Expectations and monetary policy transmission: the determination of the exchange rate and long term interest rates in the Banca d'Italia's quarterly econometric model

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Introduction

In this paper, we address the issue of the determination of the exchange rate and of the long-term interest rates in the Banca d'Italia quarterly model (BIQM)[2], by introducing an explicit expectation formation mechanism. The interplay between exchange rate expectations and inflation expectations contributes to the endogenous determination of asset prices, together with international factors, like currency market volatility and foreign long term rates.

The results we present are part of a research work still in progress. To a large extent, they reflect the changes that took place in the Italian and international economy in the last few years, which strengthened the role of expectations in the transmission of monetary policy and in the determination of asset prices. Structural changes of foremost importance took place in the currency market and in domestic securities markets (the lifting of controls on international capital movements, the development of a deep and efficient market for long-term securities, the floating of the exchange rate).

These changes have had two consequences: a shift in the relative importance of different channels of monetary policy transmission, with an increased emphasis on the "expectations channel"; and a larger sensitivity of domestic variables to developments in the expectational climate on international markets. To assess these effects and evaluate their quantitative importance, an investigation on the determination of expectations about the exchange rate, future inflation and interest rates is needed.

The paper represents a first attempt to do so. First, mechanisms of endogenous determination of exchange rate expectations and inflation expectations are introduced: exchange rate expectations are of foremost importance in determining the actual behaviour of the spot exchange rate and the impact of monetary policy on currency markets; while inflation expectations exert important effects in the wage-setting block of the model and contribute to determining the real interest rate, the ex-ante evaluation of real wealth relevant for consumption choices and the ex-ante real cost of capital relevant for investment decisions. Second, a new forward-looking determination of long-term interest rates that links them to inflation expectations and to international factors is analysed and introduced in the model. The relative role of domestic short-term rates and of yields on foreign market in determining long term rates is tested. The role of monetary policy, if it can affect exchange rate and inflation expectations, is significantly altered.

The paper is organised as follows. Section 1 presents a brief review of the different methods used to model expectations in the BIQM and the research still in progress. Section 2 addresses the problem of endogenising exchange rate expectations and their role in determining the exchange rate. Section 3 presents an estimate for the determination of long term interest rates that

1 Banca d'Italia, Research Department. We are indebted to F. Altissimo, L. Buttiglione, K. Tsatsaronis and I. Visco for useful comments and suggestions.

2 The structure of the quarterly model is described in Galli, Terlizzese, and Visco (1989) and Terlizzese (1995). Its long-run behaviour is consistent with a neo-classical model with exogenous growth. In the short run a number of adjustment processes governs the dynamics; the most important reflect the putty-clay nature of capital, the stickiness of prices and wages, the possibility that expectations differ from realised values and the corresponding revisions of both plans and expectations.

links domestic long yields to domestic short rates and inflation expectations, to foreign yields and to volatility in the currency market. Section 4 presents the main results on the formation of inflation expectations. Finally, in Section 5, the working of the whole model under the estimated mechanism of expectation formation is exemplified by means of a simulation exercise of the effects of monetary policy. Results are compared with those obtained from alternative schemes such as rational expectations or purely adaptive-regressive mechanisms. The effects of an increase in uncertainty in the currency markets are also studied.

1. The modelling of expectations formation in the BIQM

For most of the profession, both for theoretical and empirical purposes, it is customary to assume that expectations are rational[3]. The advantage of this hypothesis, it is argued, lies in its relative "neutrality" with respect to the structure of the model whose results would then be independent from arbitrary assumptions for the expectations formation mechanism. The latter conclusion, however, is not warranted. First, it is not granted even in a context of rational expectations (e.g. in the presence of self-fulfilling expectations and rational bubbles) and the possibility, in many rational expectations models, of multiple equilibria, poses serious problems of selecting the equilibrium in a non-arbitrary way.[4] Secondly, the extreme informational requirements of the REH are not to the credit of the absence of arbitrariness. More generally, in order to assess the arbitrariness of an assumption, the latter has to be tested.

