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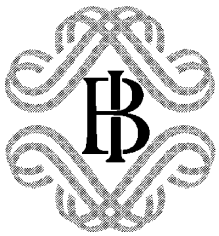
Are Model-Based Inflation Forecasts Used in Monetary Policymaking? A Case Study

by S. Siviero, D. Terlizzese and I. Visco



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SINTESI

Il contenuto di questo lavoro esprime solamente le opinioni degli autori; pertanto esso non rappresenta la posizione ufficiale della Banca d'Italia.

L'utilizzo di un modello econometrico nella formulazione delle scelte di politica monetaria non avviene mai secondo le modalità, schematiche e meccaniche, descritte nei manuali di economia. La complessità della realtà economica e la fondamentale incompletezza del modello impediscono che i risultati degli esercizi di simulazione si traducano in automatiche, precise reazioni delle autorità monetarie, rendendo così non banale la domanda: le decisioni prese hanno tenuto conto dei risultati del modello?

Obiettivo del lavoro è documentare, con una metodologia econometrica, le eventuali "tracce" di un utilizzo delle previsioni di inflazione elaborate con l'ausilio del modello econometrico trimestrale della Banca d'Italia nelle decisioni di politica monetaria relative al periodo 1995-97, anni in cui il perseguimento di un sentiero disinflazionistico ha costituito l'obiettivo primario dell'autorità monetaria.

I risultati empirici mostrano che le previsioni relative alla dinamica dei prezzi prodotte con il modello trimestrale hanno svolto un ruolo significativo nel processo decisionale: in particolare, le differenze tra quelle previsioni e gli obiettivi di inflazione annunciati, per l'anno in corso e per il successivo, dal Governatore della Banca d'Italia sono positivamente correlate con l'andamento dei tassi di interesse di *policy.* Le conclusioni dell'analisi empirica appaiono essere robuste, in quanto il legame tra le previsioni realizzate con il modello trimestrale della Banca d'Italia e gli interventi sui tassi di *policy* non viene meno anche qualora si tenga conto di altre variabili potenzialmente rilevanti nell'ambito del processo decisionale (tasso di inflazione effettivamente osservato nel periodo precedente, previsioni di inflazione elaborate in maniera indipendente da altre istituzioni, evoluzione di breve periodo del cambio della lira).

Pur senza configurarsi come una descrizione accurata ed esauriente di un'ipotetica "funzione di reazione" delle autorità di politica monetaria, i risultati indicano come queste ultime abbiano agito, nel periodo in esame, in modo *forward-looking*, basando le proprie decisioni non solo sull'andamento effettivo della dinamica dei prezzi rispetto al sentiero di disinflazione desiderato, ma anche sullo scostamento delle proprie previsioni dagli obiettivi annunciati.

ARE MODEL-BASED INFLATION FORECASTS USED IN MONETARY POLICYMAKING? A CASE STUDY

by Stefano Siviero,[*] Daniele Terlizzese[*] and Ignazio Visco[**]

Abstract

The process through which economic policy is conceived and decided cannot be simply described as the optimisation of a well-defined loss function subject to the constraints provided by a model of the economy. Even ignoring the forbidding difficulties of eliciting a stable and explicit loss function from real-life policymakers, the availability of a model reliably describing all the responses of a complex economy to policy interventions is hardly to be expected. Policy will therefore be made against the background of an incomplete model, lacking some policy transmission channels, subject to data revision and possibly to instability in the estimated equations, requiring continuous reassessment in the light of the available data.

Drawing on the experience gained with a macroeconometric model at the Bank of Italy, in this paper we describe the uses to which such a model can be put in the policymaking process. We find empirical support for the claim that the model is used in policymaking by assessing the extent to which the monetary policy followed by the Bank of Italy in a recent episode was influenced by inflation projections that diverged from the announced targets and by trying to identify other influences that played a role. The episode considered covers the 1995-97 disinflation, when upper limits to the current- and next-year inflation rates were explicitly announced by the Governor. The empirical analysis clearly indicates a role for model forecasts of inflation in monetary policymaking. This conclusion is robust, as inflation forecasts are shown to possess explanatory power with respect to policy choices, together with a number of other factors, including lagged values of the policy instrument, lagged inflation and other, independent, inflation forecasts.

Contents

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1. Introduction and main findings[1]

Are macroeconometric models used in policymaking? In more explicit terms, is the design of policy based on a quantitative, forward-looking assessment of economic conditions and the impact of policy instruments, thereby avoiding the often voiced criticism that likens policymaking to the attempt at driving a car while looking in the rear-view mirror? If models were used in the textbook way the answer to these questions could be easily obtained by comparing the values of the policy instruments required to achieve (given the model) the policy targets — or, more generally, the values of the policy instruments implied by the minimisation of the policymaker's loss function subject to the constraints provided by the model — with the policies actually implemented. If the two sets of values are the same, then it can be safely concluded that the model has been used; if substantial differences are found, the opposite conclusion should be drawn.[2]

However, for reasons which will be recalled in the next section, models are not used in the textbook way by policymakers, who rarely, if ever, accept the straight-jacket of a model-based policy rule.

To provide an answer to the original question — and implicitly a rebuttal of the mentioned criticism — a different approach is therefore needed. One such approach could be simply to investigate whether model simulations and forecasts are provided to policymakers, and thus form part of their information set when taking policy decisions. From this point of view our direct experience within a central bank, and our indirect knowledge of the practice followed in other central banks, certainly confirms that model forecasts and simulations are

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[1] A previous version of this paper was presented at the Congress "Empirical Models and Policy Making", Tinbergen Institute, Amsterdam, 14-17 May 1997. Helpful comments from the participants in that congress, as well as from Ignazio Angeloni, Fabrizio Barca, Peter van Bergeijk, Paola Caselli, Carlo Giannini, Giuseppe Parigi, Salvatore Rossi and Paolo Sestito, are gratefully acknowledged. The usual disclaimer applies. The views expressed in this paper are the authors' own and do not necessarily reflect those of the Bank of Italy nor those of the OECD.

[2] This conclusion is a bit sharper than it should be. In fact, an external observer uncertain as to the precise loss function of the policymaker or overlooking the possible conditional nature of the policy prescriptions arising from the model might detect differences between the latter and the policies actually implemented which should not be taken as evidence rejecting the hypothesis that the model is used in policymaking. Hence, the comparison between the two sets of policy instrument values should be made with some care.

regularly presented to decision-makers. This however provides no guarantee that the actual choices do reflect, in some form, the model-based inputs.

Drawing on the experience gained in using a macroeconometric model at the Bank of Italy, we follow a more customary behavioural approach, looking for "traces" of the model-based inputs in policymakers' behaviour, that is, in their policy decisions. In particular, we find empirical support for the claim that the model is used in policymaking — the more ambitious claim that it is useful would require a counterfactual experiment and will not be attempted — by assessing the extent to which the monetary policy followed by the Bank of Italy in a recent episode was influenced by inflation projections that diverged from the announced targets and by trying to identify other influences that played a role. The episode considered covers the disinflation of the period from mid-1994 to end-1997, when upper limits to the current- and next-year inflation rates were explicitly announced by the Governor of the Bank. It thus has the advantage of allowing direct comparison between forecasts and targets. The sample is small, however, so that there is a need for caution in interpreting the results. This notwithstanding, the empirical analysis clearly indicates a role for model forecasts of inflation in monetary policymaking.

This conclusion is robust, as inflation forecasts are shown to possess explanatory power with respect to policy choices, together with a number of other factors, including lagged values of the policy instrument, lagged inflation and other, independent, inflation forecasts. We do not interpret the estimated equation as a fully-fledged reaction rule of the monetary authority. Indeed, as mentioned before, we doubt that monetary policy could ever be characterised, with an operationally acceptable degree of accuracy, as a stable and simple policy rule. In the period that we investigate, however, the overriding concern of monetary policy was wringing inflation and inflation expectations out of the Italian economy, making it more likely that a relatively simple characterisation of policymaking behaviour emerges. At any rate, we interpret our investigation as a modest attempt at verifying, with a case study,

whether there is any econometrically detectable record of model forecasts having played a role in policy decisions.[3]

It is perhaps interesting to draw a parallel between our attempt and that of a recent paper by Christina and David Romer (1996). Romer and Romer, after establishing that the inflation forecasts produced by the Fed are superior to those produced by commercial forecasters, investigate whether the latter could extract the additional information embodied in the Fed forecasts (released with a five-year lag) by looking at the Fed's policy decisions. This implicitly assumes that these are influenced by "in house" forecasts.[4] It is this implicit assumption that we are testing in the case of the Bank of Italy's decisions.

The paper is organised as follows. Section 2 briefly outlines the difficulties inherent in the textbook approach to economic policy, stressing in particular that some policy transmission channels are likely to be missing. Section 3 places the recent period of exchange rate fluctuation and disinflation — which provides the basis for our empirical analysis — within the perspective of longer-term price developments and exchange rate arrangements; this also helps to clarify the problems arising with the use of the model as a result of the changes in exchange rate regime that Italy went through recently. Section 4 lays down a conceptual framework within which the use of an incomplete model can be better understood and justified. Section 5 empirically tests whether the policy followed relied on the model forecasts, possibly together with other sources of information and other anticipatory indicators. Section 6 concludes. The Appendix details the data used in the empirical investigation.

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[3] As we rely on the specific experience gained with a model used in a central bank, we shall identify the general notion of economic policy with the more specialised one of monetary policy and focus on inflation as the main (indeed, for the sake of simplicity, the sole) variable of interest.

[4] In particular, Romer and Romer are able to reject the hypothesis that the superior information embodied in the Fed's forecasts concerns the future course of monetary policy, leaving only the other possibility, namely that the Fed reacts to its inflation forecasts in taking its decisions.

