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DISCUSSION PAPERS

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Juha Tarkka – David Mayes

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31.12.1999

The Value of Publishing Official Central Bank Forecasts

SUOMEN PANKIN KESKUSTELUALOITTEITA • FINLANDS BANKS DISKUSSIONSUNDERLAG

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Abstract

The aim of the present analysis is to shed light on the question whether Central Banks should publish their macroeconomic forecasts, and what could possibly be gained in monetary policy if they did so. We show that disclosing the Central Bank's assessment of the prevailing inflationary pressures in the form of a forecast improves macroeconomic performance even if this assessment is imprecise. This is because it makes policy more predictable. We are also interested in finding out the useful content of the forecasts, if published, and answering the question whether it makes a difference if these official forecasts are "unconditional" in the sense of incorporating the Central Bank's forecasts of its own policy as well, or "conditional" on some other policy assumption. Possible conditional alternatives may include assuming unchanged instruments, however specified, or assuming the kind of policy that the private sector is estimated to expect. The analysis comes out in favour of publishing unconditional forecasts, which reveal the intended results of monetary policy. A discussion of some practical issues related to publishing official macroeconomic forecasts is also provided.

Key words: forecasting, transparency, monetary policy, central banks

Mitä hyötyä on keskuspankkien virallisten ennusteiden julkaisemisesta?

Suomen Pankin keskustelualoitteita 22/99

Juha Tarkka – David Mayes
Tutkimusosasto

Tiivistelmä

Tutkimuksessa tarkastellaan kysymystä, pitäisikö keskuspankkien julkaista kokonaistaloudellisia ennusteitaan ja mitä hyötyjä julkaisemisen avulla voitaisiin saavuttaa. Osoitetaan, että keskuspankki voi parantaa kansantalouden toimintaa julkistamalla näkemyksensä vallitsevista inflaatiopaineista, vaikka nämä näkemykset olisivat virheellisiäkin. Tämä johtuu siitä, että julkistaminen lisää rahapolitiikan ennustettavuutta. Tutkimuksessa pyritään myös selvittämään, mitä julkistettavien ennusteiden pitäisi sisältää, sekä vastaamaan kysymykseen, millaisiin rahapolitiikkaa koskeviin olettamuksiin julkistettavat ennusteet pitäisi perustaa. Pitäisikö ennusteiden olla ehdollistamattomia siinä mielessä, että rahapolitiikka sisällytetään niihin sellaisena kuin keskuspankki odottaa sen tulevaisuudessa muodostuvan, vai tulisiko niiden olla ehdollisia jollekin muulle rahapolitiikkaa koskevalle oletukselle? Mahdollisia ehdollisia politiikkaolettamuksia ovat joko rahapolitiikan instrumenttien, kuten koron, olettaminen muuttumattomiksi tai rahapolitiikan määrittely sellaiseksi kuin yksityisen sektorin arvioidaan odottavan. Tutkimuksessa suoritettu analyysi tukee ehdollistamattomien ennusteiden käyttämistä, koska niiden kautta välittyy tietoa myös siitä, mihin rahapolitiikalla pyritään. Tutkimuksessa tarkastellaan myös eräitä virallisten talousennusteiden julkistamiseen liittyviä käytännön kysymyksiä.

Asiasanat: ennuste, avoimuus, rahapolitiikka, keskuspankki

Contents

1 Introduction

Most Central Banks use forecasts to help them decide how to set monetary policy. Those who have an exchange rate peg or follow a strict money aggregate rule may have only a limited need but any Central Bank running an independent monetary policy targeted on price stability will have such forecasts at the heart of its policy making.[1]

However, relatively few Central Banks publish forecasts. Well-known exceptions among the OECD countries are the Swedish Riksbank, the Bank of Norway, the Bank of England and the Reserve Bank of New Zealand. Others such as the Bank of Canada and the Reserve Bank of Australia publish projections showing how specific shocks might alter prospects for the future and hence influence policy. The publishing of such forecasts is intended to make monetary policy more effective. The Federal Reserve Board in the US publishes its forecasts with a five-year lag but there the purpose is rather different. A trend appears to be developing towards publishing more forward-looking information as the European Central Bank (ECB) has also begun to publish statements on the GDP growth outlook and private sector inflation expectations.

No Central Bank is legally required to publish a forecast, although the Bank of England is required to deposit a version of its model for public access and the Reserve Bank of New Zealand is supposed to explain how it intends to maintain price stability over the coming five years.[2] They publish forecasts because it supports their monetary policy strategies. With such a publication they hope to minimise any uncertainty that other decision-makers may have about the Central Bank's intentions.[3] That uncertainty will have at least three components:

– Uncertainty about the Bank's target for policy
– Uncertainty about the Bank's view of the future
– Uncertainty about what the Bank will do in the event of 'shocks' that lead to the prospect of a different future from that laid down in the Bank's forecast.

Such publication may also reduce uncertainty about the Bank's interpretation of recent economic data. Rather more Central Banks have sought to explain their interpretation of published data in their regular reports, the Eurosystem is an example of this.

Central Banks go about publishing their forecasts in various ways. Only the Bank of Finland and the Reserve Bank of New Zealand have published forecasts of more than the key price and output variables. The Bank of Finland publishes

[1] While this forward-looking approach is current best practice there has been some evidence (Taylor, 1993, 1996, for example) that after the event policy in the United States (and elsewhere) appears to have followed a relatively simple rule applying largely equal weights to the avoidance of inflation and output variability round its potential. However, more recent analysis (Orphanides, 1998a, b) has shown that, once allowance is made for the data actually available at the time rather than the revised estimates published subsequently, even this rule-based approach has been forward-looking.

[2] Something it has not done in a strict sense as its forecasts have typically only been two or three years ahead. It explains the method/strategy by which price stability will be maintained over the period.

[3] By choosing inflation targeting, money targeting or other simple rules, Central Banks are already trying to reduce uncertainty about their policy.

rounded forecasts for the main variables for each of the coming two years, whereas the Reserve Bank of New Zealand publishes quarterly forecasts for quite a wide range of variables for one year ahead and then annual forecasts for a further two years. Since the Bank of Finland is a member of the Eurosystem the logic of publishing projections and hence their form and content is somewhat different. Since the appropriate path for monetary policy is determined by the euro area as a whole and Finland has a weight of less than 2 percent in the total area (in terms of GDP or population), the outlook of the Finnish will have little impact on it. Nevertheless, the purpose is to facilitate the adjustment of Finnish firms, households and Government to euro monetary policy.

Obviously, the question of publishing or not is not the only important choice the Central Banks have to make about their forecasts. In all cases the forecasters have to make a series of assumptions in coming to their view of the future and all forecasts are thus conditional. In all cases except the Reserve Bank of New Zealand this conditionality includes assuming that the settings of monetary policy instruments are unchanged.[4,5] The 'forecast' is thus a projection under readily understandable but artificial assumptions. It represents a scenario under which current trends, possible shocks and macroeconomic outcomes can be discussed and the bank's decisions over monetary policy explained. If the outcome of such a forecast is unacceptable, the central bank may want to adjust its policy instrument in order to prevent its own forecast from being realised. We return to the subject of conditionality in more detail in section 4 below.

The Riksbank and the Bank of England take this discussion of possible shocks rather further and publish in their *Inflation Reports* not just a central track but a probability distribution for possible inflation and GDP, quarterly, over the coming two years. These are commonly referred to as fancharts, although the original Bank of England chart for inflation was nicknamed the 'Rivers of Blood' chart as it showed increasing probability by greater density of red. Their methodology is not identical and the difference has considerable importance as we discuss in section 5. In summary, the Riksbank produces its fancharts on the basis of assumed probability distributions of the main exogenous (conditioning) variables or "factors" over the forecast period and computing the resulting probability distributions for inflation and GDP (Blix and Sellin, 1998). The Bank of England on the other hand applies the probability distributions directly to inflation and GDP.

This difference in part reflects a key difference in their forecasting procedures, as reported in Blix and Sellin (1998). In principle, the Swedish methodology is conditional on the weights attributed to different factors in the determination of inflation. By contrast, the Bank of England practice would include any uncertainty on the "transmission mechanism" as well, because the resulting probability distribution of outcomes will come not just from decisions over the distribution of shocks but also on the way the economy is assumed to respond to them. (This may seem rather complex but in practice the MPC simplifies the outcome by agreeing just three parameters of the distribution over

[4] Normally this involves assuming constant short-term nominal interest rates but it may also involve assuming a fixed nominal exchange rate as well.

[5] The Bank of England also publishes a projection using market forecasts of what monetary policy will be. These are not of course consistent as the private sector expectations are likely to be conditioned on different forecasts from those of the Central Bank, as we explain in the text.

each quarter in the future, namely the most likely outcome, the variance and the skew.)

Other Central Banks tend to approach this problem of uncertainty a little differently and show the results of alternative scenarios (or variants) that also have reasonable probabilities of occurring but rather different characteristics and implications for policy. The Bank of Norway and the Reserve Bank of New Zealand have shown these in graphical form whereas the Bank of Finland has shown a different set of quantitative results ('scenarios') in tabular form.

The key characteristic of all of these approaches to uncertainty is that they show not just an outcome and the reasoning that lies behind it but also give a clear indication of how the Bank thinks the economy behaves and of the risks it faces over the next few years. The Bank can then set out *a strategy in the face of uncertainty*. In this way it may be able to make its future reactions to unforeseen developments more predictable.

2 Benefits of giving a transparent view of the future

There are several potential reasons why a Central Bank should make public statements on its view of the future:

1 It helps reduce uncertainty for other decision-makers, which is widely thought to tend to lead to more efficient pricing and investment decisions and hence better output and employment performance, in terms of stability and possibly growth as well
2 It helps make the Bank's pursuit of price stability more credible and hence reduces the costs of and need for disinflationary monetary policy
3 It helps improve the co-ordination of the fiscal and independent monetary authorities in formulating macroeconomic policy as a whole
4 It helps provide the sort of democratic accountability that both society and the Bank itself would prefer, namely, that it is judged on its professional performance not just on outcomes that may be the result of unavoidable shocks
5 It helps the Bank follow a consistent strategy where it can learn from experience without damaging its credibility

Below, we focus on the analysis of the first point (reducing uncertainty) in the above list, with some comments on the issue of credibility. This restriction in the scope of the analysis does not mean that we think the other points are irrelevant. Logically, any of the above points alone, proven valid, could justify publishing forecasts. However, as a caveat we must note that one might come to different conclusions regarding the best content of the forecasts depending on the motivation for publishing.