Research work is being conducted on the Bank of Italy quarterly model to assess the implications and the relative merits of different mechanisms of expectations formation. The approach we follow in this paper is based on the use of direct observations from survey data on expectations; on the one hand, this makes it possible to assess the validity of the REH[5] and, on the other, to directly estimate alternative models of expectations formation.[6]

This approach is implemented using a survey conducted quarterly by *Forum - Mondo Economico* since 1957 on a group of Italian experts, belonging to different sectors (finance, commerce, production and academics).[7] In general, it is assumed that agents know (or think they know) the reduced form of the relevant model and the values of its parameters. The parameters of the expectation formation mechanism are then estimated using the direct observations on expectations, with particular attention to the specification of the reduced-form model used by agents.

A second approach that is being investigated which is worth mentioning although we do not present it here, is to solve the model by assuming that expectations are formed under the "bounded rationality" hypothesis.[8] The hypothesis is that agents know the reduced form of the relevant model but do not know, or are uncertain about, the value of its parameters and use some reasonable rule to estimate them. The estimated parameters, therefore, change through time and, if expectations enter the behavioural equations, the parameters of the structural model will also be time-varying. When the

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3 The rational expectations hypothesis, REH, of Muth (1961).

4 This problem is particularly serious, for example, in the case of endogenising the exchange rate by assuming rational expectations and an uncovered interest parity condition in capital markets; see the next section.

5 That could alternatively be verified only indirectly and conditionally on the chosen behavioural model - i.e. testing cross equation parameters restrictions.

6 It also allows us direct verification whether the expectations formation mechanism is invariant to regime changes (the Lucas critique) and to explore the way in which the mechanism is eventually revised.

7 The main characteristics of this survey are described in Visco (1984).

8 See Marcet and Sargent (1989), Sargent (1994) and Evans and Honkapohja (1995), among others. For a first implementation of this hypothesis in a large scale econometric model see Hall and Garratt (1994).

estimates converge to a stable solution, a rational expectation equilibrium is found; however neither convergence nor stability of the equilibrium are granted, as the results will in general depend on both the chosen expectation rule and the behavioural model.[9]

2. The modelling of expectations and the determination of the exchange rate

The role of expectations in determining the lira spot exchange rate increased after 1987-1990, when the removal of restrictions on international capital movements was completed; and after 1992, with the exit of the lira from the ERM of the EMS. In the last few years, the fluctuations of the exchange rate were mostly linked to shifts in expectations, originating either from domestic factors or from international shocks.

In the period during which the lira participated in the Exchange Rate Mechanism, both the stability of expectations and the presence of controls on capital movements limited, in the short run, the scope for a fully market-based determination of the spot exchange rate. Control of the exchange rate by the monetary authorities was obtained, in the short run, by intervention in the currency market and in the longer run by adjusting interest rates to the level necessary to avoid reserve outflows. In econometric modelling, the exchange rate was usually considered exogenous and determined by the monetary authorities.[10]

The endogenisation of the exchange rate is based on an uncovered interest parity condition (UIP) of the form:

$$s_{t+1/t} = s_t + r_t + r_t{*} + \rho_t \tag{1}$$

where $s_{t+1/t}$ represents the logarithm of the exchange rate expected in period t for the period $(t+1)$, s_t is the logarithm of the spot exchange rate, r_t and $r_t{*}$ are the domestic and the foreign interest rates over the same time span[11] and ρ_t a time varying risk premium. For given interest rates and risk premium, the exchange rate is determined once an expectation formation mechanism is specified.[12]

A standard way to close the model is to impose rational expectations; this is the approach followed and discussed in Nicoletti et al. (1995). However, the assumption requires imposing a terminal condition for the exchange rate in (1), which implies a high degree of arbitrariness.[13] The alternative approach used in this paper builds on the work of Altissimo et al. (1995) and estimates an

9 A first attempt to solve the BIQM under the hypothesis that agents revise their expectations on inflation and on the exchange rate using a Kalman filter rule is contained in Altissimo et al. (1995), where the convergence of the model and the consequences of this hypothesis for the transmission channels of monetary policy are studied.

10 See Gressani, Guiso and Visco (1988) for interaction of exchange rate and interest rate policy in the EMS period. They give a rationalisation of the monetary policy transmission mechanism prevailing in those years. The transmission of monetary policy to domestic prices occurred mainly through the exchange rate; interest rates were then adjusted in order to make the exchange rate target sustainable in terms of the current account. The working of this mechanism was, to some extent, conditional on imperfect capital mobility.