2. Why the textbook approach to economic policy does not work

The policymaking role of economics is paradigmatically exemplified[5] in the approach pioneered by Ragnar Frisch and Jan Tinbergen: formally compute the values of the policymaking instruments that minimise some loss function subject to the constraints provided by an econometric model of the economy. Under this approach economics almost replaces policymaking: the policymaker provides the loss function, the economist does the rest. A clear distinction is made between value judgements concerning goals and technical judgements concerning the feasibility of policymaking, and the roles of policymakers and economic analysts are defined accordingly.

Many criticisms can be, and have been, raised against the Frisch and Tinbergen approach, though it undoubtedly has the great merit of having described the contribution of economics to policymaking in a logically consistent way, thereby making it possible for objections to be precisely formulated.

The policymaker does not always have a clear idea — independently of the actual possibilities available — of what he wants to achieve and the relative trade-offs. It is therefore likely that knowing what could be achieved, and at what cost, will influence the setting of the policy targets. In addition, the weights attributed to sequentially changing goals are likely to shift through time, taking into account the genuine accumulation of new knowledge as time goes by — as opposed to the mere unfolding of a specific path along a pre-specified date-event tree. Moreover, even if we grant that a policymaker has the conceptual equivalent of a stable loss function in his mind, the difficulty of eliciting that information is likely to be insurmountable, for reasons pertaining both to culture and language on the one hand and to accountability, political pressures and changing constituencies on the other. There goes, then, the sharp separation between policymaker and economist of the approach just outlined.

Even more important, however, are reservations regarding the second ingredient of the approach, namely the availability of a model that reliably describes all the responses of a

[5] The paradigm is not uncontroversial. In particular, it implicitly assumes that the economy needs policy, as it does not always produce optimal results. Furthermore, the impossibility — demonstrated by Arrow — of deriving a collective criterion to evaluate economic results solely on the basis of individual preferences is side-stepped by resorting to the preferences of a democratically (or otherwise) designated government.

complex economy to policy interventions. To start with, the simple assessment of the initial conditions will be at best fuzzy, with the distinction between what is already known, what can be confidently guessed and what is still unknown all too often blurred. In addition there is, of course, the Lucas Critique on the lack of invariance of the model structure to policy changes, a point that has perhaps received more attention than it deserves.[6] But even if the model were to show little sensitivity to the sort of problems raised by Lucas, some of the policy transmission channels are likely to be lacking and others will only be crudely and approximately taken into account. Indeed, model simulations are — and are recognised to be — unfinished products, to be combined with a number of other "factors of production" in the making of policy. Given an incomplete model, lacking some of the policy transmission channels, subject to data revision and possibly to instability in the estimated equations, requiring continuous reassessment in the light of the available data, policy will not derive in the textbook fashion from the minimisation of a loss function subject to the constraints provided by a model of the economy. It will rather "emerge" — to use the expression introduced in a perceptive recent paper by R. Smith (1998), where a number of additional remarks on the use of models by policymakers can be found — from a variety of sources, with the model providing, perhaps indirectly, some of the ingredients used in the policymaking process. To put it differently, no straightforward model-based "policy rule" is offered to policymakers — we doubt whether it would be taken seriously anyway — for a reason that is much more fundamental than the non-structurality of coefficients. Models are inherently incomplete, both in their descriptions of the economy and in their ability to capture all the channels through which policy might affect the behaviour of the economic system, so that the very exercise of deriving the optimal policy rule is a forbidding one.[7] Most importantly, those who use models are aware of this, and have to find ways to recover the

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[6] In fact, agents might adopt feedback behaviour — as opposed to the feedforward behaviour that is at the root of the non-structurality identified by Lucas — and this could be tested (Hendry, 1988; Favero and Hendry, 1992); even if we assume that agents form their expectations rationally, the possible indeterminacy of the equilibrium might lead to "Lucas-proof" decision rules (Farmer, 1991); the sort of policy changes in which we are interested might not be the fundamental regime changes envisaged by Lucas (Sims, 1982); even if each individual agent revises his decision rules anticipating a change in policy regime, the aggregation of heterogeneous responses might turn out to be much less sensitive than any of the individual ones, so that entirely neglecting the individual non-structurality might be better (Altissimo, Siviero and Terlizzese, 1999).

[7] A Bayesian approach, involving a prior distribution on the possible "completion" of the model, is theoretically conceivable. However, this is not likely to be a viable option due to the practical difficulties that would arise and thus to the "complexity-induced" scepticism on the policymaker's side.

information embodied in model simulations and to make good use of it for policymaking purposes. More specifically, models need to be supplemented with an assessment, most likely a fuzzy one, perhaps only of a qualitative nature, of the missing channels. As the policymaker is often in the best position to make that assessment — if only because he must bear the responsibility for the ultimate choice — the incompleteness of models leads to a crucial interaction between model and policy, which is absent in the textbook approach. In the end, the quantitative contribution from the model will often be framed in terms of a forecast, providing a benchmark — conditional on informed guesses regarding the missing transmission channels — to be compared with the policy targets in order to assess the need for changes in the policy stance, even if their precise size cannot be determined as the result of an optimal control exercise.

These arguments are certainly not new among economists in central banks and other policymaking bodies. While less common in the academic literature, interestingly they appear to underlie, at least in our reading, the distinction recently introduced by Svensson (1998) and Rudebusch and Svensson (1998) between "targeting rules" and "instrument rules", where the former "is represented by the assignment of a loss function over deviations of a goal variable from a target level" and the latter expresses the "policy instrument as an explicit function of available information". Clearly, in a "textbook world" these two kinds of policy rule would be equivalent. Indeed, as stated by Rudebusch and Svensson (1998), when coupled with a particular model the targeting rule becomes a (perhaps implicit) instrument rule. On the other hand, in a world in which policymakers are reluctant to commit to the exclusive use of a particular model — due to the inherent incompleteness of models — and want to retain the freedom to supplement model simulations with additional information and judgements, that distinction can be justified. In fact, targeting rules are the superior alternative.[8]

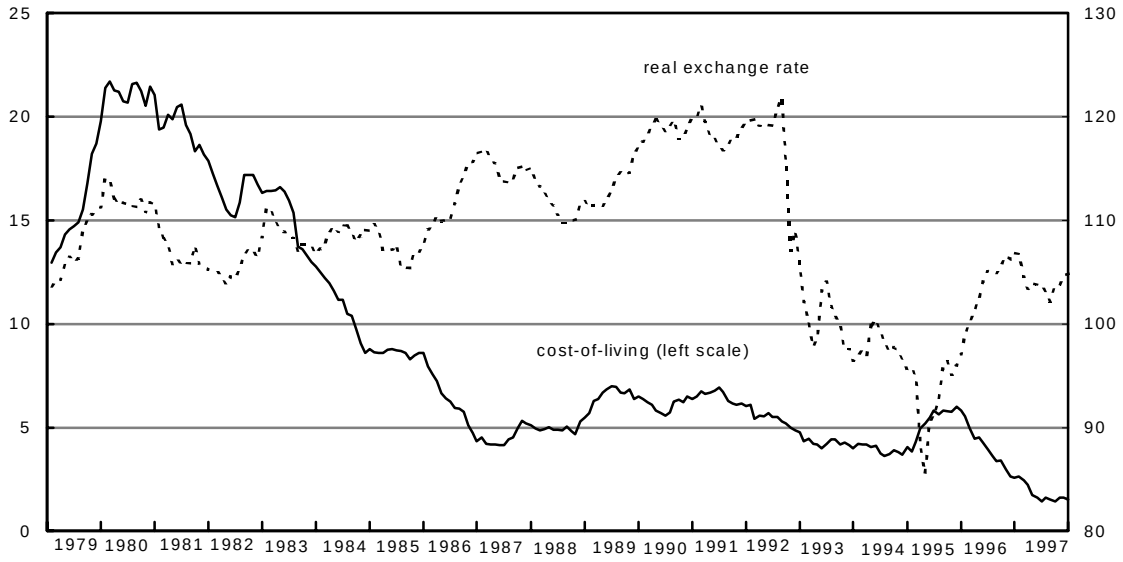
[8] In the words of Rudebusch and Svensson (1998, p. 2): "Every central bank uses more information than the simple (instrument) rules are based on, and no central bank would voluntarily restrict itself to react mechanically in a predescribed way to new information".

3. Monetary policy in recent years: a bird's eye view

Between 1980 and 1985, that is between the aftermath of the second oil shock and the eve of the oil counter-shock, the Italian rate of inflation more than halved, from above 20 to below 10 percent (Figure 1). Between 1986 and 1992 — which saw both a far-reaching labour cost agreement that led to the formal termination of the existing wage indexation systems and the September exchange rate crisis — it hovered around 5.5 per cent. The disinflation was mainly pursued through a non-accommodating exchange rate policy within the ERM agreements of the EMS, supported by an appropriately rigorous monetary policy stance.[9] Owing to the slow progress in creating the necessary flexibility in the bargaining system, and more generally in price setting behaviour, and above all to the continuous build-up of public sector deficits, which led to the accumulation of an extremely large public debt, the exchange rate commitment proved insufficient to complete the process of disinflation.

Figure 1

COST OF LIVING AND REAL EXCHANGE RATE OF THE LIRA (1)
(percentage changes on twelve months earlier for the cost-of-living;
index 1993=100 for the real exchange rate)



(1) Calculated vis-à-vis the currencies of Italy's principal trading partners. A rise in the index indicates an appreciation of the lira.