The future is uncertain and as a result people can be expected to hold different views about what may happen. There are three main sources of uncertainty: uncertainty about the present state of the economy; uncertainty about how the economy responds to shocks, and uncertainty about what will affect behaviour in the future. All of these are relevant to the formulation of monetary policy, and

therefore the Central Bank's views of these uncertainties are valuable information to agents who try to predict how monetary policy will operate in the future.

2.1 Uncertainty about the present state of the economy

Macro-economic 'data' are only estimates. These estimates are in most cases revised as new information comes available (although consumer price indices are not normally revised). These estimates are subject to inaccuracy and some statistical authorities give estimates of the likely confidence intervals of such estimators. In any case the measured statistics are themselves often somewhat poorly specified versions of the underlying economic concepts. Typically people try to combine different sources of information in order to get more reliable estimates.

Moreover, national accounts and other "objective" statistics on the recent performance of the economy are not the only input forecasters use in their implicit or explicit models. Forecasts are also conditional on the prevailing business and consumer expectations, and therefore Central Banks' assessment of these expectational factors is an important input to their forecasts and policy. This is a point we analyse in detail in the next section of this paper.

The Central Bank can reduce uncertainty in two respects. It may have more information about the data or a better ability to interpret what the underlying values are, in which case it can help the private sector improve its decision-making. In this case, there is an obvious benefit from disclosing such "inside" information. Secondly, the bank can explain how it views the short-run data. At least, even if the private sector disagrees with the Bank's assessment, it can assess how the Bank will react in the future. For example, if the Bank discounts the information content of a set of earnings figures that *prima facie* imply an increase in inflationary pressure, the private sector can deduce that if later information confirms the earnings figures, the Bank will wish to increase its estimates of inflationary pressure. Actually, knowing the Central Bank's assessment of the current situation would be important for the private sector, even if this assessment were completely erroneous, if monetary policy is nevertheless based on it.

The informational asymmetries between the Central Bank and the private sector are naturally an important consideration in deciding what the Central Bank communication and disclosure policy should be. It may be difficult to believe that the Central Bank is somehow generally better informed than the private sector about prevailing economic conditions, even though it may have access to some confidential information if it is involved in banking supervision (see Peek, Rosengren and Tootell, 1999). The formal model we present below focuses on two rather obvious asymmetries: the private sector typically knows more about its own expectations than the Central Bank, whereas the Central Bank may well have an informational advantage regarding the money supply process and the "transmission mechanism" of monetary policy.

2.2 Uncertainty about how the economy responds to shocks

Model uncertainty is probably the greatest source of difficulty for interpreting the Central Bank's actions. The Bank is not certain about the nature of the transmission mechanism. Not only is it not certain about what will happen even if there are no shocks to the economy but it is not certain how much its policy actions will affect that outcome. There are two ways of reacting to this. In one case the Bank will be rather cautious about its actions, preferring a strategy that will tend to produce outcomes towards the middle of the range by setting its policy instruments towards their steady-state or medium term values. For example, this could imply a tendency towards neutral yield gap settings for interest rates or steady-state values for money aggregates. In the other case the Bank will be risk averse and react on the basis of the worst case scenario. As Onatski and Stock (1999) show, this will tend to result in a hyperactive and overshooting policy.

The cautious response has to be interpreted correctly, as it is not simply inertia in the sense of being reluctant to move the instruments – unless of course the initial setting is in equilibrium in the steady state. It is a reluctance to diverge from the steady state values. If the policy reaction function (such as the Taylor rule) would be explicitly specified, caution would be visible in the weights given to the state variables in setting up the rule.

A second response to uncertainty is to avoid making the target for inflation exact. If the committed outcome is a fixed number then the reputation of the bank will readily be damaged as outcomes diverge from it. If the target is a band then some uncertainty can be accommodated within that band and reactions are only required when worst case interpretations of the parameters require it. Clearly other sources of uncertainty will be bound up within this same approach. This can represent one of the most important responses to uncertainty, namely, to be imprecise or to avoid spurious precision. This decision over imprecision is, however, completely different in concept from being outright obscure (see Goodfriend, 1986). Explaining that the Bank has decided not to respond to small shocks because it thinks this is the appropriate response under uncertainty is completely different from trying to make public statements vague enough in order to be able to claim correct foresight after the event over a wide range of outcomes.

The appropriate response to uncertainty is still to make probabilistic statements about the future. Choosing a band for the inflation target is a crude means of placing some limits on reactions to uncertainty. A band target has some obvious advantages. On the one hand it permits inaction where the probabilities of needing to act are low and on the other it compels action before the probability mounts up too far.

There will be uncertainty not just about the size of the impact of policy but about how fast it has its impact. In these circumstances the target is likely to be interpreted as an average of the outcomes over a period of time rather than as a specific single period value. In the case of New Zealand, the time dimension of the policy framework is based on the FPS model (Black *et al*, 1997), which provides a representation of the Reserve Bank of New Zealand's stated view of the issue. Monetary policy is set so as to try to be in the middle of the target range 6–8 quarters ahead. Not only is 'middle' not a point but a range but it is averaged

over three quarters. Again this generates an element of smoothing in the setting of policy and avoids the sort of very active policy prescriptions that emanate from many simplified models (Svensson, 1998).

An alternative way of expressing these problems is to say that the Central Bank has an imperfect ability to influence inflation in the way it would like. Even though it can indicate what it would like to see as an outcome it cannot ensure it. Just setting an interest rate or quoting a reference value for money will not provide the necessary link or signal. The Central Bank has to demonstrate how it sees that particular setting delivering the outcome it hopes for. Because the relationship is complex it will not be possible for the private sector to derive any completely clear view of whether the particular setting for the instrument is consistent with the expected outcome.[6] If the Bank does not publish an explicit forecast then some of the uncertainty involved may be interpreted by the private sector as a lack of commitment by the Bank to the price stability target.

Moreover, in the inflation targeting regime, if the formal target itself is flexible either in the sense of a band target or in the sense of being defined in terms of medium term inflation outcomes, then the target of the Central Bank does not contain sufficient information on what the Central Bank sees as the expected result of its policy. Therefore, inflation forecasts may be used to inform the private sector of the actual aims and intended consequences of the policy when the target is flexible.

Providing a clear view of the Bank's policy intentions and views of the future does not require that the Bank's policy makers hold a single view of either the future or of how economic behaviour should be represented (modelled). It merely needs to articulate these views and explain the weight attached to them. Whatever the prior uncertainties the Bank has to come to a decision, these decisions should also be explained if giving misleading signals is to be avoided.[7] If the forecast is to be valuable for predicting monetary policy, it should be agreed by the actual decision-makers (such as the governing council, open market committee or the monetary policy committee). Publishing a 'staff forecast' not accepted by the decision-makers could convey misleading signals about future policy.

2.3 Uncertainty about what will affect behaviour in the future

The traditional source of uncertainty is the "exogenous" factors that affect future economic developments but cannot be predicted exactly. Forecasts must be conditioned on a set of assumptions about what might happen. Forecasting exercises are not simply generated by mechanical extrapolation of past experience, as it is possible to form rather more detailed views of specific events that may affect the future. In the modelling context, the exogenous factors have to be projected separately, traditionally as tracks for the exogenous variables. On the

[6] As we explain in the next section this expectation is not just the expectation held by the Bank but the private sector's expectation of what the Central Bank's expectations of the future will actually lead to. Thus there is second layer of expectations to contend with.

[7] Contradictory explanations, even if they are intended merely to be different people's form of words for the same conclusion can confuse and damage credibility. This is why full Inflation Reports are provided, where the detailed explanation has been agreed.

other hand, they also relate to behaviour itself, as simple use of the same model would generally require that behavioural patterns in the future will be the same as in the past. The forecasters may wish to assume that people learn or may wish to assume that recent errors in the forecasting ability of their models will continue or will run off at some particular rate. These two categories of conditioning assumptions will therefore take the form of changes to the model's parameters and residual adjustments (add factors).

Such assumptions tend to be simple (mechanical) or rely on knowledgeable sources outside the particular forecasting model used. The simplicity reflects two things. First of all it reflects the degree of possible plausibility of any statement about the future but secondly it reflects the need to provide a basic framework from which other hypotheses can be run. This enables the forecaster to run other scenarios or variants or even stochastic simulations round the basic track. Often these simple assumptions are conventional: existing levels or recent rates of growth continue into the future for example. Policy regimes are often projected to continue unchanged or change at an election in a fairly stylised manner. Use of knowledgeable sources often enables projections to be compared with the projections of others.

Making plausible assumptions is necessary to make the forecast reasonably realistic. However, making the assumptions explicit enables others to understand the basis for the forecast and rework it using their own assumptions if they are different. When an explicit forecasting model is used, it is also possible to show which assumptions are critical to the forecast and which could be varied considerably without much implication for policy.

One particularly important specific issue that we deal with in this paper in this regard is what to assume about monetary policy in making forecasts. The traditional idea until recent years has been to assume that the settings of policy instruments would be unchanged as well as ipso facto the policy itself. With inflation targeting this generally introduces a contradiction, as the aim of the policy is not particular settings of the instruments of policy but the achievement of the outcome, namely, that inflation lie within the target set for it. Moreover, assuming constant instrument settings is not synonymous to assuming constant monetary policy, because same targets can be pursued with several alternative instruments (using the interest rate, the exchange rate or base money as instruments, to give some examples). Yet, "freezing" one instrument in the forecast (say, the interest rate) is not generally equivalent to freezing another (e.g. the money supply).