11 Three months euro-deposit rates are used in the BIQM.

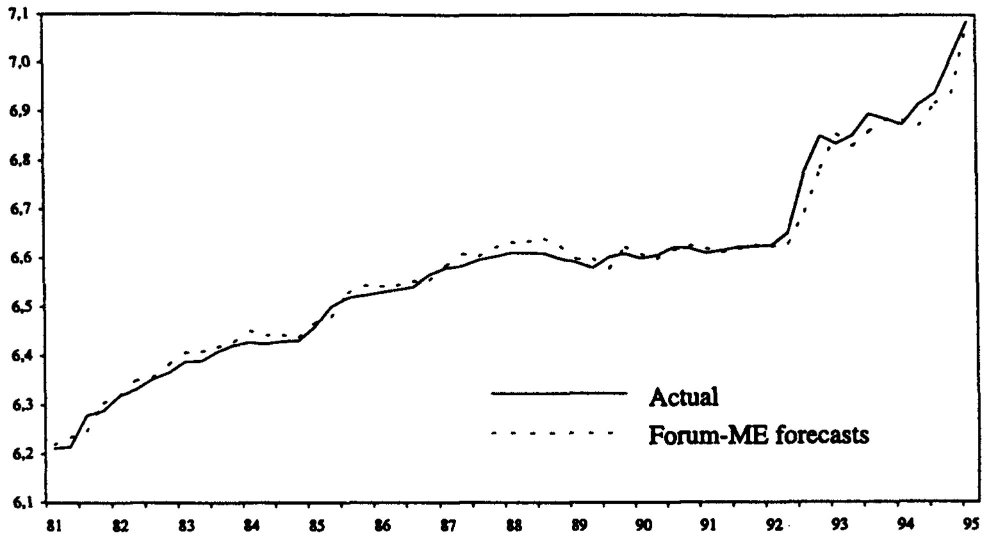
12 An alternative approach is to directly estimate a reduced form for the exchange rate and can be obtained by substituting the expectation equation into the UIP condition. Parigi and Prati (1993) follow this approach for the EMS period; they find that the exchange rate appreciates in response to an increase in the interest differential and in the long run is affected by relative prices.

13 As it is well known, the presence of a forward unit root in (1) implies that the terminal condition has always the same effect on the solution of the model, no matter how far in time it is imposed, and completely determines the evolution of the system, as well as the effects of policy changes. See, for example, Fisher et al. (1992).