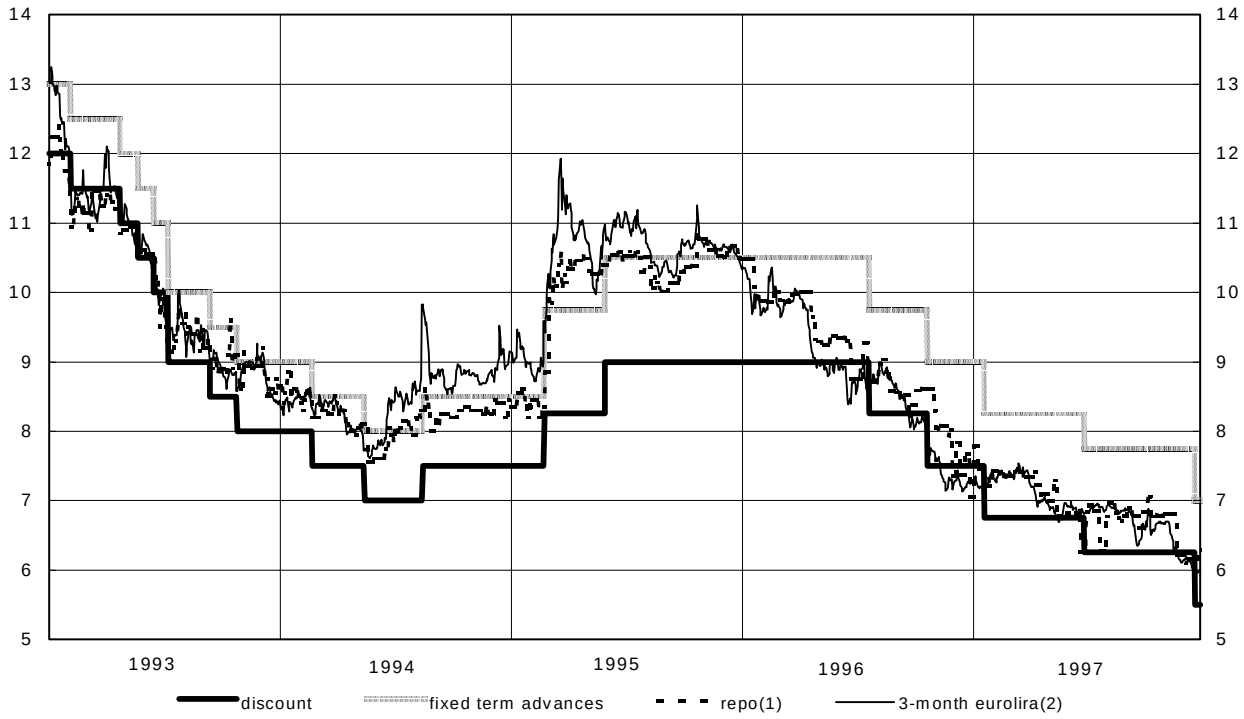
[9] For more details, see Gressani, Guiso and Visco (1988), where the role of incomes policy measures in the mid-eighties is also described.

This state of affairs eventually led to the exchange rate crisis, with the suspension of the Italian lira from the ERM and its free floating (and major depreciation) thereafter.

While this is not the place to provide a detailed evaluation of that episode,[10] it should be observed that up to the September crisis the disinflationary role of monetary policy, acting through the exchange rate channel, had been effective on the whole and in line with a priori expectations. However, in the absence of the necessary adjustment in labour relations and given the absorption effect of the growth in domestic demand fostered by the rising public sector deficits and debt, the current account of the balance of payments progressively reflected the loss of competitiveness associated with the stability of the nominal exchange rate and the country's overall net foreign debt became substantial.

Figure 2

BANK OF ITALY POLICY RATES AND EURO-LIRA INTEREST RATES
(percentage points)



(1) Marginal allotment rate.
(2) Libor rate.

[10] See Visco (1995) and Rinaldi and Santini (1998).

After September 1992, the risk of inflation, especially as a result of the pronounced depreciation of the lira, was countered by a very restrictive monetary stance accompanied by a major fiscal tightening. This helped to defuse the view that a public debt above 100 per cent of GDP and still growing meant an "inflation solution" was inevitable. Together with the depreciation of the lira, the substantial slowdown of domestic demand fostered a remarkable sequence of current account surpluses that has now practically eliminated the net external debt.

Notwithstanding the pronounced depreciation of the lira, in the following two years inflation continued to decline, partly owing to the wage moderation produced by the two labour cost agreements of July 1992 and July 1993 and the high level of unemployment.[11] The Bank of Italy accompanied the reduction in inflation with a gradual easing of monetary conditions (Figure 2). Short-term interest rates were gradually and steadily lowered, while monetary objectives were pursued that incorporated the ambitious targets for inflation set by the government.

In the summer of 1994, as the risk of inflation started to materialise in connection with a further weakening of the exchange rate (Figure 3), the acceleration of economic activity and the deterioration of both financial market and survey price expectations, monetary policy was unexpectedly tightened. At first money market rates were raised, followed in August by the official rates. With political turmoil and considerable uncertainty regarding fiscal policy, inflation expectations and long-term interest rates continued to rise in the following months, and the exchange rate continued to weaken.

As the dollar tumbled in the wake of the Mexican crisis, the lira collapsed in February and March 1995, notwithstanding a further increase in the official rates and the introduction of a substantial fiscal package by the new Italian Government. To the inflation risks which stemmed from the depreciation, originating in the financial markets' assessment of the state and prospects of the public finances, the Bank reacted immediately with a further hike of its repo rates, followed at the end of May by a third increase in the discount rate (to 9 per cent, 225 basis points higher than in the spring of 1994).

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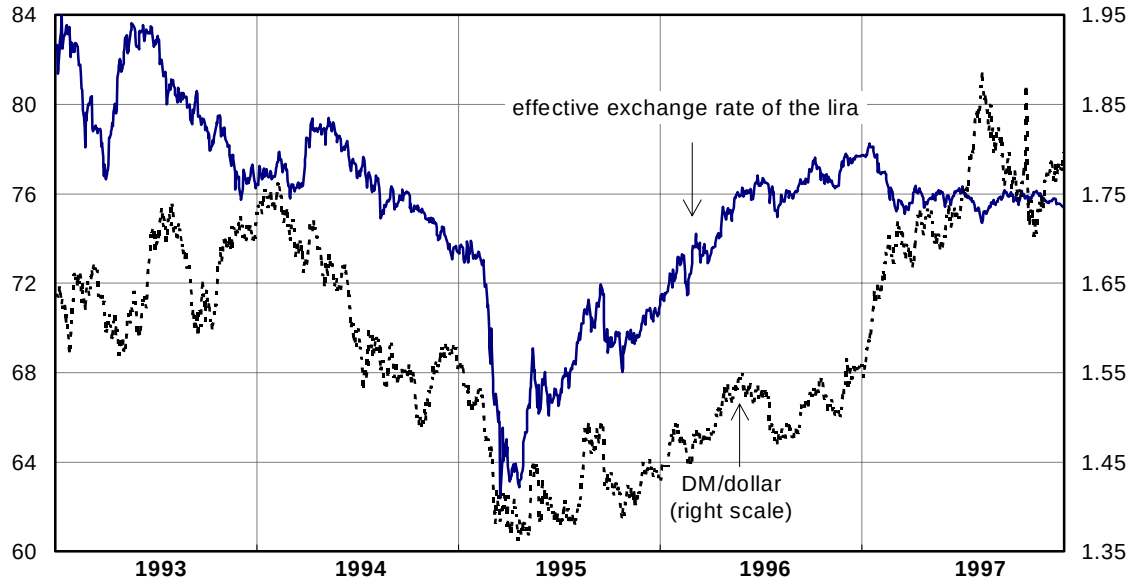
[11] The effects of the labour cost agreements and the exchange rate depreciation on the balance of payments and inflation are examined in more detail in Locarno and Rossi (1994).

Figure 3

EFFECTIVE EXCHANGE RATE OF THE LIRA[(1)]
AND DM/DOLLAR EXCHANGE RATE

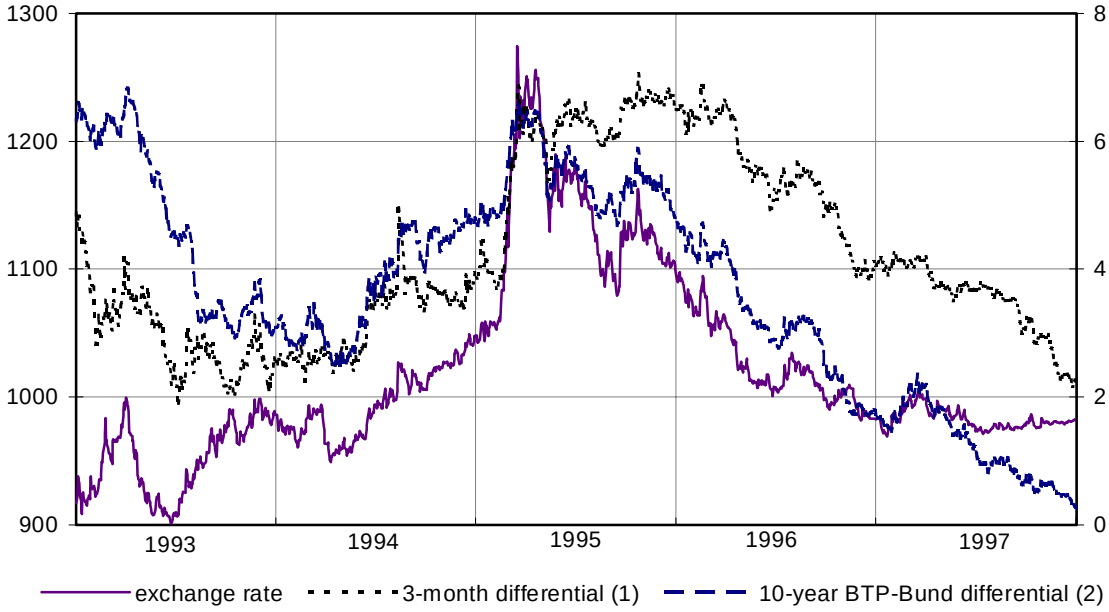


(1) Calculated *vis-à-vis* the currencies of Italy's 14 principal trading partners: index, 11.9.1992=100. A rise in the index indicates an appreciation of the lira.