If a Central Bank shows a projection where it does not achieve its own target it must at least explain how the settings of policy will differ from those assumed in the projection, and probably also how these deviations from the forecast path will affect future outcomes, so that the private sector can be convinced both that the bank has not changed the goals of policy and that they can be achieved with the instruments at hand. From time to time Central Banks will be unable to project inflation within the target, either because of past errors in policy settings or because of the sheer size of shocks to the economy that have occurred. In the New Zealand and UK regimes the requirements for what to do are actually laid down beforehand for the Central Bank. They have to explain why they have got into the problem and what they propose to do to get out of it. In both cases those responsible could expect to lose their jobs if the explanation were not convincing (Mayes and Razzak, 1998). Unless the Central Bank is successful in persuading

everyone else that it has not changed the goals of policy the basis for setting price expectations will change. Indeed this is what any forwarding-looking model will itself predict. Forecasts play an especially important role in maintaining credibility when temporary deviations from its target are expected.

Thus the Bank needs to guard against introducing any uncertainty about its own intentions. At first blush it may seem ridiculous to publish a track for future monetary policy when those setting it do not know what the actual future settings will be. They only decide on the current setting, although in the case of the US Fed there is sometimes a clear indication of which way the settings are likely to change next. What they do know is the strategy they will follow in setting the policy instruments in the future. The particular track shown by the model or in the projection is not a commitment to a particular sequence of actions but a demonstration using simple assumptions of how policy could evolve, given the rest of the assumptions in the projection, to maintain price stability. It helps demonstrate the feasibility of the strategy, which is of course a condition for credibility.

2.4 Implications for transparency

All of these sources of uncertainty thus present difficulties for the policy maker. All of them are well-known and it would not be possible to pretend either that they did not exist or that one had special knowledge that rendered them unimportant. Decisions have to be taken in this framework and the question is whether there are any reasons why one might not want to spell out the nature of the assumptions, the associated projections, the way uncertainty has been faced and the resultant decisions. Prima facie the publication of all that information can only aid understanding and improve the quality of the information available to the private sector on which it can take its own decisions.

The main issue for this paper could actually be presented in the inverted form, viz. *are there circumstances in which transparency is a disadvantage?* This is largely equivalent to asking whether there are circumstances under which society would benefit if the Central Bank were to follow a policy of ‘discretion’. The straightforward answer under certainty is clearly no (Faust and Svensson, 1997) but in the face of uncertainty the position is not so clear. Furthermore, given the great complexity of the information set and the relationships in the economy full transparency might be difficult to define in principle or to achieve in practice even if one were to televise the meetings of the decision-making bodies and to make all the briefing papers available.

3 A framework for analysis

In order to study the effects of publishing Central Bank forecasts in a meaningful way, we must specify an analytical framework that allows for uncertainty, and in particular one that allows the expectations formed by the Central Bank and the private sector to differ – at least in advance of the publication of the Central Bank forecast. This is obviously necessary for the Central Bank forecast to constitute any kind of news. If the expectations of the Central Bank and the private sector were completely identical, and known to be so, the publishing of official forecasts by the Central Bank could not have any value or effect on efficient private behaviour.[8]

Central Banks keep a close watch on the economy on a continuous basis but they normally take decisions on monetary policy at discrete intervals, fortnightly in the case of the Eurosystem, monthly for the Bank of England and six-weekly for the Federal Reserve. Only in the case of unusual shocks will the Central Bank feel that it needs to act in the interim, such as during the crisis with the Exchange Rate Mechanism of the European Monetary System during 1992/3. While the forecasts that support these decisions will be updated regularly, full-scale forecasts will tend to be made less frequently, quarterly in the case of the Bank of England and half yearly in the case of the Eurosystem. The private sector on the other hand is taking decisions about setting prices all the time. In taking those decisions it will form judgements about what will happen to the economy and judgements about what the Central Bank will do when the time arrives for it to decide how to set monetary policy.

We can set out the decision-making problem as a sequence of overlapping cycles, constituting a process over time such as illustrated in Figure 1.

Figure 1. **Decision-making and monetary policy cycles**

Cycle A		Private sector expectations and CB forecast formed for 2 periods ahead	CB gets velocity shock signal, CB sets policy	Shocks observed Production occurs	
Cycle B			Private sector expectations and CB forecast formed for 2 periods ahead	CB gets velocity shock signal, CB sets policy	Shocks observed Production occurs
Time period	–1	0	1	2	3

[8] Forecasts should be distinguished from another kind of policy statements, which are better characterised as commitments or promises. Commitments may have an effect on private expectations by "tying the hands" of the Central Bank, as analysed by the so-called "cheap talk" literature (Stein, 1986, for example). The publishing of forecasts, by contrast, works by releasing some information, which would otherwise be available only to the Bank.

This is a repeated sequence, which we have illustrated just twice in the figure. We label Cycle A for the first occasion and Cycle B for the second. Focusing on Cycle A.

Period zero is the forecasting and contracting period. The private sector forms its expectations of inflation (the future price level). The private sector makes contracts (binding commitments) on the supply price of output. Private sector expectations will be based on information about previous periods and on its forecasts about future periods, including its assessment of what the Central Bank will do. That set of information will include any published Central Bank forecast.

Period 1 is the decision-making period for the central bank. The Central Bank will base its decision on how to set monetary policy on the past, any new information it receives and on its assessment of the future, including its view of the future decisions it expects to take. We illustrate the case where the Central Bank receives new information relating to monetary behaviour (a velocity shock) during period 1. The Central Bank can accompany the publication of its monetary policy decision with a new forecast explaining the new information it has received.

In *period 2* the future is revealed, shocks are observed and the consequences of private sector decisions occur as 'production'.

In the next cycle, B, the whole sequence is shifted one period on. The private sector knows what the bank decided in period 0 and any information it published to explain or support the decision. In period 2 the Central Bank has seen how the economy has evolved and can compare that with its previous forecast and can develop a new forecast and so on. There will have been similar sequences before Cycle A. As a result of the overlapping of the cycles, each of the three phases in the model happen in each period (expectations are formed, monetary policy determined, and shocks realised), but these relate to different cycles.

We begin by taking a snapshot of this process and just considering periods zero and one after which the process is repeated in the subsequent cycles.

This kind of sequence has become the standard way of analysing monetary policy in the literature. The point in models incorporating sequences like this is that they give monetary policy makers some flexibility to counteract shocks which the private sector is unable to respond to. Therefore, these models can be used to explain why monetary policy makers adjust their instruments in an active way, rather than fixing them permanently. It will be apparent from the following analysis that this of framework (with monetary policy responding to some shocks in an "active" way) is needed to make the analysis of Central Bank forecasts informative.

Our specification differs from the standard "textbook" case developed by Rogoff (1985) and others in two ways. We distinguish between the expectations of the Central Bank and the private sector, and we assume that any information advantage the Central Bank has is limited to the monetary transmission mechanism (in the sense of being able to react to signals correlated with the coming velocity shocks). This is more realistic than assuming that Central Banks' information advantage is on the future behaviour of the real economy and hence that monetary policy is mainly important in counteracting real shocks.

We consider *two cases* within these sequences. In the first the Central Bank does not disclose its own forecast and its information on the prospective velocity shock, while in the second it publishes all the information it has.

Supply behaviour of the private sector is specified according to the conventional expectations-augmented Phillips relation, or the Lucas supply function:

$$y = a \cdot (\pi - E_{P,0}(\pi)) + s \qquad (3.1)$$

where y is the deviation of output form its equilibrium growth path, π is inflation and s is a supply shock. All these variables are dated period two, which may be called the production period. $E_{P,0}(\pi)$ is the inflation expected by the private sector in period 0 (more precisely, conditional on the information set available to the private sector in period 0 when the private contracts are made. Using somewhat longer notation, we could write $E_{P,0}(\pi) = E_{P,0}(\pi \mid I_{P,0})$ where $I_{P,0}$ is the information set of period 0.).

Generally, we will denote expectations by different agents in different time periods by subscripts containing the letter P or C (for the private sector and the Central Bank, respectively) and a number (0 or 1) indicating the period when the expectation is formed. Under a rational expectations interpretation, these specify the particular information set (of a given agent at a given point in time) on which the expectation is based.

The demand side of the model economy is given by the simple quantity equation

$$y = m - \pi + \nu \qquad (3.2)$$

where m denotes the growth rate of the money supply, and ν is a velocity shock.

In the model, it is the expectations formed by the private sector in period 0, which matter for the determination of output and inflation. Because of this, the forecast of the Central Bank, if it is to have any effect on private behaviour, must be published in period 0 (and based on the information available to the Bank at that time). In period 1, however, the Central Bank receives a signal u on the coming velocity shock ν. This signal reveals the mean of the velocity shock, $u = E_{C,1}(\nu)$ but has as a random error e so that $\nu = u + e$. The signal, when received, changes the Central Bank's information set and influences policy. Note that the private sector's expectations and actions depend upon whether the Central Bank just sets policy or whether it reveals its full information set. If the information set is not revealed then the private sector can only guess from the setting of monetary policy and any explanation what the full information set is.

We assume in case 1 that the agents' expectations of the different shocks are as follows:

Expectations in period 0:

$$E_{P,0}(s) = 0 \qquad E_{P,0}(\nu) = 0 \qquad (E1)$$

Expectations in period 1

$$E_{C,1}(s) = 0 \qquad E_{C,1}(\nu) = u \qquad E_{C,1}(e) = 0 \qquad E_{C,1}(e \cdot \nu) = 0$$

(ν and e are assumed to be independent)

We now proceed to solve the model. Combining (3.1) and (3.2) gives

$$\begin{aligned}\pi &= \frac{a}{(1+a)} \cdot E_{P,0}(\pi) + \frac{1}{(1+a)} \cdot (m + \nu - s) \\ &= \alpha E_{P,0}(\pi) + (1-\alpha)(m + \nu - s).\end{aligned} \tag{3.3}$$

We see that inflation is determined as a weighted average of the private sector inflation expectations on the one hand, and the money supply (after accounting for the effects of velocity and supply shocks), on the other. The weights of these two factors depend on the slope of the aggregate supply function: the lower is the elasticity of output with respect to surprise inflation, the lower weight private expectations have in the determination of actual inflation. On the other hand, the higher is the elasticity of supply, the weaker is the relative effect of monetary policy, or other fundamentals, on actual inflation.