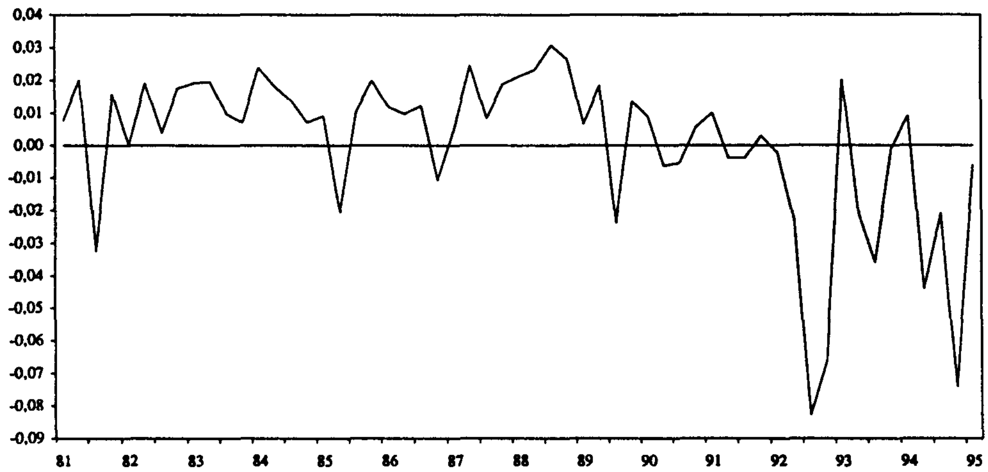
Figure 1

The lira-DM exchange rate

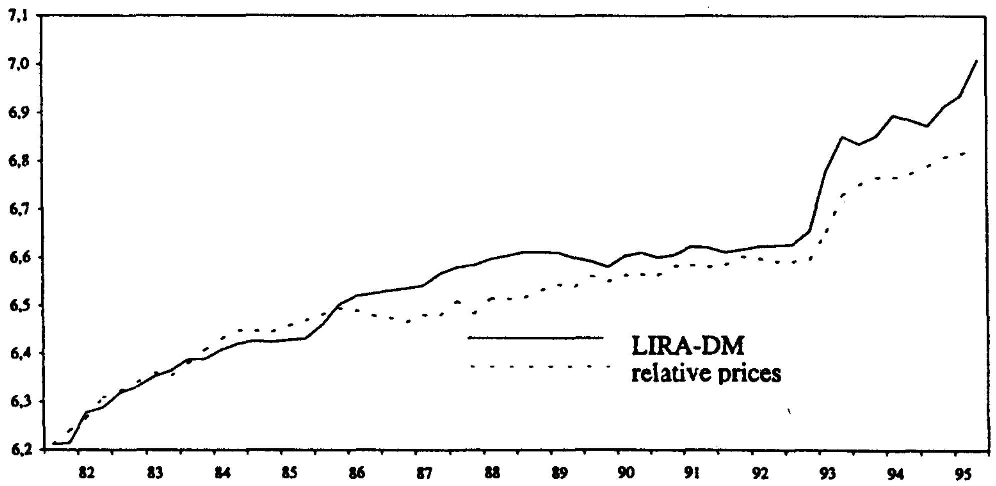
1a: Forecasts and actual values



1b: Forecast errors



1c: The lira-DM exchange rate and relative export prices



Note: All variables are in logs.

equation for $s_{t+1/t}$ using direct observations from the *Forum - Mondo Economico* survey discussed above, and then uses equation (1) to determine the spot exchange rate.[14]

The survey-based expected lira-DM exchange rate, compared with actual values, and the implied forecast errors are reported in Figure 1. The latter clearly increased and became more volatile after the exit of the lira from the ERM of the EMS. Tests of unbiasedness of these expectations on the exchange rate were performed by Altissimo et al. (1995);[15] according to their results, the presence of a systematic forecast error could not be rejected, and a closer look indicates a tendency to overestimate up to 1990 and to underestimate after 1992.[16]

For our purposes, i.e. in order to use survey-based data in the framework of equation (1), it is relevant to test whether the uncovered interest parity condition is actually satisfied for the expectations of the survey participants. Since (1) is an identity, it actually amounts to testing that the risk premium term is not correlated with the other variables on the RHS of (1) and that it is not too volatile (or it is a stable function of some variables). If this is not the case, changes in interest rates would be reflected in changes in the risk premium rather than in expected depreciation. As it is well known from the literature on the subject, starting from the work of Froot and Frankel (1988),[17] the UIP condition was usually rejected when tested in conjunction with the hypothesis of rational expectations, while the results have been more favourable when survey data were used.

We tested the UIP condition by regressing the survey-based, three-month ahead expected depreciation of the lira-DM exchange rate[18] on both the domestic and the German three month interest rates.[19] We tested the UIP jointly with the assumption of a white noise (plus a constant risk premium ρ). The results (rows I and II in Table 1) show that the UIP condition is not rejected: the coefficients on the domestic and foreign yield are not significantly different from 1 and -1 respectively, while the constant term is not significantly different from 0. However, some autocorrelation in the residuals suggests that some systematic behaviour of the risk premium may be present; we re-estimated the equation introducing some very simple modelling of this term, using, as a proxy, the coefficient of variation of the exchange rate in the period (both current and lagged);[20] this variable proved to be significant and its introduction improved the fit, while retaining the basic result (rows III and IV in Table 1). We can conclude that the standard link between expected depreciation and the interest

14 The survey collects data on expectations on the Lira-Dollar and Lira-Deustche Mark exchange rate quarterly since 1981. Both one-quarter and two-quarter ahead expectations are available. The survey is not, however, homogeneous through time. Up to the second quarter of 1990 only qualitative data are available. Both the direction (appreciation or depreciation) and the intensity (little or much) of the expected movement of the exchange rate were asked. Afterwards, point expectations were collected and the consensus forecast is constructed as an arithmetic mean of all survey participants after deletion of outliers. To have a continuous series of expectations the method of converting of qualitative expectations proposed by Carlson and Parkin (1975) was employed. For a survey of the possible methodologies and the associated problems see Visco (1984) and Pesaran (1989).

15 For the methodology to be used to test for unbiasedness in the presence of non-stationary series, see Giorgianni (1995a). See also the works of Frankel and Froot (1987) and Froot and Frankel (1988) for an empirical application to surveys on exchange rates expectations.