In the latter part of 1996, the exchange rate returned to its end-1993 level; in November, the Italian lira rejoined the ERM of the EMS, which had been abandoned in September 1992. Meanwhile, long-term interest rates fell substantially (the 10-year differential with Germany narrowed from more than 6 percentage points in the spring of 1995 to less than 2 points at the end of 1996; Figure 4), inflation expectations were subdued (Figure 5) and actual inflation fell from a peak monthly seasonally adjusted rate of about 8 per cent in the first half of 1995 to less than 2 per cent in the latter part of 1996 (Figure 6). Starting in July 1996, monetary conditions were gradually eased; however, only in 1997 did the official interest rates fall below the level reached in the spring of 1994. The long-term differential with Germany declined throughout 1997, amounting to about 30 basis points at the end of that year. With the lira/DM exchange rate basically stable since the end of 1996, inflation remained below 2 per cent for most of 1997 (1.7 per cent on an average annual basis). After systematically over-estimating actual inflation since the end of 1995, inflation expectations converged to the latter in late 1997.

Figure 4

LIRA/DM EXCHANGE RATE AND INTEREST RATE DIFFERENTIALS BETWEEN ITALY AND GERMANY

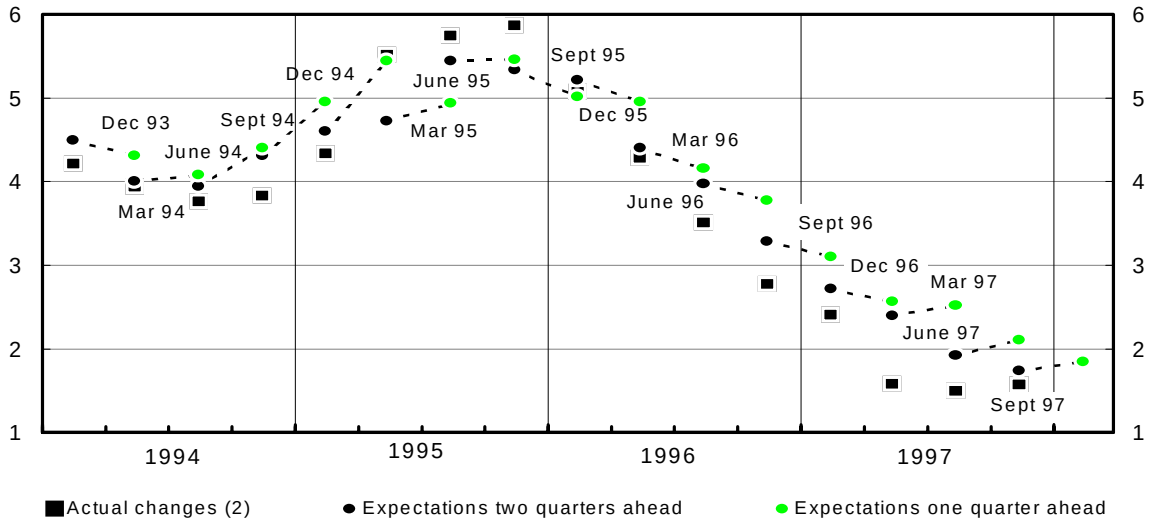


(1) Difference in percentage points between 3-month LIBOR in lire and Deutsche Mark.
(2) Difference in percentage points between the 10-year lira and Deutsche Mark swap rates on the Euromarket.

Figure 5

FORUM-ME SURVEY OF BUSINESS EXPECTATIONS: CONSUMER PRICE INFLATION[1]

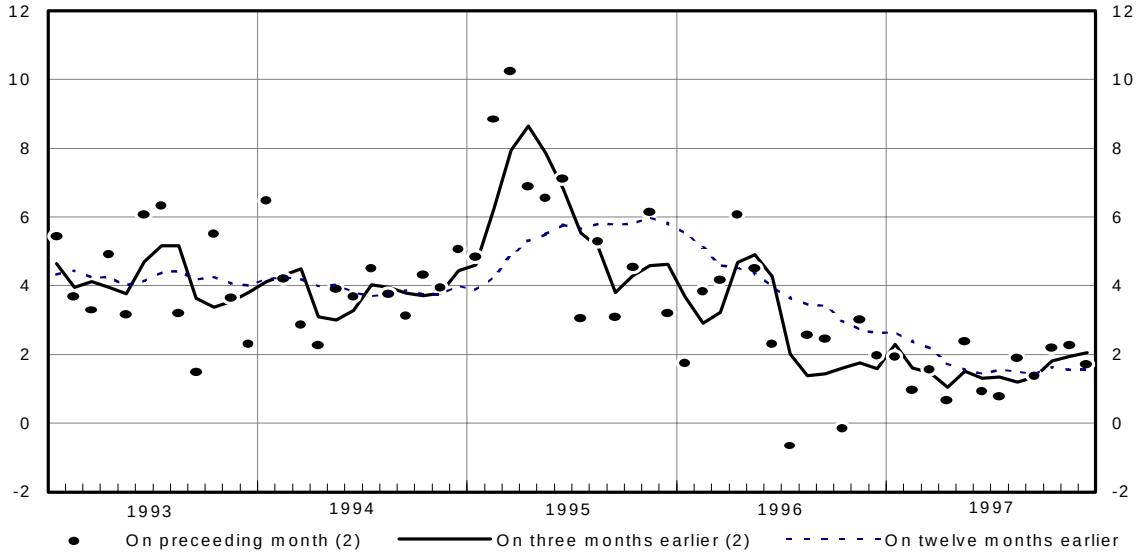
(quarterly figures; percentage changes on year-earlier quarter)



(1) Some aspects of the methodology were changed in March 1995.
(2) Cost-of-living excluding tobacco products.

Figure 6

COST OF LIVING[(1)]
(percentage changes)



(1) Index of consumer prices for worker households, excluding tobacco products.
(2) Annualised; seasonally adjusted.

The period from May 1995 to the end of 1996 is the one in which the use of the model forecasts for the conduct of monetary policy is being examined and tested here. There are two main reasons for this choice. First, although targets for inflation had long been present in the Government's multi-year planning documents, it was only in 1995 that the Bank of Italy started announcing explicit upper contours for future inflation (see Banca d'Italia, 1995, 1996, 1997, 1998).[12] There is thus a meaningful benchmark against which the performance of expected inflation could be evaluated. Overall, this reinforced the credibility of the inflation targets set by the Government, both because the Bank is recognised to have a direct policy responsibility for inflation developments and because it is known to devote substantial

[12] It should be observed that it is only recently, after the 1992-93 trilateral agreement among government, labour and business unions linking nominal wages to inflation targets and scrapping former indexing clauses, that the notion of an inflation target has begun to figure prominently in public debates on economic policy. For an account of the role of targets in the Italian experience see Visco (1995), where the need for budgetary discipline as a precondition for their credibility was also emphasised.

resources to the maintenance and use of the model upon which inflation forecasts are based,[13] thus providing a sort of guarantee that inflation targets are not hopelessly out of reach. Secondly, inflation during the period was not monotone — it first rose rapidly, then steadied and eventually declined — thus making, at least potentially, the availability of "sophisticated" — i.e., not merely extrapolative — inflation forecasts all the more important. On the other hand, it is obvious that this is a most complex period on which to study the role played by the model, if only because, as the above cursory overview should have made clear, many channels of monetary policy transmission that likely played a major role are absent from the model. The reason for their absence is straightforward: we live in a very different world from the one that generated most of the observations on which the model is estimated. While difficult to detect econometrically, there is no doubt that the role of financial markets has become paramount, with exchange and interest rates expectations now playing an especially critical role.[14] Abandoning the ERM thus laid the stress, given the very high degree of capital mobility, on the exchange rate channel; the greater importance of expectations highlighted the role of fiscal uncertainty and political instability; and consumers and firms may have started to react less predictably to sudden changes in confidence. However, forecasts had by necessity to be produced basically relying on a model that did not fully describe those relationships, given the lack of data as well as an insufficient body of convincing evidence.[15] To the use of the model under these circumstances we now turn.

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[13] For a summary reference to the Bank of Italy's quarterly econometric model (BIQM), see Galli, Terlizzese and Visco (1990). Recent discussion of the main transmission channels of monetary policy present in the model is contained in Nicoletti Altimari *et al.* (1995).

[14] Even though Siviero and Terlizzese (1997) found little evidence in favour of the hypothesis of presence of structural breaks in a number of the model equations, not all the channels through which monetary policy exerts effects on inflation are explicitly accounted for in the model. In particular, while "demand" channels are sufficiently detailed (see Gavosto, Siviero and Terlizzese, 1995), as are some of the effects of monetary policy on price expectations (see Gaiotti and Nicoletti Altimari, 1996), the BIQM only allows for an assessment of the impact on inflation of a *given* change in the exchange rate (see Nicoletti Altimari *et al.*, 1995). The model thus lacks, by and large, the essential channel linking actual and expected values of the latter variable to policy-controlled interest rates.