Now, assume that the Central Bank sets the money supply so as to achieve some given inflation target π^*. However, because of the shocks s and e, inflation is partly outside the control of the Central Bank, meaning that the target cannot generally be achieved exactly. We assume that the Central Bank chooses the money supply so that it expects the target to be realised, i.e. so that

$$E_{C,1}(\pi) = \pi^*. \tag{3.4}$$

Recall that $E_{C,1}(\pi)$ denotes the expectation of π based on period 1 information of the Central Bank (this is the information available to monetary policy makers when the monetary policy instrument is set). It is straightforward to demonstrate that in a linear model, where certainty equivalence holds, we could derive (3.4) by assuming that the Central Bank sets its monetary policy by minimising the following loss function:

$$L = E_{C,1}(\pi - \pi^*)^2. \tag{3.5}$$

In many studies, more general Central Bank objective functions are used, which include real output considerations. This makes it possible to explain the inflationary bias of monetary policy (in excess of a target such as π^* above) or the role of monetary policy in stabilising real fluctuations emanating form the supply side. In the model specified here, however, introducing real arguments to the objective function would actually be superfluous because in our formulation the Central Bank has superior information relative to the private sector *only* regarding the velocity shocks (and possibly on its own macroeconomic projections, if these are not published). In doing so, we avoid making the rather odd but frequently used assumption that the Central Bank is better informed on *real* developments than the private sector.

We will *not* make the assumption that the inflation target is known by the private sector with certainty. Note that in our framework, the inflation target is defined as the inflation rate expected by the Central Bank as the result of its monetary policy. This definition of the target is somewhat different from a “legal” or “committed” definition of the target. “Legal” or “committed” definitions may often be specified as target zones, or they may be specified in terms of statistical

measures (indices) which are imperfect measures of the price level actually relevant for macroeconomic behaviour (aggregate demand and supply). Moreover, the precise inflation target (in our sense of the term) might actually change after private expectations are formed and before actual policy is determined. These kinds of regime shifts are always conceivable in real-life situations. For the sake of policy relevance, the assumption that the private sector merely forms an expectation of the inflation target seems therefore more relevant than the alternative of assuming the target to be known with certainty.

We assume that the money supply is perfectly controllable. Taken literally, this would seem an unrealistic assumption. Note, however, that the effects of additive uncertainty in controlling money – if this uncertainty were included in the analysis – would be equivalent in its effects to unexpected velocity shocks. Therefore, it seems that including simple imperfections in monetary control would not change the results of our analysis. Taking expectations of (3.3) conditional on the Central Bank's information set in period 0 and applying the condition (3.4) gives

$$m = \pi^* - a \cdot \{E_{C,1}[E_{P,0}(\pi)] - \pi^*\} - u. \tag{3.6}$$

So, in setting its monetary policy, the Central Bank, which targets its own inflation forecast, must take into account not only its inflation target, and its forecast of the coming velocity shocks (here given by the signal u), but also the information it may have on the deviation of the private sector inflation expectations from the Bank's inflation target. If, for example, the Central Bank estimates the private sector inflation expectations to exceed its inflation target, it will adjust the money supply downwards compared to the situation where the private sector expectations conform with the target. This countering of private inflation expectations (instead of even partial accommodation of them) emerges here because of the effect of expectations on inflation in (3.3) and the assumed instantaneous adjustment of monetary policy to achieve the inflation target, as specified in (3.4)).

With monetary policy given by (3.6), actual inflation is determined as follows

$$\pi = \pi^* + \alpha\{E_{P,0}(\pi) - E_{C,1}[E_{P,0}(\pi)]\} + (1-\alpha)(e-s). \tag{3.7}$$

This expression for actual inflation outcomes has a simple interpretation in terms of the inflation target, and the two sources of error in the inflation control exercised by the Central Bank. These sources of error are in the Central Bank's assessment of private sector inflation expectations on the one hand, and errors in the forecasting of velocity and supply shocks (e and s respectively), on the other. If the Central Bank overestimates the prevailing private inflation expectations, it will under-shoot its inflation target, and vice versa. Surprise increases in velocity will cause the inflation target to be exceeded, and surprise increases in productivity lead to below-target inflation.

If we denote the error made by the Bank in measuring the private inflation expectations by w, so that $w = E_{C,1}[E_{P,0}(\pi)] - E_{P,0}(\pi)$, we can write (3.7) as

$$\pi = \pi^* - \alpha w + (1-\alpha)(e-s). \tag{3.8}$$

Let us now turn to the formation of private sector inflation expectations. We assume that all private sector agents have the same expectations. Because of the linearity of our model, this simplifying assumption does not change the main insights that can be derived from our analysis.

Note first that the following equation holds for private sector expectations

$$E_{P,0}(\pi) = E_{P,0}(m) - E_{P,0}(s) + E_{P,0}(\nu). \tag{3.9}$$

Under the above assumptions on the velocity and supply shocks this simplifies into

$$E_{P,0}(\pi) = E_{P,0}(m). \tag{3.9'}$$

Of course, the extreme simplicity of (3.9') merely reflects the stylised nature of Case 1 in our model (e.g. the complete unpredictability of the velocity shocks from the private sector's point of view).

Now, subtracting (3.9') from (3.3) for the determination of actual inflation and rearranging we get the intuitive result that the private sector's errors in predicting inflation can be expressed in terms of errors in understanding the basis for monetary policy, and the impact of velocity and supply shocks

$$\pi - E_{P,0}(\pi) = (1-\alpha)(m - E_{P,0}(m) + \nu - s). \tag{3.10}$$

This is a traditional result from rational expectations models. It has the well known implication that if the shocks ν and s were not forecastable by anybody, the Central Bank could minimise private sector prediction errors by fixing the policy in advance and communicating this to the private sector so that the term $m–E_{P,0}(m)$ would be zero at all times. This highlights the reason why it is important to model some kind of information advantage for the Central Bank relative to the private sector: otherwise, monetary policy activism (in the sense of changing instruments) cannot be justified in the model.

Now, taking into account the way in which the Central Bank sets the money supply, *under the inflation targeting policy regime*, private sector expectations of monetary policy can be expressed as

$$E_{P,0}(m) = (1+a)\cdot E_{P,0}(\pi^*) - a\cdot E_{P,0}\{E_{C,1}[E_{P,0}(\pi)]\}, \tag{3.11}$$

so that private sector inflation expectations can be expressed as

$$E_{P,0}(\pi) = (1+a)\cdot E_{P,0}(\pi^*) - a\cdot E_{P,0}\{E_{C,0}[E_{P,0}(\pi)]\}. \tag{3.12}$$

Now, note that $E_{P,0}\{E_{C,1}[E_{P,0}(\pi)]\} - E_{P,0}(\pi) = E_{P,0}(w)$ and thus (3.12) can be rewritten as

$$E_{P,0}(\pi) = (1+a)\cdot E_{P,0}(\pi^*) - a\cdot [E_{P,0}(w) + E_{P,0}(\pi)] \tag{3.13}$$

or, equivalently,

$$E_{P,0}(\pi) = E_{P,0}(\pi^*) - \alpha \cdot E_{P,0}(w). \quad (3.14)$$

To interpret this, inflation expected by the private sector is equal to its expectation of the inflation target of the Central Bank, less a term which is proportional to the private sector's estimate of the error the Central Bank makes in measuring private sector inflation expectations.

Subtracting (3.14) from (3.7), which gives the determinants of the actual rate of inflation, the error of the private sector in predicting inflation, can now be written as

$$\pi - E_{P,0}(\pi) = \pi^* - E_{P,0}(\pi^*) - \alpha \cdot \left[w - E_{P,0}(w)\right] + (1-\alpha)(e-s). \quad (3.15)$$

As indicated by (3.15), the errors made by the private sector in predicting inflation have four possible sources:

(i) failure to predict the actual inflation target of the Central Bank;
(ii) lack of information on how the Central Bank sees the prevailing private expectations of inflation;
(iii) the part of the velocity shocks which are surprises to the Central Bank; and
(iv) the supply shocks.

We can now turn to the analysis of the effect of publishing forecasts on macroeconomic behaviour. Two very important cases arise depending whether the Central Bank's assessment of private sector inflation expectations $E_{C,1}[E_{P,0}(\pi)]$ is known to the private sector in period 0 or not.

First, if the private sector *does not* know the Central Bank's assessment of private sector inflation expectations, but merely knows that they are correct on average, we have $E_{P,0}(w) = 0$. In that case, by equation (3.14), $E_{P,0}(\pi) = E_{P,0}(\pi^*)$, meaning simply that private sector inflation expectations will be equal to the expectation of the private sector concerning the Central Bank's inflation target. We call this the *opaque case* because all of the Central Bank's information set (of period zero) is not included by the private sector's information set (of period zero). We could interpret this by saying, "the private sector cannot see the macroeconomic assessment done inside the Central Bank". In this case, the private sector's errors in predicting inflation are given by

$$\pi - E_{P,0}(\pi) = \pi^* - E_{P,0}(\pi^*) - \alpha \cdot w + (1-\alpha)(e-s). \quad (3.15')$$

It is easily seen that any errors w committed by the Central Bank in measuring private sector inflation expectations will cause related prediction errors $\pi - E_{P,0}(\pi)$ by the private sector in the opaque case. This happens because these Central Bank errors disturb inflation control by the Central Bank and thus cause surprise fluctuations in inflation.

In the *second* case, the Central Bank's estimate of private sector inflation expectations *is known* by the private sector (is part of the private sector's information set in period 0). Thus the private sector also knows the Central Bank's error in estimating inflation expectations. This we call the case of *transparency*, because the case could result from a deliberate disclosure policy by the Central Bank.