16 These tests, however, can not be considered as conclusive since the systematic error in the first period might well be due to the process of converting the qualitative data and the more recent period is too short to give a precise answer.

17 For a comprehensive survey on the subject, see Takagi (1990).

18 Since the survey is collected during the last month of each quarter, in computing expected depreciation we used the average spot rate over the same period. The interest rates on the right hand side refer to the same interval.

19 A risk premium correlated with the yields on the RHS in (1) would bias the estimated coefficients away from 1 and -1. This testing procedure is a more general version of the one used in Froot and Frankel (1988), who regress the expected depreciation on the forward exchange rate premium; the two approaches coincide when the restriction of equal coefficients on the domestic and foreign interest rate is imposed.

20 In this estimate, the coefficient of variation is measured over daily observation in the last month of each quarter.

differential seems to hold for Italy. Part of the variability of the time varying risk-premium, as measured using the observed expectations, can be explained by the volatility of the exchange rate;[21] however, the residual variability is still quite high, on average 0.8 percent per quarter.

Table 1

Tests of the uncovered interest parity condition

Dependent variable: expected depreciation

	Const.	γ_{lira}	γ_{DM}	σ_t	σ_{t-1}	Corr. R2	SEE	DW	Restrictions test
I..........	–.002	1.25	–1.64	–	–	.47	.009	1.4	–
	(0.3)	(4.1)	(–5.3)						
II	–.005	1.0	–1.0	–	–	.44	.009	1.2	12.0%
	(3.7)	(res.)	(res.)						
III	–.008	1.4	–1.4	–.49	–.37	.59	.008	1.96	–
	(0.9)	(5.1)	(4.9)	(2.5)	(2.0)				
IV	–.002	1.0	–1.0	–.46	–.42	.57	.009	1.8	17.4%
	(0.9)	(res.)	(res.)	(2.5)	(2.3)				

Interestingly enough, the recursive estimation of the UIP over the 1982-1994 period, shown in Figure 2, seems to suggest that the restrictions are accepted much more significantly in the floating (post-June 1992) period. Although, in principle, the move to floating rates could have increased the volatility of both expectations and the premium, rendering the estimation of the UIP more troublesome, this did not seem to have happened.

The deviations from the UIP resulting from equation (1) are shown in Figure 3. In the years after 1992 the premium based on survey data is constantly positive; according to our estimates, the higher mean level of volatility after the move to floating rates lead to an increase in the risk premium of about 3 percentage points. The residual component is also positive in this period; it may be due to a systematic bias in the timing of the observations, although other factors may be present. In the same figure the risk-premium resulting from the assumption of perfect foresight is also plotted: the latter is much more volatile.

In estimating the expectation formation equation, we started from a general specification of the kind:

$$s_{t+1/t} = c + \sum_{i=1}^{p} \alpha_i s_{t+1/t-1} + {}_t\sum_{i=0}^{p} \beta_i s_{t-i} + \sum_{i=0}^{p} \gamma_i x_{t-i} + \mu_t \tag{2}$$

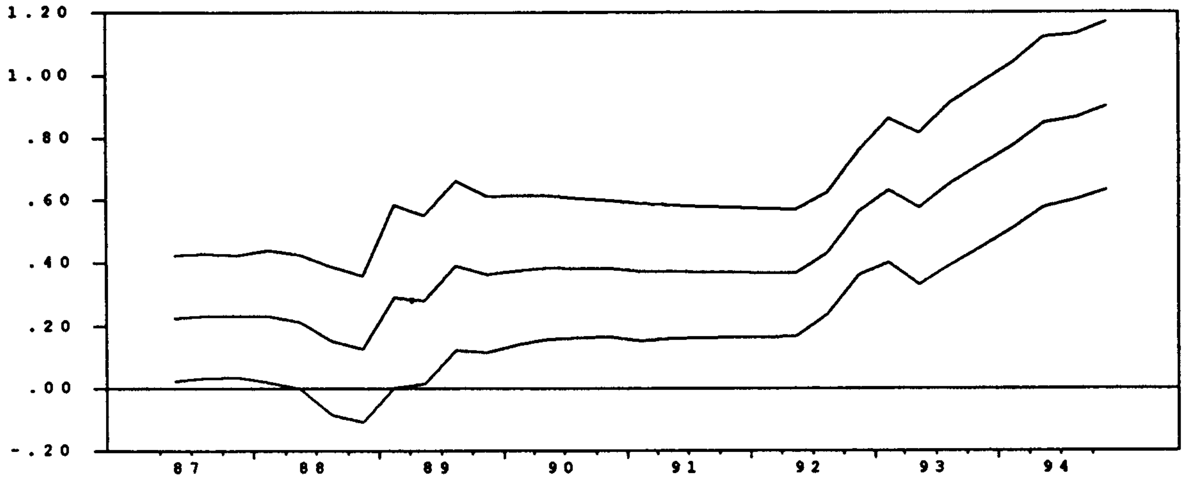
where, besides lagged values of the expected and spot exchange rate, other variables (x_t) in the information set of the agents[22] are allowed to affect the formation of expectations of the lira-DM exchange rate. The interest rate differential, the relative price of exports (*pp)*, the change in official reserves relative to GDP (*VP*) and the change in the dollar-DM exchange rate (*dmus*) were initially