[15] In particular, even if the relationship between actual and expected inflation, interest and exchange rates, as well as modelling of risk premia, have been extensively studied in this period (see, again, Nicoletti Altimari *et al.*, 1995, and Gaiotti and Nicoletti Altimari, 1996, as well as the VAR analysis presented in Gaiotti , Gavosto and Grande, 1997), model forecasts have been generally produced under the "technical" assumption of *unchanged* exchange rates.

4. How can an incomplete model be used?

It is perhaps not obvious that a model lacking the specification of a number of policy transmission channels may nevertheless be used in policymaking. In reality, the model can be used to that end only to the extent that the policymaker has a — possibly no more than qualitative — idea of the missing links and can therefore "complete the model". Knowing where inflation would go, conditional on pre-specified paths for the variables that monetary policy is likely to influence but whose transmission channel is not modelled — notably, the effect of interest rate changes on the exchange rate — will be a piece of information if the monetary authority has a sense of which policy setting is implicit in the pre-specified paths and of the directions in which the latter would change were the policy modified. Under these conditions, the model forecast can provide the basis for the policy choice.

To clarify this possibility, suppose the true model of the economy is:

$$p_{t+1} = m(x_{t+1}, p_t, y_{t+1}) + \varepsilon_{t+1}$$
$$x_{t+1} = h(u_t, x_t) + \eta_{t+1}$$

where p is the variable that the policymaker is interested in controlling, u is the control, x is a variable that affects p and is affected by the control, y represents other variables affecting p but independent of the control, ε and η are zero unconditional mean random factors. Note that the control only acts with a lag of one period. We shall refer to the output of the first equation, for given values of x_{t+1} and y_{t+1}, as the model (conditional) forecast.

As we are considering, for simplicity, only one variable of interest — that is, we are neglecting the possibility of multiple, possibly conflicting goals — the full specification of a loss function can be replaced by the simpler reference to target values for p. Given a sequence of targets for p, say $\{p^*\}_{t+1}^{T} = (p_{t+1}^*, p_{t+2}^* \ldots p_T^*)$, and given the initial conditions and a sequence of values for y, one could easily solve for the values of the control, say $\{u^*\}_t^{T-1}$, that yield, in expectation, the desired sequence. This, of course, would be nothing else than the Frisch and Tinbergen setting.

Suppose, however, that the only information concerning the function $h(\cdot)$ were: (a) conditional on a constant setting of the control, the expected value of the next-period x is

equal to the current period value, i.e. $h(u_{t-1}, x_t) = x_t$; and (b) the sign of the partial derivative of h with respect to its first argument is, say, negative.

Consider now the following sequence of steps:

- produce a forecast conditional on unchanged x, that is $\{\hat{p}\}_{t+1}^{T} = (\hat{p}_{t+1}, \hat{p}_{t+2} \ldots \hat{p}_T)$, with each predicted value given by $\hat{p}_{t+i} = m(x_t, \hat{p}_{t+i-1}, y_{t+i})$, $i = 1, 2, \ldots, T-t$ and $\hat{p}_{t+1} = m(x_t, p_t, y_{t+1})$; note that, as a consequence of (a), this amounts to a forecast conditional on an unchanged control with respect to period $t-1$;
- compute a measure of the "shortfall from the target" by applying some functional to the difference between the forecast and the target: $s_t = f(\{\hat{p}\}_{t+1}^{T} - \{p^*\}_{t+1}^{T})$;
- set the current value of the control as a function of the shortfall; the simplest rule would be — under the assumption that $m_1 > 0$, and remembering that, because of (b), $h_1 > 0$ — to increase (reduce) the current value of the control whenever the shortfall is positive (negative). By appropriately choosing a shrinking factor for the changes in the control, this setting would ensure that the forecast eventually converges on any constant target. More sophisticated settings of the control are obviously possible, where the size of the shortfall as well as its sign would matter, possibly speeding up the convergence on the target.
- as new information becomes available, update the forecast and, correspondingly, the measure of the shortfall; possibly, update the rule linking the setting of the control to the shortfall.

Although the sequence of steps outlined does not define a precise "reaction function", it does provide a set of behavioural rules for the choice of the control that make essential use of the model forecast. Two things need to be stressed about such a set of rules.

First, the reason why the model forecast provides a convenient benchmark for the choice of the control is that it tells the policymaker what would happen were the control left unchanged. This is a direct consequence of our assumption (a). More generally, however, the variable x could be expected to change from the current period to the next, even with an unchanged control because either the conditional expectation of η is different from zero or the dynamic equation for x is not in equilibrium. To the extent that the policymaker has some

clue as to the expected value of x_{t+1} conditional on an unchanged control he could still use the model forecast in essentially the same way as under our assumption (a) ; if he has no clue, the model forecast is probably useless.

Secondly, use of the model makes it possible for the rule to be forward-looking, which is essential given the lagged response of the economy to the control.

The generality, and to some extent the lack of determinacy of the above set of control-setting rules matches the position of rather extreme agnosticism adopted as far as the function $h(\cdot)$ is concerned, which forced us to abandon the more familiar ground of optimisation techniques and resort to "rules of thumb" whose justification lies, pragmatically, in their (asymptotic) good behaviour. It is perhaps useful to show that, following a more traditional line of argument and putting much more structure both on the "true" model and on our knowledge of it, we could end up with a similar control setting rule.

Suppose we specified the above model as follows:

$$p_{t+1} = \alpha\ x_{t+1} + \beta\ y_{t+1} + \gamma\ p_t + \varepsilon_{t+1}$$
$$x_{t+1} = \delta\ x_t - \lambda\ u_t + \eta_{t+1}.$$

As before, given $\{p^*\}_{t+1}^{T} = (p_{t+1}^*, p_{t+2}^* \ldots p_T^*)$, the initial conditions and a sequence of expected values for y and assuming that ε and η have zero conditional expected value, we can immediately obtain the values of the control $\{u^*\}_t^{T-1}$ that minimise the expected value of a quadratic distance from the desired sequence.[16] At time t we have:

(1) $$u_{t+i-1}^* = (\lambda\alpha)^{-1}[\alpha\delta\ \hat{x}_{t+i-1} + \beta\ E_t(y_{t+i}) + \gamma\ p_{t+i-1}^* - p_{t+i}^*], \qquad i = 1,\ 2,\ \ldots,\ T\text{-}t,$$

with $p_t^* = p_t$, $\hat{x}_{t+i-1} = \delta\ \hat{x}_{t+i-2} - \lambda\ u_{t+i-2}^*$ and $\hat{x}_t = x_t$, for $i = 2,\ 3,\ \ldots,\ T-t$. To capture the idea that information availability is a scarce resource in the policy choice process, we assume that no additional information accrues on the values of y after time t and up to time $t+T$ — for simplicity of notation, $\hat{y}_{t+i}$ is used to denote the expectation as of time t of the same variable; we assume instead that the current values of p and x are observable. Taking

[16] As we are neglecting, for simplicity, the possibility that changes in the value of the control are penalised, the problem can be effectively solved one period at a time.

account of the available information, the actual choice of the control at time $t+i-1$, $i=1,\ 2,\ \ldots,\ T-t$, will be:

(2) $$u^{*}_{t+i-1} = (\lambda\alpha)^{-1}[\alpha\delta\ x_{t+i-1} + \beta\ \hat{y}_{t+i} + \gamma\ p_{t+i-1} - p^{*}_{t+i}].$$

Defining the sequence of model forecasts at time t conditional on a given sequence of values for x, say unchanged with respect to time t, as $\hat{p}_{t+i+1} = \alpha\ x_t + \beta\ \hat{y}_{t+i+1} + \gamma\ \hat{p}_{t+i}$, $i = 0,\ 1,\ \ldots,\ T-t-1$, with $\hat{p}_t = p_t$, we can rewrite the optimal value of the control as:

(3) $$u^{*}_{t+i-1} = (\lambda\alpha)^{-1}(\hat{p}_{t+i} - p^{*}_{t+i}) - \lambda^{-1}(x_t - \delta\ x_{t+i-1}) + (\lambda\alpha)^{-1}\gamma(p_{t+i-1} - \hat{p}_{t+i-1}).$$

This equation relates the optimal value of the control to a measure of the predicted shortfall from the target; moreover, observed changes in the variable which the forecast is conditional upon, relative to the value underlying the forecast, and observed prediction errors influence the setting of the control. In particular, if we flesh out our abstract model by interpreting the target as the price level (or inflation rate), the control as the policy interest rate and the conditioning variable x as the exchange rate (with rising values indicating depreciation), we can say that, for a given predicted shortfall from the target, the increase in the policy interest rate should be larger, the more the exchange rate has depreciated relative to the value assumed in the forecast and the larger is the previous over-prediction of prices.

It is clear that if we now assume that the parameters λ and δ are unknown, equation (3) cannot be interpreted as an operational reaction rule. Rather, we will take it as a convenient framework within which to investigate what use — if any — is made in setting the control of the information provided by the deviation of the model forecast from the target. The extreme simplicity of the linear set-up outlined above, while providing a clear benchmark for our investigation, might obscure some of the issues involved in policy setting with an incomplete model. In particular, while equation (3) explicitly points to two additional sources of influence in the choice of the policy instrument, other sources might be important if the assumption of a conditional zero expectation for ε and η were relaxed, thus permitting the accrual of new information either on the forecasting model or on the “transmission channel”. Moreover, lagged values of the control variable would appear in the equation if a cost were assigned to changes in the control. Moreover, the uncertainty regarding the transmission

channels might be reflected in a cautious approach to policy setting, with actual inflation being given a non-negligible weight.