In the case of transparency we have $E_{P,0}(w) = w$ by definition, and (3.14) can be rewritten as

$$E_{P,0}(\pi) = E_{P,0}(\pi^*) - \alpha \cdot w. \qquad (3.14')$$

We see that under transparency, the private sector's inflation expectations will be based on its estimate of the inflation target of the Central Bank, *and* the knowledge of the error the Central Bank is making in measuring private sector inflation expectations. The latter piece of information distinguishes this case from the opaque case.

Note that in the case of transparency, the Central Bank's forecasting activity and the private sector's expectation formation are simultaneous and their outcomes are interrelated. This is in contrast with the case of "opaqueness", in which the private sector expectations are independent of the Central Bank's forecasts. We could say that in the "opaque" case the expectations formation and forecasting processes are recursive by nature.

Further, in the case of transparency the errors of the private sector in predicting inflation are given by

$$\pi - E_{P,0}(\pi) = \pi^* - E_{P,0}(\pi^*) + (1-\alpha)(e-s). \qquad (3.15'')$$

It is immediately seen that private sector's forecasting ability is improved by transparency, as compared to the opaque case. One of the sources of error, namely the factor w, is entirely eliminated by transparency. This is because the private sector no longer makes mistakes over how the Central Bank sees the prevailing inflationary expectations.

We can now turn to the determination of output in the two cases. This is straightforward given the supply relationship (3.1)

$$y = a \cdot \left[\pi^* - E_{P,0}(\pi^*)\right] - a\alpha \cdot w + (1-\alpha) \cdot e + \alpha \cdot s \qquad \text{(the opaque case)} \qquad (3.16)$$

$$y = a \cdot \left[\pi^* - E_{P,0}(\pi^*)\right] + (1-\alpha) \cdot e + \alpha \cdot s \qquad \text{(the transparent case)}. \qquad (3.16')$$

What is striking here is that in the case of transparency, the errors of the Central Bank in measuring private sector inflation expectations, while they may cause variation in the actual inflation rate, do not disturb real outcomes at all. This is because the "mistakes" in monetary policy that are caused by these measurement errors are predictable by the private sector, when the forecasts are published.

The output forecast by the Central Bank at time 0 can be obtained by taking expectations of (3.1) as follows

$$E_{C,0}(y) = a \cdot \left\{E_{C,0}(\pi) - E_{C,0}\left[E_{P,0}(\pi)\right]\right\} + E_{C,0}(s) \qquad (3.17)$$

which is equivalent to

$$E_{C,0}(y) = a \cdot \left\{\pi^* - E_{C,0}\left[E_{P,0}(\pi)\right]\right\}. \qquad (3.18)$$

In our model, the logic of the Central Bank forecasts is quite simple: *the Central Bank forecasts a recession if it estimates private sector inflation expectations to exceed its inflation target, and a boom if it estimates private sector inflation expectations to be less than its inflation target.*

By using the definition of the Central Bank's measurement error w, the Central Bank forecast can also be expressed as a function of the private sector expectations

$$E_{C,0}(y) = a \cdot \left[\pi^* - E_{P,0}(\pi) - w\right]. \tag{3.19}$$

The Central Bank's decision for the setting of its monetary policy instrument is

$$m^* = \pi^* - a \cdot \left\{E_{C,0}\left[E_{P,0}(\pi)\right] - \pi^*\right\} \tag{3.20}$$

or, equivalently, [9]

$$m^* = \pi^* - a \cdot \left[E_{P,0}(\pi) - \pi^* + w\right]. \tag{3.21}$$

From the above analysis it follows that by publishing its output forecast $E_{C,0}(y)$, and the setting of its monetary policy instrument m*, the Central Bank can reveal its inflation target π^* and its estimate of the private inflation expectations $E_{C,0}[E_{P,0}(\pi)]$. These data allow the private sector to predict future monetary policy to the best possible extent (from the perspective of period 0) and thus reduce the variability of output as much as possible without ability to predict ν and s. In a sense these data define the "optimal" content of the official Central Bank forecast. Note however that if the precise inflation target (forecast) is published, then the macroeconomic forecast $E_{C,0}(y)$ and the setting of monetary policy instrument m* convey the same information, at least in the simple framework used here.

The optimal disclosed forecast defined by $E_{C,0}(y)$ and m*, or by π^* together with either of them, is "unconditional" in the common use of the term, meaning that it uses all available information (available on period 0); in particular, monetary policy is assumed to be as expected by the Central Bank itself.

4 Some further considerations

Up to this point we have merely demonstrated that the Central Bank can achieve an overall improvement in outcomes by disclosing its forecast. This reduces uncertainty in the private sector about the Central Bank's intentions and passes on any 'private' information (or idiosyncratic misperceptions) the Central Bank may have for the benefit of the public. We can, however, go further than this and explore gains from formulating forecasts in different ways. Let us begin by considering some obvious alternative forecast assumptions.

[9] Note that it is not necessary to express this process in terms of forecasts of the output gap and hence it may be possible to avoid some of the difficulties from poor forecast performance in the US outlined in Orphanides (1998) for example.

A common practice for official forecasting is to base the forecasts on the assumption of "unchanged policy". Apart form the obvious ambiguity in defining what constitutes unchanged policy, the question arises, does this kind of forecast work in the sense of communicating to the private sector the information it needs about the Central Bank's estimates of prevailing inflation expectations and the actual policy target (in our sense of the expected outcome of policy)? This question can be analysed in the present framework in the following way. Denote the previous value of the monetary instrument by m_{-1}. Under the assumption that $m = m_{-1}$, the Central Bank's forecast for inflation would be as given by the following expression

$$E_{C,0}(\pi | m = m_{-1}) = \alpha \cdot E_{C,0}\left[E_{P,0}(\pi)\right] + (1-\alpha) \cdot m_{-1} \tag{4.1}$$

i.e. a weighted average of the assumed monetary policy and the estimate of private inflation expectations. The output forecast consistent with the above would be

$$E_{C,0}\left(y | m = m_{-1}\right) = a \cdot \left\{E_{C,0}(\pi) - E_{C,0}\left[E_{P,0}(\pi)\right]\right\}, \tag{4.2}$$

or, equivalently (by (4.1)),

$$E_{C,0}\left(y | m = m_{-1}\right) = \alpha \cdot \left\{m_{-1} - E_{C,0}\left[E_{P,0}(\pi)\right]\right\}. \tag{4.3}$$

It can immediately be observed from (4.1) and (4.3) that by publishing its *conditional inflation forecast* $E_{C,0}(\pi \mid m = m_{-1})$, along with information on the forecasting assumptions ($m = m_{-1}$), the Central Bank indeed reveals its forecast assumptions of private sector inflation expectations. If the forecast assumptions of private sector expectations accord with the Central Bank's estimates of the actual prevailing expectations, the forecast reveals the Central Bank's estimates and helps to predict monetary policy. This is apparent by noting that private sector agents can simply solve for $E_{C,0}[E_{P,0}(\pi)] = E_{C,0}(\pi \mid m = m_{-1}) + (1/a)\cdot[E_{C,0}(\pi \mid m = m_{-1}) - m_{-1}]$.

The same effect (revelation of information on estimated private expectations) can, in this model, be equally well achieved by publishing the conditional *output forecast* $E_{C,0}(y \mid m = m_{-1})$. In this case, the private sector can find out the Central Bank's estimate of the prevailing private inflation expectations by applying the formula $E_{C,0}[E_{P,0}(\pi)] = m_{-1} - (1-\alpha)\cdot E_{C,0}(y \mid m = m_{-1})$.

However, neither the conditional output nor inflation forecasts contain information from which the inflation target of the Central Bank could be inferred. If conditional forecasts are published, they should therefore be accompanied by disclosing the precise inflation target (which is actually the *defined* here as the *unconditional* inflation forecast by the Central Bank) in order to permit the private sector to predict future monetary policy in an efficient way.[10] There is a clear source of confusion here that needs to be resolved, as the Central Bank would be using conditional and unconditional forecasts simultaneously.

[10] 'Unconditional' in the sense used here means 'without other constraints'. As was mae clear in Section 3, the forecast is of course 'conditional' on the information set available but we do not consider that at this point.

There is, however, an additional problem in constructing conditional forecasts: the conditional inflation forecast (as expressed in (4.1) above) contains private sector inflation expectations which are based on another kind of policy expectations than the forecast itself. This problem is worth elaborating in some more detail.

In order to convey to the private sector how it sees the prevailing private sector expectations, even the conditional forecast must be based on the Central Bank's available information on the actual prevailing private sector expectations. This is completely different from assuming "rational" or model-consistent expectations i.e. expectations which would be unbiased and efficient under the assumed policy. The "rational" private expectation of inflation conditional on unchanged policy would be just $E_{P,0}(\pi \mid m = m_{-1}) = m_{-1}$ which is, of course, quite uninformative about the actual prevailing expectations.

On the other hand, the construction of forecasts based on assuming unchanged policy instruments in a way which would be satisfactory for the private sector's information needs is a conceptually complex task. These forecasts would have to be conditional on a monetary policy assumption $m = m_{-1}$ (which is generally different from the policy actually expected) *and* also conditional on the actual prevailing inflation expectations. The problems inherent in this become apparent especially if one considers multiple-period forecasts, which are important if the private sector is to be able to make efficient multiple-period commitments. In order to reveal its estimate of private sector expectations, these conditional multiple-period forecasts would have to assume away any learning or expectations adjustment even though the private sector is assumed to be surprised by policy in this kind of forecast.

Another serious problem in assuming unchanged policy instruments would follow from the price level indeterminacy which may arise in the forecast if the instrument in question happens to be the interest rate, for example. This problem cannot be examined with the present simple model in which the Central Bank controls the money supply directly, however.

In principle, another alternative to unconditional forecasting would be to publish forecasts based on (i.e. conditional on) the private sector's expectations of monetary policy. These policy expectations would then have to be measured (estimated) by the Central Bank itself. What does the Central Bank's macroeconomic forecast look like, formulated in period 0 and based on the assumption that the estimated policy expectations of the private sector are realised?

Recall that we have already established that in this model we have $E_{P,0}(\pi) = E_{P,0}(m)$ and that the errors of the private sector in predicting inflation can be reduced to errors in predicting the policy instrument (plus the eventual supply and velocity shocks), as given in (3.10) above.