21 For the limited purpose of this paper, we do not address the issue of the "fundamental" shocks underlying exchange volatility, which would be needed to give a full theoretical explanation of the risk premium. See Fornari, Monticelli and Tristani (1995). Further research is in progress on this topic. For a study of the determinants of the risk-premium in Italy using a different survey on exchange rate expectations, see Giorgianni (1995b).

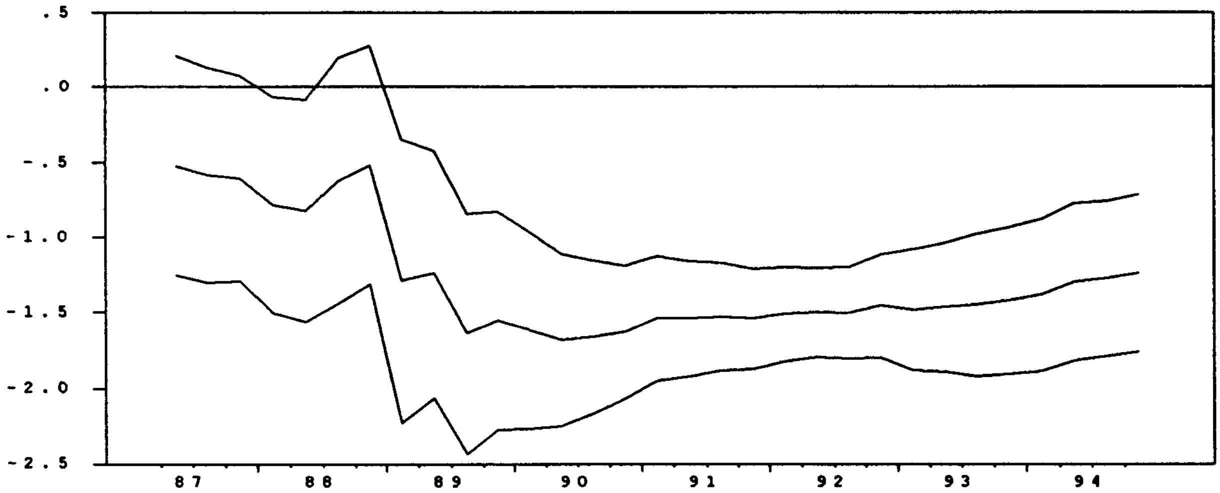
22 The timing of the variables entering the information set of the agents when forming the expectations is crucial. It must be remembered that expectations are taken during the last month of the quarter t when forecasting the quarter (t+1). Two strategies have been followed when estimating the equation: excluding the last month of the quarter from the variables in the RHS of the equation or using all the information of the quarter t but instrumenting with variables dated at (t-1). Only the results of the latter procedure are reported in this paper. Results using the former are only marginally different. If no information for the quarter t was used, however, the fit of the estimate decreases.