It is perhaps worth noting that, even if the model were complete (that is, even if all parameters were known), expressing the optimal value of the control as a function of the forecast reduces the number of variables that the policymaker needs to take explicitly into account. The model forecast is a sort of sufficient statistic for that (possibly large) information set of variables — such as y in our simple setting — that affect the target variable but are not affected by the control. The effort of producing a path for these variables, particularly if the relevant information is not available on a regular basis, is best undertaken within the model framework, both in view of the discipline it imposes on information gathering and processing and because it allows a more economical "division of labour" between the policymaker and the economist.[17]

5. Some empirical results

In light of the above discussion, most of the forecasts produced with the quarterly model of the Bank of Italy (BIQM), especially in the most recent period, are conditional on a constant value for the exchange rate — often that prevailing at the beginning of a forecasting round. While a great deal of effort goes into trying to identify a path for the policy interest rate that is deemed to be consistent with the given exchange rate — relying on off-model information, for example that embodied in the term structure — it is fair to say that in the horizon usually adopted for the forecast (up to two years ahead) the inflation developments simulated with the BIQM would show, for a given exchange rate, little sensitivity to alternative interest rate assumptions.[18] In the most recent period, the quarterly forecasts produced with the BIQM — usually available to the Governor in late January, late April and late September — have been supplemented with a monthly "focus" on inflation, aimed at producing the monthly profile consistent with the model forecast and — between two

[17] Of course, if the model were "complete" there would be no need for such a division of labour: knowing the target, the economist could directly compute the optimal value of the control.

[18] Alternative assumptions on the path of the policy interest rates would, on the contrary, have a sizeable impact on the developments of real variables and on public finance balances.

"proper" forecasting rounds — at updating the monthly profile on the basis of the observed preliminary inflation data, available around the 20th of each month. Whenever the observed data were consistent with the forecast, no change was made to the annual figure produced with the model; if the observed data put too much strain on the model result, the latter would be modified, possibly with a quick model re-run.[19]

Defining each elementary period as the interval between two updates and considering that in some months more than one update was made, we have a total sample of 34 periods, from late February 1995 to late December 1997. The span of time covered by the sample is defined by the simultaneous availability of a monthly breakdown of the model forecast and of a limit value for future inflation — also referred to, slightly inaccurately, as the "target" — explicitly announced by the Governor.[20] As the regressions include the lagged value of the endogenous variable, and the data for 1997 were reserved for out-of-sample stability tests, the actual estimation sample includes 24 periods, starting from 4 May 1995 and ending on 21 January 1997 (periods 2 to 25 in Table A.1 in the Appendix).

At the beginning of each period the following information is available: the inflation forecasts for the current year and the next year; the inflation targets — as announced by the Governor — for the current year and the next year (up to December 1995 and from May 1996; from January 1996 to April 1996 only the target for 1996 announced in May 1995 was available; similarly from January to May 1997); the sequence of forecasting errors realised thus far (whether the current month inflation data is available or not depends on the precise day on which the period begins and thus may vary from period to period); the exchange rate realised thus far. Also known, of course, are the assumptions upon which the latest available forecast is conditional and a host of other, sometimes only qualitative, information on the state of the economy and expectations.

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[19] An almost equivalent procedure, which was also followed, involves the production of a range of model forecasts — conditional, for example, on alternative paths for the exchange rate — and the selection of the forecast that proves to be closest to the observed value.

[20] While the first official announcement was made by the Governor on 31 May 1995, forecasts available at the beginning of the month were close to those produced later. We therefore assume that the Governor had already formulated the targets by the beginning of May. In fact, our results are robust to the inclusion of the additional period starting at the end of February 1995, although the assumption that the target had already been formulated by then is more strained. However, as mentioned in the text, this additional period is used as the "initial condition" when considering lagged variables.

The available information can be used to construct a measure of "inflationary pressure". We take a weighted average of the differences between current-year and (when available) next-year annual inflation forecasts and target values, with a larger weight assigned to the current year up to the end of the summer and rapidly declining thereafter. It must be stressed that the announcements made by the Governor set the upper limit of the targeted inflation rate, as they were phrased as "less than x per cent". Therefore, there is an element of arbitrariness in our measure of inflationary pressure. As we assume that the difference between the "true" (unknown) target and its (known) upper limit is a constant, the arbitrariness should not be of serious concern. However, our assumption might be too restrictive and the attempt to correct for past forecast errors can also be interpreted as a way of taking account of the (time-varying) probability assigned to respecting the upper limit.[21] During each elementary period a certain number of very-short-maturity repo auctions are conducted. We take the average of the auction interest rates to be the control variable of the monetary authority, as we assume that any short-run demand factors affecting the repo rate are quickly averaged out. A detailed description of the data is provided in the Appendix.

We use these data to assess the role of model forecasts of inflation — given the announced target — in policy decisions. We do this by taking advantage of the main implication of the analysis in Section 4 — the possibility of expressing the policy control as a function of the difference between model forecasts, conditional on "unchanged policy", and targets — regressing the policy instrument on the measure of inflationary pressure as defined above.

The estimates are presented in Table 1.[22] Since, as mentioned earlier, the presence of costs associated with changing the policy instrument would add a dynamic element to policy setting, we take the change of the repo rate as the dependent variable and include its lagged value in the regressions to allow for this possibility. Moreover, all the specifications include a

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[21] A regression in which positive and negative discrepancies between predicted inflation and target values are allowed to impact differently on the policy variable (results not reported below) did indeed confirm that the reaction of the policy interest rate was asymmetric, with a larger coefficient on positive inflationary pressure.

[22] Given the nature of the data used (specifically, our elementary periods are not equally spaced), one might expect heteroschedasticity of residuals; however, as no evidence of heteroschedastic errors was detected with the usual tests, Table 1 reports standard OLS estimates.

Table 1

RESULTS OF REPO RATE REGRESSIONS

(dependent variable: Δi; sample period: see the Appendix)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
constant	0.334 (0.851)	0.288 (0.812)	-0.151 (0.724)	2.906 (1.281)	1.071 (0.969)	2.545 (1.144)	2.600 (0.920)
dummy (1996.01)	-0.619 (0.268)	-0.648 (0.237)	-0.591 (0.207)	-0.517 (0.196)	-0.435 (0.215)	-0.614 (0.178)	-0.504 (0.190)
i_{-1}	-0.066 (0.121)	-0.045 (0.086)	-0.009 (0.077)	-0.548 (0.195)	-0.252 (0.164)	-0.455 (0.178)	
$\hat{p}$	0.548 (0.287)						
p^*	-0.507 (0.376)						
$\hat{p} - p^*$		0.574 (0.261)	0.495 (0.229)	0.412 (0.198)	0.490 (0.217)	0.402 (0.199)	0.368 (0.165)
$100 \cdot \log(e / e_{-1})$			0.083 (0.030)	0.054 (0.028)	0.070 (0.030)	0.058 (0.028)	0.057 (0.026)
$\hat{p}^C$				0.184 (0.164)	0.307 (0.172)		
p_{-1}				0.329 (0.143)		0.382 (0.136)	
$\hat{p}^C - p_{-1}$							0.215 (0.144)
$i_{-1} - p_{-1}$							-0.514 (0.175)
R^2	0.386	0.384	0.558	0.714	0.625	0.693	0.711
σ	0.231	0.225	0.196	0.167	0.185	0.168	0.163
Serial correlation	0.040	0.053	0.002	0.041	0.012	0.022	0.025
n	24	24	24	24	24	24	24

Notes: Serial correlation: Lagrange multiplier test, F version, tail probability.
For the definition of variables, see the Appendix.

constant and a dummy, corresponding roughly to January 1996, when the CPI basket and weights were modified.

In the specification in column 1 the model forecast and the target are included separately to verify whether the restriction implicit in the construction of inflationary pressure is accepted by the data. The coefficients of the two variables have the expected sign and roughly the same size.

Imposing the restriction that they sum to zero, accepted with a tail probability of more than 80 per cent, leads to the specification in column 2, where inflationary pressure is significant at a 5 per cent confidence level.

While the analysis in Section 4 suggests that exchange rate "surprises" — vis-à-vis the assumption underlying the forecast — and past forecast errors might play a role, attempts to include these variables were not successful. Rather, the underlying trend in the lira/DM exchange rate — as measured by the log change in the latter variable — is included in column 3.[23] This variable is significant at the 5 per cent confidence level. The sign and size of the other coefficients are basically unaffected, but the proportion of variability explained is substantially higher.

In none of the specifications presented in the first three columns is the lagged repo rate significant. This might be due, however, to a "lack of balance"; more explicitly, to the lack of a level variable for inflation, permitting the determination, in equilibrium, of the real rate. In column 4 two such variables are included: the last inflation rate known at the beginning of each period and the inflation forecast produced by a pool of private sector forecasters (the so-called Consensus forecast), which is also known at the beginning of each period. While the former is clearly significant, the latter is only significant at a confidence level of 10 per cent. However, the lagged repo rate is now significant, with a coefficient the absolute value of which is roughly equal to the sum of the coefficients of the two inflation-level variables. This suggests a specification which pins down, in equilibrium, the real rate. The coefficient of inflationary pressure remains highly significant (with a tail probability

[23] Problems of simultaneity might be important here. However, they are mitigated by the lags with which changes in the policy interest rate are likely to affect the exchange rate. Moreover, the inclusion of the exchange rate in the regression does not materially change the value of the other coefficients.

slightly higher than 1 per cent) and roughly of the same size. The significance of the coefficient of the underlying trend in the exchange rate declines marginally.