Now, applying the Central Bank's expectations to the result (3.10), the Central Bank's period 0 forecast of the private sector's prediction error of inflation, *conditional on the assumption that* $m - E_{P,0}(m) = 0$, is just zero

$$E_{C,0}\left[\pi - E_{P,0}(\pi) \middle| m = E_{P,0}(m)\right] = E_{C,0}(v - s) = 0. \qquad (4.4)$$

This means simply that if the policy expected by the private sector is assumed to be actually followed, then only the supply and velocity shocks can cause prediction errors regarding to inflation. In period 0, the expected value of these

shocks is definitionally zero both from the point of view of the private sector and the point of view of the Central Bank.

Applying this result for the inflation forecast to the supply relationship (3.1), the Central Bank's output forecast conditional on the policy expected by the private sector also reduces to zero

$$E_{C,0}\left[y \middle| m = E_{P,0}(m)\right] = 0. \tag{4.5}$$

Finally, the Central Bank's inflation forecast under the assumption of policy expected by the private sector is simply equal to the Central Bank's estimate of the prevailing inflationary expectations

$$E_{C,0}\left[\pi \middle| m = E_{P,0}(m)\right] = E_{C,0}\left[E_{P,0}(\pi)\right]. \tag{4.6}$$

The first observation that was made above on conditional forecasts based on unchanged monetary policy applies here also. These forecasts do not reveal the policy target of the Central Bank and should therefore be complemented by an unconditional inflation forecast (i.e. the precise inflation target defined as the predicted result of the monetary policy pursued).

However, the consistency problem related to the forecast assumptions on the one hand, and the private expectations incorporated in the forecast, on the other, is a bit different here. The consistency between the Central Bank's estimate of the private inflation expectations and the Central Bank's estimate of the private policy expectations depends on whether the Central Bank sees the private sector agreeing itself on the transmission mechanism of monetary policy. If this condition is not satisfied, the assumption of "monetary policy as expected by the private sector" does not lead to an inflation forecast that would coincide with the Central Bank's conception of the private inflation expectations.

Now, the above problem could in principle be alleviated by forecasting subject to two independent assumptions: policy would be assumed as the Central Bank believes the private sector to expect, and inflation expectations would be included according to the Central Bank's estimate of the prevailing private sector inflation expectations. However, in this kind of forecasting, the assumed policy would be just as exogenous as in the case of "unchanged policy" and the same complications, which arise in that case, would emerge.

So far, we have analysed the forecasting problem under the assumption that the only informational asymmetry *in the forecasting-and-contracting period* of the monetary policy cycle is the imperfect ability of the Central Bank to observe prevailing private sector expectations. In practice, the problem of conditionality is even more wide-sweeping than this as the private sector and the Central Bank will form possibly different expectations of all 'exogenous' factors that may affect the economy. Private sector decision-makers are likely to feel that they know more about the potential shocks to economy than under the white noise shocks we have thus far assumed here. Insofar as these implicit views differ from the Central Bank's assumptions then private sector expectations will be built on a different basis from the Central Bank's forecast. This means that the private sector expectations may not be "rational" in terms of the Central Bank's forecast assumptions. We are not going deeper into the analysis of this problem here, but it seems obvious that the forecasting assumptions need to be made explicit by the

Central Bank if the private sector is to be able to extract the full information from the bank's forecasts and work out how the bank will have to change its settings of its instruments to achieve its target if the private sector's view of the 'exogenous' variables is correct.

The form of the model we have set out thus far in effect has a single period future since we assume we have no information about future shocks other than the expectations set E1, set out in section 3. 'Contracts' underlying the supply function are also assumed to have only a single period duration. In principle, our analytical framework could be extended to include interesting dynamic effects. Then, in forming a forecast in a multi-period framework the Central Bank would have to decide upon

$$E_{C,0}(s_t) = s_t^* \quad E_{C,0}(\nu_t) = u_t \quad E_{C,0}(e_t) = 0 \quad E_{C,0}(e_t \cdot \nu_t) = 0 \qquad \text{(E2)}$$

as well as π_t^* and a for as many periods t as there are in the forecasting horizon, where the s_t^* are the assumptions about future values of the 'exogenous' real factors and u_t the assumptions about future velocity shocks.[11] Monetary policy would in effect involve minimising a loss function over the future periods $U_0 = E_{C,0}(\Sigma_{i=0,t}\, \beta_i L_i)$ where $L_i = (\pi_i - \pi_i^*)^2$ and the β_i are the weights on the importance of the different periods (Walsh, 1995).

In the simplified way we have set our model up there would be little difference between the "static" and dynamic frameworks as the Central Bank can recover completely in the next period from an error made in the previous period.[12] In practice, however, there are lags between the decisions over the setting of policy and their impact on the target variable. The time horizon may be too short to correct an expected shock. Furthermore correcting shocks fully in the short run may lead to wide fluctuations in inflation in the longer run as the full effect comes through. In deciding upon policy, therefore, the Central Bank has to take the full impact into account across all relevant time periods.[13] On the basis of its expectations of the future fundamentals, the Bank will be able to solve out for the implied path of the setting of monetary policy m_t^*, even though, only the very first value m_1^* is actually set before the next forecasting round.

Since the private sector's expectations of the future are likely to differ from those of the Central Bank, it may form a view as to how the Central Bank will in practice alter the settings of monetary policy from those it projects, when it finds out that its assumptions about the future are incorrect. Then, we could distinguish several different cases in the equivalent of our earlier equations (3.16) and (3.16'). In the *opaque case* the Central Bank discloses nothing other than m*, its policy decision. In the *transparent case* it discloses the whole of its views about the

[11] More complex assumptions involving e might be possible especially with serial correlation but we abstract from these.

[12] This would even be true if the bank had a price level target and not merely an inflation target that lets bygones be bygones.

[13] The policy-relevant time horizon therefore has to include the whole of the major range of impact otherwise problems will tend to be built up for the periods just beyond the horizon and policy may become very unstable (Mayes and Chapple, 1995a). In the text we suggest three ways of mitigating this: having a target spread over the main period of impact; having a target that is a band and not just a point; adding a penalty for changing the instrument into the loss function (Svensson, 1997).

future including the implied path for m_t^*. It is obvious that in the general dynamic case, the full horizon would need to be included in the forecast (including the associated path of the instrument) if the Central Bank's particular views are to be disclosed in full and gains from transparency realised.[14]

5 Cheap talk, reputation and credibility

So far, we have not touched upon the important issue of credibility. We have assumed, in particular, that anything the Central Bank states about its view of the future is believed, including the actual inflation target. However, credibility issues are central to the theory and practice of monetary policy, and forecasts may not be believed if the Central Bank can mislead the public and has an incentive to do so; on the other hand, publishing forecasts may affect Central Bank credibility.

Generally, the private sector's inflation expectations are influenced by a combination of the track record of monetary policy and the commitments that the Central Bank makes regarding its future policy. The overall credibility of the bank is normally measured by the smallness of the gap between the target and public expectations of inflation. In order to stabilise private inflation expectations to a level corresponding to the inflation target, the Central Bank therefore has to convince the private sector of two things. First it has to persuade it that the strategy is likely to work and second it has to persuade them that the strategy is being followed. Indeed the more successful it can be in this persuasion the higher may be the weight the public puts on the forward-looking element of expectations and the less important history becomes. Nevertheless history will always remain important. A Central Bank therefore not only has to have a track record that the private sector associates with success but it has to be careful not to set up unfulfillable standards of success for the future.

In effect, therefore, credibility, as the difference between the private sector's expectation of inflation and the Central Bank's target $E_{P,0}(\pi) - \pi^*$, will depend on a combination of the Central Bank's record, its strategy, the framework for monetary policy and its current action in the face of prevailing circumstances. It is easy enough to think of the first element of the track record as a form of adaptive expectations or backward-looking weight. Clearly a Central Bank would like that weight to be high if the record is good and low if it is not. Hence considerable effort will be placed on the other three elements by those with weaker records. They will want to set up a strong institutional framework, with clear incentives for good performance to improve confidence – as with the Maastricht Treaty. The effort spent on the choice of m* will be correspondingly careful to avoid giving wrong signals. In a credible environment private sector expectations are not readily shifted by temporary deviations of m* from what the private sector would expect for m given its estimate of π^* and the prospects for the economy. By contrast, when credibility is low the private sector will readily believe that π^* is actually different from what is claimed or that the Central Bank's policy will not be successful in attaining its inflation objective.

[14] Clearly than is a whole spectrum of possible veiled cases between the transparent and opaque cases when only some of the information is revealed.

The principal concern in the literature on credibility problems (see Backus and Driffill, 1985, and Faust and Svensson, 1997, for example) is that the Central Bank's loss function is not $L = (\pi - \pi^*)^2$ as in (5) but something like

$$L = \lambda(y - y^*)^2 + (\pi - \pi^*)^2. \qquad (3.5')$$

In other words that the Central Bank then also has some concern for output as an objective as well as inflation. This could arise for several reasons, the simplest of which is that some Central Banks, such as the Federal Reserve do indeed have mandated multiple objectives that include output. Observed behaviour in the United States seems to have followed such a simple loss function (Taylor, 1993). In any case, governments are likely to have output and employment objectives in their loss functions as well as inflation (Walsh, 1995). Even though many Central Bank charters, such as that of the ECB, have been drawn up deliberately to exclude other objectives that might conflict with the pursuit of the inflation target, it would not be unreasonable if some people thought that from time to time the government would like the Central Bank to bear the other objectives in mind and that the Central Bank might respond.[15] Anyway, if the perceived Central Bank objective function includes output effects, or other incentives to surprise inflation, and if there are no "penalties" for reneging from commitments regarding to inflation, credibility will be undermined in the sense that private inflation expectations will deviate from the target π^*.

