardless of the severity of the inflation) is a fairly clear dichotomy between those countries (Austria, Hungary, Germany and Poland in the past and Chile and Denmark more recently) for which there is strongest evidence of a credibility effect and those countries (Argentina, the U.K. and the U.S.) for which the evidence is much weaker. The distinguishing hallmarks of the former group were a rigid adherence to some form of managed exchange rate and a coherence between monetary and fiscal policies which pre–empted any speculation about the future monetization of budget deficits. Confirmation of these findings for other countries and other episodes is beyond the scope of this paper and is left as an important area for further research.

Another important line of inquiry would be to test the time inconsistency hypothesis which is intimately related to the credibility hypothesis. One method might be to expand upon the research noted earlier regarding the evidence of a systematic inflationary bias in those

countries where the central bank is more subservient to the central government. Another might be to investigate whether policy makers actually formulate their decisions in a way which is sufficiently sophisticated to enable them to realize that the natural rate of output is too low. More generally, the empirical research to date has focused on only one aspect of the game–theoretic literature (i.e., the credibility of anti–inflationary policies) but many other issues have been raised which require equal attention. On top of all this must be the search for more definitive tests of the game–theoretic approach and a sensitivity analysis to check the robustness of any results which may be forthcoming.

VII. CONCLUDING REMARKS

Most industrialized countries have been plagued by recurrent episodes of inflation and unemployment. Many commentators have found it curious why those in charge of monetary policy should have allowed this to happen, given that they have at least a partial (and, in many cases, a strong) influence over both the impulse source and propagation mechanism of economic fluctuations. A new body of literature which envisages monetary policy as a game between centralized policy makers and intelligent private agents has offered a new set of explanations and, in doing so, has focused attention upon other interesting and important issues. The implications of this literature appear far–reaching and take on added significance upon realising that they are germaine to economic policy design in general.

At first glance, the problem of credibility may appear over–stated. Part of the literature emphasizes that formal constitutional restrictions upon policy maker's actions are unnecessary since informal reputational mechanisms are likely to do the trick. This conclusion is, however, premature, especially in an uncertain environment where idiosyncrasies in the information structure seem to be capable of sustaining almost any result. One important message of the literature is that the properties of an equilibrium are extremely sensitive to apparently minor modifications of the information structure, a conclusion which merits much further consideration (especially along the lines suggested below). A major cause for concern here is

over the multiplicity of solutions that exist and the problem of how a decentralized economy coordinates upon one particular solution.

A general criticism of the literature is that it consistently adopts a rather ad hoc macroeconomic model and preference technology. These are useful to the extent that they allow precise analytical expressions to be derived, even for fairly complex game structures, and reveal vividly the main issues without having to wade through unnecessary complications. As indicated throughout this paper, however, there is a serious question to be raised over the extent to which these stylized paradigms either merely characterize, or overly caricature, what a stripped–down macroeconomic model might look like. There is a strong case for arguing that the existing literature would benefit considerably from further research devoted to developing firmer microeconomic foundations, specifying individual's preferences and budget sets more carefully and exploring the relationship between the objectives of policy makers and private agents.

To the extent that a political undercurrent to the literature can be detected, there are the seeds of a new formal research programme into the issue of monetary politics. This seems to be an especially interesting venture, not least because it is already making more precise some of the arguments that have been developed informally elsewhere. It is also within this context that the secrecy and mystique which frequently surround monetary policy are most appropriately interpreted. Needless to say, however, the potential rewards from further research in this area appear enormous. Above all, the channels of influence on centralized decision making and the way in which these interact to constantly shape the objectives and conduct of monetary policy need to be spelled out in much greater detail.

The area which offers the greatest scope for future research is undoubtedly empirical. The results to date are at most suggestive, rather than conclusive, evidence of some sort of credibility and reputational influences being operative. The few studies that have been conducted have already identified some important technical and conceptual problems which must be resolved if the quantitative significance of credibility and reputation effects are to be

measured and the relative importance of these for practical policy making are to be made clear. Since it is unlikely that any definitive tests of credibility and reputation will be forthcoming in the near future, one must maintain a rather eclectic position and reserve judgment on results until their robustness has been verified. One eagerly awaits the day when it is possible to be more confident about the extent to which strategic interactions have played a role in determining observed economic phenomena. Perhaps then one will have a better idea about the extent to which these games merit applause from a critical spectator audience.

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