In the next two specifications (columns 5 and 6) we check separately for the two variables capturing the level of inflation. In both cases they are significant, together with the lagged value of the repo rate, with coefficients having opposite signs and roughly the same size, thus confirming an equilibrium specification that identifies the real rate. The measure of inflationary pressure remains highly significant in all cases. The underlying trend of the exchange rate also retains its explanatory power, with a roughly unchanged coefficient.

Comparing the two alternatives, actual lagged inflation seems to have more explanatory power than the Consensus forecast.[24] A contribution of the latter to policymaking cannot be ruled out, however. Specifically, Consensus forecasts can be seen as representing the use in the decision-making process of other anticipatory variables — other choices could be survey data on expectations or market expectations as embodied in the yield curve — in addition to the model forecasts. Imposing the homogeneity constraint in the specification in column 4 that the sum of the coefficients of the lagged repo rate, the last observed inflation rate and the Consensus forecast be zero, we can rewrite the specification as in column 7. The Consensus forecast thus contributes to the choice of policy to the extent that it differs from observed inflation — perhaps signalling the intention to curb private expectations. The restriction is accepted with a tail probability of almost 70 per cent; our measure of inflationary pressure is largely significant. Both the underlying trend of the exchange rate and the measure of "excessive" private inflation expectations — representing off-model information relevant to the choice of policy — play a sizeable role and are statistically significant at a confidence level of 5 and 10 per cent, respectively.

As stated above, these estimates only aim at verifying whether econometric evidence can be detected of model forecasts having played a role in policy decisions: thus, we do not believe that the estimated equation can be interpreted as a fully-fledged reaction function of

[24] It is worth reporting that a very simple specification regressing the level of the repo rate on a constant and on a measure of inflationary pressure would show a highly significant coefficient on the latter and an R^2 larger than 0.6 when the pressure is computed on the basis of the model forecast, whereas, when it is computed on the basis of the Consensus forecast, the coefficient is both smaller in size and not as significant, with an R^2 of about 0.3.

the monetary policy authority. The reaction rule may in fact be unstable over time, as the policymaker's preferences may change.[25] In addition, our estimates ignore the possibility that other targets may also be of concern for the policymaker (e.g., output growth): to the extent that the discrepancies between forecasts and target values for the missing targets are correlated with those for inflation, our estimates are bound to be unstable even if the policymaker's actual preferences are not (the fact that, as argued above, within the sample period examined here inflation was unquestionably the overriding objective of the monetary policy authority partially alleviates these concerns).

All this notwithstanding, it may be interesting to look at the "equilibrium" implications of the estimated equation in order to detect its implications for the value of the real interest rate and to assess how relevant, from a quantitative point of view, the effect of the inflationary pressure variable is on the policymaker's setting of the interest rate. To do so, subtract the target inflation rate from both sides of equation (7) and define the real interest rate as the difference between the (nominal) repo rate and target inflation.[26] The latter can then be written as a function of a composite inflationary pressure indicator (itself a function of model forecasts, Consensus forecasts and past inflation):

$$r = 2.600 + 0.486 r_{-1} + 0.882(\overline{p} - p^{*})$$

where the composite inflationary pressure indicator $\overline{p}$ is given by the following expression:

$$\overline{p} = 0.417\,\hat{p} + 0.244\,p^{C} + 0.339\,p_{-1}.$$

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[25] Actually, the equation reported in column 7 of Table 1 is considerably stable throughout most of 1997. Specifically, an out-of-sample Chow test for periods 26 to 33 (for a total of 8 out-of-estimation-sample observations, from January to October 1997) gives a tail probability of almost 90 per cent, the average forecast error amounting to less than 7 basis points (the largest error is just slightly higher than one time the standard error of the regression). By contrast, if one includes the 34th observation (from 23 October to 21 December 1997), the tail probability drops to less than 2.5 per cent; the forecast error in the 34th period exceeds 65 basis points. As to the causes of this sudden instability emerging in November-December 1997, it is interesting to note that inflation expectations, after being systematically higher than actual inflation throughout 1996 and most of 1997, converge to the latter in the closing part of 1997 (see Section 3 above). One might thus conclude that the estimated equation, after performing remarkably satisfactorily in the first 10 months of 1997, becomes unstable precisely when monetary policy appears to have succeeded in curbing inflation expectations (it is worth noting that the estimated equation implies a high equilibrium level of the real interest rate, at over 5 per cent; see below).

[26] The lagged real interest rate is here defined as the difference between the *lagged* (nominal) repo rate and the *current* target inflation rate. However, given that we are only interested in the "equilibrium" implications of the estimated equation, this does not affect the main conclusions.

The estimated equation thus implies that the policymaker assesses inflation on the basis of several sources, the largest weights being given to the model's forecasts and to past inflation, the role of Consensus forecasts being slightly less relevant.

Eliminating the dynamics, the expression above becomes:

$$r = 5.058 + 1.716(\overline{p} - p^{*}) .$$

According to our estimates, the composite inflationary pressure indicator, as defined above, has a rather large impact on the real interest rate: if all sources of information signal that inflation (whether prospective or current) is 1 percentage point higher than its desired value, then this will result in an increase of about 170 basis points in the real interest rate. Thus, the econometric estimates show not only that a statistically significant relationship between model forecasts and policy rates can be found, but also that that relationship is quantitatively relevant. The positive response of the real rate to inflationary pressures is a common feature of "successful monetary policymaking", as argued by Clarida, Gali and Gertler (1997, 1998a and 1998b).[27] In fact, a coefficient larger than one is shown to be required in order to avoid self-fulfilling equilibria.

The estimates also imply that the equilibrium level of the real interest rate (where equilibrium is defined as the situation in which no inflationary pressure is perceived that requires a stiffening of the monetary policy stance) is therefore fairly high (around 500 basis points). Such a high level of the real interest rate is consistent with the fact that, within the sample period examined here, the monetary policy authority in Italy needed to firmly establish low inflation expectations and convince the public that all necessary measures would be taken in order to complete the disinflation process fully.

6. Concluding remarks

Against the background of long monetary policy transmission lags, central banks are often accused of relying excessively on past and current inflation in their decision-making.

[27] While not strictly comparable, due to significant differences in the approach and sample period, a similar result — i.e., a positive response of the real interest rate to inflationary pressures in Italy — is also found by Angeloni and Dedola (1998).

The case study examined in this paper suggests that the criticism is ungenerous. Monetary policy choices are shown to react to differences between target and forecast inflation, thus embodying a clear forward-looking component. Reliance on actual inflation, in this context, is not a sign of "looking backward". Rather, actual inflation provides the initial conditions of the forecast, allows the assessment of forecast errors and, particularly in the context of a disinflation strategy, may have a signalling role in anchoring the public's inflation expectations.[28]

The role of inflation forecasts stressed in this paper is not new. Indeed, precisely as a consequence of the long transmission lags, it is hard to imagine an effective monetary policy strategy that does not rely on a forecast of future inflation. This point has been emphasised recently in the literature on inflation targeting with the suggestion that the central bank should pursue inflation forecast targeting (Svensson, 1997). Our analysis bears many similarities with that in Svensson's paper, which likewise concludes that "if the inflation forecast is above (below) the target, the repo rate should be increased (decreased)" (p. 1120). The main difference is that we do not share the somewhat optimistic view on the production of an inflation forecast that is implicit in much of Svensson's paper, together with the idea that there is a complete model readily available that is quite accurate up to a symmetric, zero-mean random component.[29] This is especially so in a complex period like the one examined in this paper, when new, un-modelled, channels of transmission of monetary policy acquired paramount importance and the stabilisation of inflation expectations became an essential element of the disinflation process. As a result, we believe that Svensson's plea for complete disclosure of the details of central banks' forecasts is perhaps too extreme, as it neglects the possibility that market participants, by mechanically interpreting the information available to the central bank, would overreact and cause turbulence in the financial markets. On a more general level, we think that monetary policymaking, while relying heavily on structured

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[28] A somewhat different perspective on the role of past and current inflation in monetary policymaking is provided by Clarida, Gali and Gertler (1998b), where it is shown that actual inflation enters a modified forward-looking Taylor rule only as an instrument for future inflation.

[29] To be honest, Svensson recognises that forecasts "will in practice have to combine both formal and informal components, for instance with judgmental adjustments of more formal structural forecasts. Forecasts will hardly be purely mechanical". However, he somehow dismisses the complications that would follow from these statements on the basis of the argument that "more structural modelling and use of extramodel information and judgement by forecasters are likely to produce forecasts with acceptable precision".

economic analyses and formal forecasting tools (as we have tried to show), embodies such an essential component of judgement and “art” that attempts to frame the decision-making process within a comprehensive rule-based strategy yield, at best, a merely suggestive analytical tool with little operational value. At worst, they give the impression that the hard thinking needed to produce good policymaking can be dispensed with, thanks to a simple rule of conduct. Unfortunately, no such shortcut is available.

Appendix

Data description

Sample period Data from 24 February 1995 to 21 December 1997 are grouped into 34 elementary periods (see Table A.1), whose starting dates correspond to the availability of a new inflation forecast in the Bank of Italy. It must be stressed that these forecasts are not available to the general public. The estimation does not make use of the forecast produced at the end of February 1995; moreover, the last 9 observations are reserved for out-of-sample stability testing. Thus, the actual estimation sample includes 24 elementary periods, starting with the forecast of 4 May 1995. The first period provides the initial condition of the dynamic specification.

e Average lira/DM exchange rate between two consecutive inflation forecasts.