In practice, the credibility of the strategy can be achieved by a number of routes: – empirical evidence that it has worked (either in the same environment or elsewhere); an inherently plausible theory; institutional structures that are consistent with the theory. In part this can be achieved by incentives or "penalties" to monetary policy makers (Walsh, 1995), such as loss of income, employment or reputation if the strategy is not followed closely, in part it can be achieved through employing people with a reputation for success in this regard. These are measures depending on legislative action. Because credibility problems are essentially information problems, Central Banks can themselves find ways to alleviate them, typically through transparency. An important aspect of a credible strategy is that people can see that it is being applied. Showing the inflation forecast, the model of behaviour that underlies it and the reaction of policy to (within) the forecast are key ingredients of that transparency.

One way of handling this formally is to suggest that the private sector can base its beliefs on the Bank's intention through assessing a signal. That signal is not just the setting of an interest rate or money reference value but the whole range of information produced by the Bank, including any forecast. If private sector and bank expectations do not previously coincide there will be an 'announcement effect' from the signal that will move the two expectations nearer to each other. However, unless there is some cost to the Bank from signalling it is unlikely that it will gain much. This is the concept of 'cheap talk'. People will expect the Bank to say it is following price stability, whatever it is actually doing,

[15] The exclusion of these other objectives from the Central Bank's remit is normally deliberately to exclude the possibility of the Central Bank succumbing to the time inconsistency dilemma that faces the government (Kydland and Prescott, 1977). In such circumstances the government may wish in the short-run to try to increase output for electoral benefit even though they, and indeed the electorate, may believe this reduces longer term welfare as the costs of bringing the subsequent inflation down exceed the initial increase in output (Mayes and Chapple, 1995b).

because that is its obligation. For that statement to have a value in affecting expectations it needs to be backed up in some way or other. There are two obvious routes. In the first case, the cost of signalling to the Bank is a commitment (trivially there are direct costs in forecasting and communicating as well, see Palmqvist (1999) and these costs actually add to the credibility of the signal. The Central Bank commits itself to act to bring private sector beliefs in line with the stated goal. This therefore acts as a disincentive to the Bank to make false statements, as it would then have to carry through actions that are costly not only to the economy in general but also undesirable to the Bank itself.

Secondly, the Bank will lose reputation if the private sector believes it to be deviating from its objectives. Reputation in this sense, if it is to mean something different from credibility, implies the degree to which statements are believed in the absence of supporting evidence. Reputation is easily lost and difficult to repair so cheap talk is not likely to be used by Central Banks for whom inflation control is important and who act with a long term perspective. Reputation can only be rebuilt either by some institutional change that makes the commitment more plausible in the future or by a new history of repeated success. Siklos (1998) actually claims that Central Banks that are more transparent talk less. However, the statistical basis for his claim, using number of speeches recorded by the BIS, is open to question. Palmqvist's (1999) results fit with this. Only Central Banks with 'ambitious' targets gain from transparency.

The existing literature is weak on the size of the appropriate cost of signalling to the Central Bank. Palmqvist (1999) merely considers how great the signalling cost must be for the Central Bank to choose not to signal. For the case where the Central Bank announces its objectives his results conflict with those of Stein (1989). He suggests that where the inflation bias is large, signalling costs increase with imprecision over the target, whereas with low inflation bias they decrease. This occurs simply because signalling reduces flexibility of response in the future and the value of this discretion rises the greater the weight that the Central Bank wishes to place on output rather than inflation.

The original 'cheap talk' literature (Stein, 1989) supported the Cukierman and Meltzer (1986) result that the Central Bank will prefer a degree of imprecision in its statements. It had assumptions like: the Fed cannot precommit itself; that it has more than one objective and that it has private information. That private information may be merely that the Fed knows which objective it is actually following. This reintroduces the traditional time inconsistency dilemma that an inconsistent policy would result in higher utility – higher utility that is for the Fed. Stein follows the example of an exchange rate objective rather than the more traditional output objective as the second preference but this has no impact on the qualitative nature of the results. A key feature of the problem is that as soon as there are advantages to the Fed from not telling the truth it will no longer be believed.

The traditional literature is thus based on the belief that there is an inherent bias towards inflation lurking behind monetary policy. Even if one appoints an ultra- 'conservative' banker in Rogoff's (1987) sense this only moves the incentive problem higher to the government which may in some situations want to overrule the Central Bank (McCallum, 1995). Fischer (1994), however, points out that one could well believe that a Central Bank has the opposite bias and will through 'conservatism' tend to aim for lower inflation than its target. Although the words are the same there is an important difference in the nature of the

underlying model being used here as Rogoffian conservative focuses on inflation whereas a Fischerian conservative in effect aims at a lower target. The Rogoffian concern is with variance, the deviation of inflation from its target. It requires a considerable track record to be able to distinguish these two in practice. A deviation of inflation or expected inflation from the target could be interpreted as an unannounced change in the target (or 'inflation pessimism' by the Central Bank) or the existence of a nonzero weight on output fluctuations in the Central Bank's objective function.

6 Dealing with uncertainty

Once there is uncertainty policy will always appear to exhibit a degree of discretion even if the policymaker is seeking 'to exploit past patterns and regularities in a systematic way' (Greenspan, 1997) because the degree of uncertainty about an particular item of information will also tend to vary over time. This is a problem for Central Banks, as they generally would like to assure the rest of the economy that they are following a consistent and credible strategy. Below, we make brief remarks on transparency in the face of uncertainty.

6.1 Uncertainty in the monetary transmission mechanism

In our basic model, in setting the monetary instrument m in (3.20) so as to expect to achieve its target for inflation the Central Bank faces only additive error e in the velocity shock $\nu = u + e$ (as shown in (3.2) and the subsequent paragraph). Certainty equivalence applies (Senegas and Vilmunen, 1999). However, a more complicated case arises when the uncertainty is multiplicative, Brainard (1967) uncertainty. In this case

$$y = b(m^*) - \pi + \nu, \text{ where } b = 1 + g \tag{3.2'}$$

and

$$E_{C,0}(g) = 0 \text{ or } E_{C,0}[b(m)] = m^*, \quad E_{C,0}(b \cdot g) = 0. \tag{6.1}$$

Under multiplicative uncertainty, the Central Bank is no longer certain about the effects of changing its instrument, and the margin of errors will also be dependent on policy. A common way to analyse this is not to assume that the Central Bank operates directly on the money supply but that it uses an interest rate to try to achieve the monetary target. Its monetary control can thus be imperfect (Lippi, 1999; Schellekens, 1998; Senegas and Vilmunen, 1999).

Multiplicative uncertainty implies both that expected inflation will be higher and that its variance will be higher. Schellekens (1998) therefore suggests that multiplicative uncertainty actually leads to a more 'conservative' monetary policy and hence tends to reduce any problem of credibility that the Central Bank might have. However, the increased variance will mean that the policy-maker is likely to be less active in setting policy than under the case of certainty. If the additive and

multiplicative shocks are thought to be negatively correlated then this weakens the ability of a cautious response to Brainard uncertainty to improve credibility.

Senegas and Vilmunen (1999) show that there is an important distinction in the effect if the multiplicative uncertainty is common knowledge among both the Central Bank and the private sector. '[T]he impact of uncertainty is not invariant with respect to the informational structure of the monetary policy … which underlies it.' (p.25). Hence revealing the nature of the uncertainty can help in reducing the cost of monetary policy on society.

In terms of the model we used above, if the private sector and the Central Bank do not share a common view about E(y|m) then setting m will no longer give a clear signal of the value of π^*. This alters the set of alternative variables that the Central Bank needs to publish in order to convey its aims and private information. Announcing the expected value of the monetary policy instrument is no longer effective in informing the private sector of the aims of the Central Bank's policy and disclosing an unconditional inflation forecast is needed to achieve this. Another (essentially equivalent) alternative would be to publish the model used to set the monetary policy instrument. The Central Bank would in effect need to publish $E_{C,0}[b(m^*)]$ which could enable the private sector to calculate the implied goals of the announced policy.

Of course the way that the uncertainty creeps in will not just be through uncertainty about the parameters of the relationships but about the data themselves. Even the price series, which in most countries is not revised, is only an imperfect measure of the underlying variable. This is not just because of the underlying biases in the series (Boskin et al, 1998) but because it does not give an exact picture of the 'underlying' or 'trend' inflation that Central Banks normally try to target (Mayes and Chapple, 1995a). Although this introduces an additional source of uncertainty it will still be multiplicative as in the case of parameter uncertainty. Since both forms of multiplicative uncertainty can occur simultaneously, we would therefore have to handle not just their variance but their covariance as well, which could increase or diminish their combined effect depending upon the circumstances.[16]

6.2 Incorporating uncertainty into the forecasts

A drawback about traditional forecasts is that they present either the expected value or the most likely outcome (Kuttner and Posen, 1999). Only a single statistic is used to represent the whole distribution of possible outcomes. However, for some years forecasters have been concerned about the distribution of their errors (McNees, 1979, 1986) and have begun to add information on past errors as an indication of the variance that can be attached to forecasts of the future (see *National Institute Economic Review, passim* from the late 1970s, for example). However, this procedure makes several strong assumptions. It assumes we know nothing about the future on each occasion that could alter the likely spread of outcomes. It assumes that we have learnt nothing from previous experience and that current errors will be similar to the performance in the past. It

[16] We are only discussing here the case where the uncertainty about the data is temporary and is resolved as revised estimates are produced. If it is never resolved then there will be biases in the estimates from the normal problem of 'errors in variables'.

assumes that all the variations in the team of people forecasting and the models and methods they have used to achieve these forecasts are irrelevant in assessing the likely future risk.

Another obvious way to assess forecast uncertainty would be to consider the calculated 'forecast' errors from the Central Bank's model. Normally with nonlinear models this will require stochastic simulations. Even this requires the assumption that the distribution of future shocks will be similar to those in the fairly recent past.[17] Indeed the problem is even more complex as soon as we consider the role of policy, where the Central Bank itself has the power to affect future values of inflation, by use of its monetary policy instruments, if they show signs of deviating unacceptably far from the target. Then the "feedback" rule of the Central Bank has an effect on the degree of uncertainty regarding inflation and other outcomes. Importantly, the Central Bank's information policy – its commitments and its transparency – will also affect private sector expectations and hence the probability distribution of actual outcomes, too. The current state of the art in quantitative simulation models is not really capable of dealing with these effects. Finally, using a single macroeconomic model is normally not sufficient for forecasting purposes in practice. It will be augmented by judgement and other models; then the formal calculation of forecast error distributions becomes even more difficult.

These difficulties notwithstanding, some Central Banks do present error variances for their forecasts. The Bank of England takes this even further by adding a measure of skewness (Bank of England, 1999). This at least enables one to discuss "the balance of risks" about the forecasts and gets over the dilemma of whether to publish the most likely outcome or the expected value (by in effect publishing both). Apparently (see Sgherri and Wallis, 1997) the Bank of England generates the variance of its forecasts from the distribution of previous forecasting errors (thus making no allowance for its own ability to correct such errors through subsequent policy) and adds a measure of the skew for each future period based on judgement. The width of the distribution published in the *Inflation Report* may therefore tend to overstate the actual variance both because it does not allow for such ability to correct and because it does not allow for the improvements in methodology of recent years.[18] The Swedish Riksbank on the other hand (Blix and Sellin, 1998) attempts to apply its uncertainty about outcomes just to the input assumptions and allow a model to compute the resulting distributions for the 'output' variables, inflation and GDP growth. However, the use of judgement in the forecasting process means these have to be overwritten to some extent in practice.

Such probability densities have two functions. First of all they give a much richer insight into how the Central Bank views the future. They help explain how strongly the views of the future are held. Round turning points one would expect the variance to increase, for instance. Similarly when consequences from some impulse are expected but appear to have been delayed this will add to the skew of the projected outcomes. Secondly they help enable the Central Bank to change its mind in the face of new evidence without any great loss of face or credibility. This

[17] Where models are calibrated, either wholly or in part, such shock distributions will need to be based on a VAR or other simple representation of the behaviour of the economy (Drew and Hunt, 1998).

[18] There is obviously a danger that if forecast ranges are shown to be very wide only a couple of years into the future, that they convey relatively little information.

not only enables the Central Bank to avoid giving any spurious impression of accuracy in its original forecasts but it enables it to explain more readily why the balance of opinion over the appropriate policy action can shift quite markedly even when there has been little new information.[19]

The use of distributed forecasts thus helps to remove any trade off there might be between reducing the costs to society from a lack of transparency in publishing the details of a forecast and the costs that would be imposed by reducing the credibility of the Central Bank by publishing 'inaccurate' forecasts.[20] The difficulties in estimating the error distribution of forecasts are considerable. However, it may be that attaching particular probabilities to different possible outcomes is not that essential to conveying what the Central Bank's intentions are. An alternative is to present scenarios, each conditional on particular events the probabilities of which need not be specified. Also that could help avoid unnecessary loss of credibility in the event inflation deviated from what was expected, while still containing a lot of information on how the Central Bank sees the future.

7 Concluding remarks

In this paper we have used a simple model of a Central Bank focused on maintaining price stability to show the advantages of transparency from publishing forecasts. While it is easy to show, in line with the existing literature, that publishing a forecast would reduce the costs of monetary policy to society in a world of limited uncertainty; greater uncertainty requires a more complex response.

Some of the main results of the above analysis can be summarised as follows

- Once the possibility of heterogeneous expectations is taken into account, the Central Bank's conceptions of the prevailing inflation expectations are a key determinant of monetary policy.
- The Central Bank's errors in assessing the prevailing private inflation expectations are one of the sources of fluctuation in the actual inflation rate and they can disturb the real outcomes too.
- If the private sector can detect the Central Bank's errors in estimating private expectations, this helps to insulate the private sector from the Central Bank's inevitable policy mistakes. In that case the Central Bank's errors in assessing the private expectations do not affect real outcomes.
- The role of publishing official Central Bank the forecasts can be that they convey to the private sector the basis of future monetary policy, in particular the Central Bank's view of predictable inflationary pressures (in our model, condensed to the private sector inflation expectations) and the Central Bank's precise inflation target (its 'unconditional' inflation forecast).

[19] Where the actual votes for policy changes are known, as in the case of the UK, this helps add to the understanding of the degree of uncertainty in the bank and to make better judgements of what decisions are likely to be made in the future.

[20] The presentation of forecasts on the basis of likely and explicit conditions explained in Sections 4 and 5 further helps reduce the chance of loss of reputation.

– The official unconditional forecast embodies all of the relevant information in the sense that both the policy target can be inferred from it (as it is equal to the Central Bank's unconditional forecast) and the private expectations (as they determine the Central Bank's own forecast of real development and/or its future monetary policy.

As is clear from the last point, even when producing multi-period forecasts, the information content and gain to the economy from reduced uncertainty are greatest when the Central Bank's published forecasts are unconditional in the sense that they include the Bank's best estimate of what the settings of policy would need to be given all the other assumptions behind the forecast.

We have shown how transparency reduces the scope for uncertainty by the private sector about the Central Bank's actual target. Once there is multiplicative 'Brainard' uncertainty then transparency will help the private sector distinguish between responses to information about the nature of the shock and a change in the target. However, in this case just producing forecast numbers will not be sufficient. '[A]n indepth explanation of the reasons behind a particular policy change' (Schellekens, 1998, p. 29) could help.

There is a fear that, since the future is uncertain, a Central Bank will lose credibility by publishing forecasts, as any such forecasts will either differ from actual outcomes, or will only be coincidentally 'right for the wrong reasons'. If this were true then there would be a trade off between the costs of the loss of credibility and the costs of the lack of transparency from not publishing. We suggest that this trade off does not exist. In the first place the danger of the private sector treating Central Bank projections as unconditional forecasts can be reduced if the assumption the Bank makes about 'exogenous' factors in the future and the 'model' of behaviour it uses are made explicit. Secondly, the relevance and accuracy of projections can be increased if they include the reaction of monetary policy. Indeed if such reactions are not included the projections will be inconsistent and would tend to show the Central Bank failing rather than succeeding in its task.

Lastly we suggest that it is the preoccupation with point forecasts that has created this artificial trade off between transparency and credibility. In an uncertain world the appropriate way forward is to project the uncertainty and show the distribution of outcomes the Central Bank expects on the basis of explained assumptions about what may happen, how the economy works and how the bank proposes to respond. Following this approach would minimise the uncertainty in the mind of the private sector about the intentions of the Central Bank and hence minimise the costs of monetary policy related to that uncertainty. At the same time it will enhance the credibility of the Central Bank by providing a credible strategy for action rather than just producing point estimates, which even with explanation, will tend to be incomplete and hence less than fully credible.

The advantages of this form of transparency are being more widely recognised. The ECB has now begun to make statements about the likely range of outcomes it foresees for GDP growth in the current and next years (Duisenberg,1999b). It has commented on the prevailing private inflation expectations in its statements. It has also made remarks about the likely direction of policy (Noyer, 1999 and Duisenberg, 1999a) although apparently the ECB does not intend to give explicit indications of the 'bias' of future policy like those given by the Federal Reserve.

The Eurosystem faces two main difficulties that are relevant in this context. The first is that there can be a suspicion that it will be open to influence. It is obvious on the one hand that some governments hold different views about the way the economy works and possibly even disagree about the importance of price stability or the definition of price stability that the ECB has chosen. There is thus a danger of prima facie scepticism, which could increase every time the euro economy appears to be performing weakly, that the ECB will succumb to these pressures, even if only subconsciously. Under such conditions, a very high degree of transparency of the policy process is required to ensure that monetary policy can react to new information without evoking suspicion that its strategy has been abandoned.

Secondly the Eurosystem faces very real difficulties in conducting monetary policy in the face of a major structural change. Introduction of a single currency to a group of countries that still have considerable discretion of fiscal and structural policies has no direct precedent. Not only can the private sector be expected to adapt and change its actions, particularly in financial markets and in the setting of prices, wages and other aspects of labour market conditions, but the public sector is likely to learn and change as well. If some countries find that they are unable to respond adequately to the pressures or see opportunities to respond more favourably they will tend to want to change their policies. There are already strong signs of these pressures from the attempts to resist change in the setting of tax rates and labour market conditions. There is a fear of a 'rush to the bottom' (Marquand, 1994; Swank, 1998).

In these circumstances there is considerable uncertainty about how the euro economy will work, particularly about how the transmission mechanism between monetary policy actions and price stability will operate. Not only will there be change in private sector behaviour and fiscal policies but the experience of the past will be somewhat irrelevant just because the euro economy is a large one by international standards, even compared with the area covered by the monetary policy previously led by Germany. International economic relations will therefore be different. Finally, structural change extends to the information base of monetary policy as well. Euro area data have had to be assembled and because of institutional differences between euro area countries, the harmonisation of the national components is necessarily limited. The information content of the new statistics may therefore be rather more difficult to interpret than the monetary authorities of the national Central Banks have been accustomed to in the past.

As Buiter (1999) explains, it is easy to overstate these difficulties by comparison with the extent of structural change in many of the countries that have opted for a more transparent approach. Indeed the transparency can be seen as a sensible response to the uncertainties introduced by structural change. Sweden, Finland and the UK were faced by a major change in behaviour when they were forced out of the ERM in 1992. New Zealand undertook what is probably the largest structural transformation of any OECD economy in recent years. Even the Czech Republic, which, as a transition economy, is facing difficulties and uncertainties an order of magnitude greater than anything in the EU is adopting a remarkable level of transparency. In all of the above cases, the efforts to increase transparency were prompted by the need to enhance credibility of monetary policy in conditions of structural change.

Further advantages stem from the explicit treatment of uncertainty in the published forecasts, as it is possible then for Central Banks to explain credibly

that its decision-making board can have legitimate differences of view about what to do in any given circumstance. The members of the board are only faced by probabilities, not certainties, and these probabilities need to be assigned weights on the basis of limited information. Secondly, changes in policy, which appear to stem from only small changes in information can be rendered much more credible. A small change in probabilities can change the balance of opinion. Uncertainty paints a world in shades of grey. A credible and transparent monetary policy takes clear and firm decisions in the light of those shades rather than trying to describe it as black and white.

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