$\hat{p}^C$ Weighted average of "consensus" inflation forecasts (simple average of the forecasts produced by the major domestic forecasting institutions). The source for these data is a digest of international economic forecasts, periodically published by Consensus Economics Inc. (various issues); the institutions in the survey include Banca Commerciale Italiana, Banca di Roma, Bank of America - Milan, Cariplo, CER, Chase Manhattan Bank - Milan, Confindustria, Credito Italiano, Deutsche Bank - Milan, ENI, Euromobiliare, FIAT, IRS, ISCO, JP Morgan - Milan, Prometeia. In each month, the exact composition of the sample may vary, but the forecasts by the major institutions are almost invariably included in the consensus figures. As to the construction of the weights, see the description of $\hat{p}$ below. "Consensus" inflation forecasts for 1995, 1996 and 1997 are shown in Figure A.1.

p_{-1} Last available monthly inflation figure (with respect to corresponding month of previous year). Monthly CPI data are usually released around the 20th of each month; however, the exact timing and sequence for the release of inflation data changed during the sample period.

p^* Weighted average of the inflation targets announced by the Governor of the Bank of Italy. For 1995, an inflation target of "at or below 4.5 per cent, net of indirect taxes", was announced on 31 May 1995; on the same date, an inflation target of "below 4 per cent" was announced for 1996. Although no target had been announced before then, it is assumed that the same values were already implicitly targeted at the beginning of the month, when the relevant forecast was already available. Also, since the target for 1995 was announced net of indirect taxes, a target gross of indirect taxes has been constructed by adding the effect of indirect taxes on inflation, as estimated at the end of the year (0.8 per cent). For 1997, an inflation target of "below 3 per cent" was announced on 31 May 1996. As to 1998, "a rise in consumer prices of 2 per cent or less" (Banca d'Italia, 1997) was the target announced on 31 May 1997. As to the construction of the weights, see the description of $\hat{p}$ below.

i Average repo rate between two consecutive inflation forecasts. In the period examined in this work (from 24 February 1995 to 21 December 1997), 165 repo operations were effected, an average of one operation every 6 days. Given that they are grouped into 34 periods (according to the dates on which new forecasts were produced), there are an average of about 5 repo operations per period, with a standard deviation of 3.8 (the minimum number of repos —one — is observed in periods 18, 24, 27 and 32,

corresponding to the time spans from 9 July to 22 July 1996, from 15 November to 25 November 1996, from 26 February to 6 March 1997 and from 29 September to 6 October 1997, respectively; the maximum number of repos — 19 operations — corresponds to the first observation, from 24 February to 3 May 1995). The within-observation variability resulting from the aggregation criterion adopted (see also the description for $\hat{p}$ below) is very limited.

$\hat{p}$ Weighted average of the Bank of Italy's inflation forecasts. Corresponding to each available forecast of inflation, a weighted average of current and next (when appropriate) year-on-year inflation is constructed, using a logistic function that attributes most of the weight to current-year inflation in the course of the first few months, while the weight is shifted to next-year inflation towards the end of the year (the current year's weight is almost 1 in January, 0.5 in August, less than 0.1 in December; experimenting with different weighting schemes did not result in appreciable changes in the main results of the paper). Out of the 34 forecasts available for this work, 14 were the result of a forecasting round requiring the use of the BIQM (although there are usually only 3 full forecasting rounds in a year, occasionally the availability of new information prompts a quick update of the latest forecast). In the months between two forecasting rounds based on the quarterly model, monthly profiles consistent with the latest available yearly figure are produced (there are thus 20 monthly profiles of this kind in our sample). This breakdown often takes place at the same time as a regular model forecast (in 7 out of 14 model-based forecasting rounds, a monthly breakdown of the annual figure was also produced; no monthly profile is available before May 1995). Occasionally, the monthly profiles incorporate new information and the implied annual figure is not consistent with the latest model forecast. On average, there are about 30 days between two consecutive forecasts (with a standard deviation of 18.5). The number of days per period varies from a minimum of 7 (between 29 September to 6 October 1997) to a maximum of 69 (from 24 February to 3 May 1995). As a result, the number of repo operations included in each observation also varies (see the description of i above). The Bank of Italy's forecasts are shown in Figure A.1, together with the "consensus" projections.

Table A.1

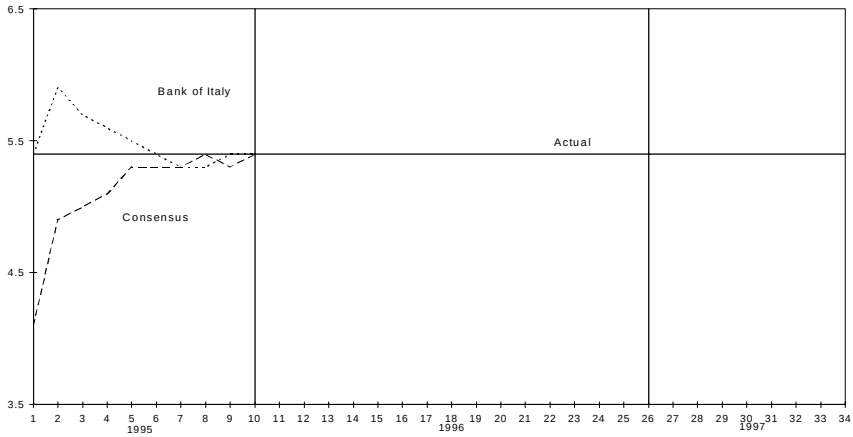
SAMPLE FEATURES

Period	From: (dd/mm/yyyy)	To: (dd/mm/yyyy)	Number of repo operations in period	Number of days in period
1	24.02.1995	03.05.1995	19	69
2	04.05.1995	17.05.1995	2	14
3	18.05.1995	20.06.1995	6	34
4	21.06.1995	19.07.1995	6	29
5	20.07.1995	09.08.1995	4	21
6	10.08.1995	21.08.1995	3	12
7	22.08.1995	12.10.1995	10	52
8	13.10.1995	26.11.1995	6	45
9	27.11.1995	26.12.1995	3	30
10	27.12.1995	11.01.1996	3	16
11	12.01.1996	22.02.1996	5	42
12	23.02.1996	06.03.1996	3	13
13	07.03.1996	24.03.1996	2	18
14	25.03.1996	17.04.1996	2	24
15	18.04.1996	08.05.1996	3	21
16	09.05.1996	23.06.1996	4	46
17	24.06.1996	08.07.1996	2	15
18	09.07.1996	21.07.1996	1	13
19	22.07.1996	06.08.1996	3	16
20	07.08.1996	08.09.1996	5	33
21	09.09.1996	24.09.1996	3	16
22	25.09.1996	08.10.1996	3	14
23	09.10.1996	14.11.1996	5	37
24	15.11.1996	25.11.1996	1	11
25	26.11.1996	21.01.1997	9	57
26	22.01.1997	25.02.1997	6	35
27	26.02.1997	06.03.1997	1	9
28	07.03.1997	23.04.1997	8	48
29	24.04.1997	19.05.1997	4	26
30	20.05.1997	22.07.1997	10	64
31	23.07.1997	28.09.1997	11	68
32	29.09.1997	06.10.1997	1	8
33	07.10.1997	22.10.1997	2	16
34	23.10.1997	21.12.1997	9	60

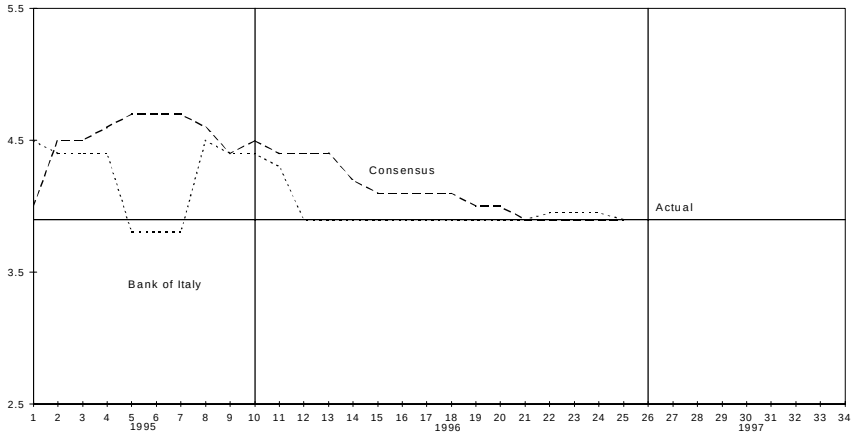
Figure A.1

BANK OF ITALY AND CONSENSUS INFLATION FORECASTS, 1995 - 1997

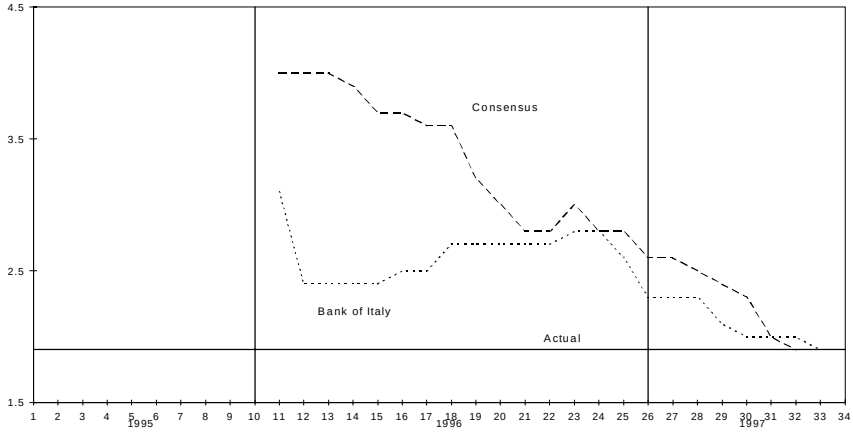
Forecasts for 1995



Forecasts for 1996



Forecasts for 1997



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