Figure 2
Uncovered interest parity: recursive estimates of the coefficients

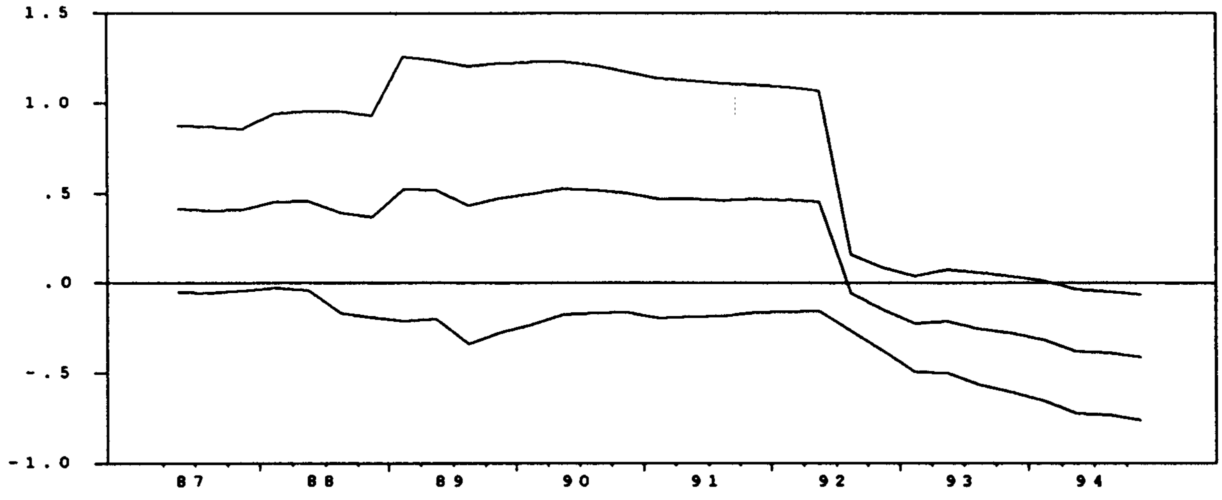
Domestic interest rate



Foreign interest rate



Exchange rate volatility

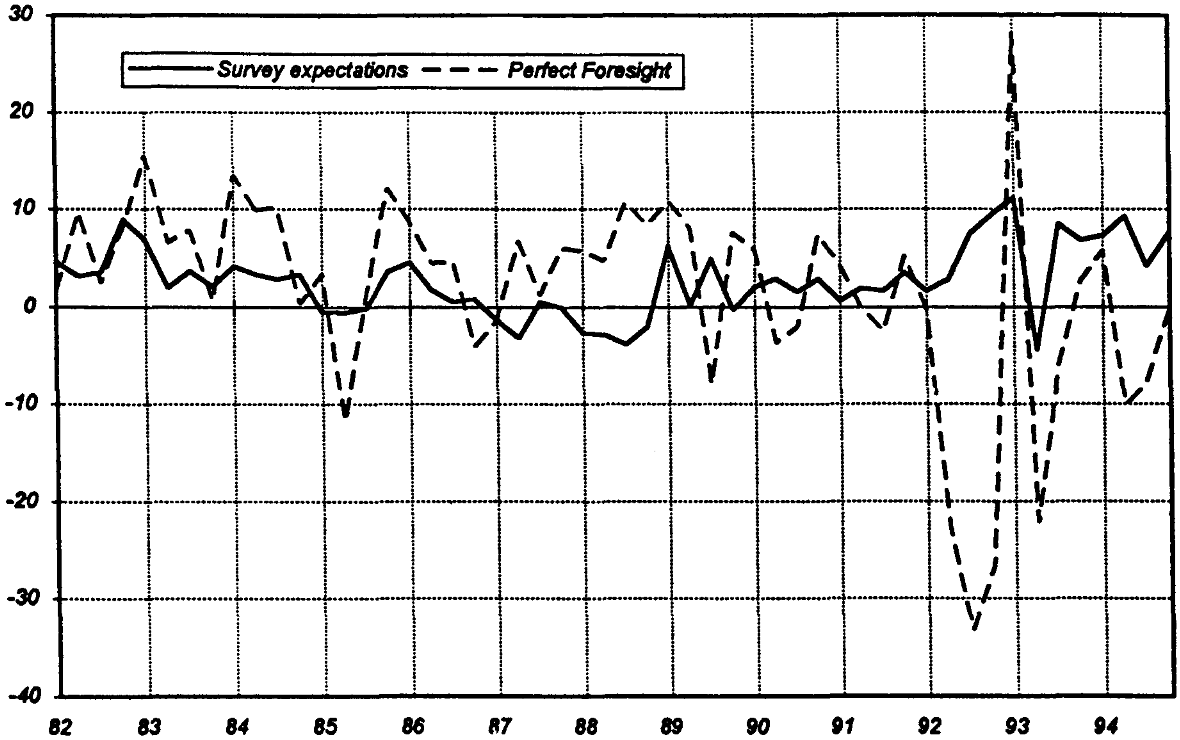


included in x_t. μ_t represents a stochastic error. This specification is sufficiently general to encompass adaptive, extrapolative or regressive schemes of expectation formation.[23] In sample, we obtained the following specification:

$$\left(s_{t+1/t}-s_{t/t-1}\right)=c+\beta_1\left(s_{t/t-1}-s_t\right)+\beta_2\left(s_{t-4}-pp_{t-4}\right)+\beta_3\left(r_{t-1}-r_{t-1}^{*}\right)+\mu_t \tag{3}$$

where pp_t represents the logarithm of the ratio of prices of tradables in the two countries. The results of the estimates are presented in Table 2. s_t was instrumented using its past values.[24]

Figure 3
Implicit risk premium in the UIP
Percentage points on annual basis



The specification indicates a very strong adaptive behaviour: more than three quarters of the deviation of the exchange rate from its forecasted value are incorporated in next period's expectation. The coefficient of the PPP is of the expected sign but not significant. The long-run convergence of the expected exchange rate to the PPP appears to be very slow; the regressive component of short-run expectations is, at best, very weak.

A short-run adaptive behaviour of expectations is a rather common result in the literature on survey-based exchange rate expectations. In this literature (e.g. Frankel and Froot, 1987 and Froot and Frankel, 1988) only expectations over longer horizons exhibit a "regressive" behaviour, i.e. the tendency to return to some nominal value. For practical purposes this increases the persistence of shocks that affect the spot exchange rate.

The interest rate differential has a positive effect on the expected exchange rate, which partially compensates its effect on the spot exchange rate via the UIP; in the framework of this model, this means that a spot appreciation due to an increase in the current differential is only partially translated into expected rates.

23 See Takagi (1990).

24 The current exchange rate must be conveniently instrumented, in order to avoid simultaneity with the UIP above.

Table 2
Exchange rate expectations
Instrumental variables estimates
Sample: 1981.3 – 1994.4

Dependent variable: $\left(s_{t+1/t} - s_{t/t-1}\right)$

Constant	0.346 (0.92)	0.379 (1.16)
$\left(s_{t/t-1} - s_t\right)$	–0.714 (–5.02)	–0.663 (–4.20)
$\left(r_{t-1} - r_{t-1}^{*}\right)$	0.596 (2.26)	0.534 (2.11)
$\left(s_{t-4} - pp_{t-4}\right)$	–0.052 (–0.93)	–0.057 (–1.27)
VP_{t-1}	–0.001 (–0.05)	
$dmus_t$	–0.041 (–0.61)	
R^2	0.74	0.73
D.W.	1.92	1.77
S.D. dependent variable	0.0237	0.0237
S.E. of regression	0.0119	0.0124
Serial correlation $\chi^2(4)$	1.87 (0.76)	2.21 (0.70)
Normality $\chi^2(2)$	2.07 (0.15)	3.47 (0.176)
Heteroscedasticity $\chi^2(1)$	0.291 (0.58)	2.48 (0.12)
Functional form $\chi^2(1)$	2.07 (0.15)	3.05 (0.08)

Note: White's consistent t-statistics in parentheses.

Solving the system for the exchange rate we get:

$$s_t - s_{t-1} = k + \frac{\beta_2}{(1+\beta_1)}\left(s_{t-4} - pp_{t-4}\right) + f\left(\Delta r_t, \Delta r_{t-1}, \rho_t, \rho_{t-1}\right) \tag{4}$$

where $\Delta r_t = r_t - r_t^{*}$ and f is a linear function of the exogenous variables. The dynamics of the exchange rate is, therefore, determined by the evolution of the exogenous variables Δr_t and ρ_t and the cointegrating vector $\left(s_{t-4} - pp_{t-4}\right)$. The estimates imply a very slow adjustment of the exchange rate to the relative price ratio.

Equations (3) and (1) give some insight into some of the basic features of the determinants of expected and spot exchange rate. Some fundamental issues, however, still remain unanswered on econometric grounds and will require further investigation. Regarding expectations, the unexplained component is large, particularly so in the first half of 1995, suggesting that other factors may be present. Regarding the determination of the risk premium, the estimated link with exchange rate volatility is a first step, but it does not explain its fundamental determinants. In a general equilibrium model, the risk premium (as well as the exchange rate volatility) would be determined by variances and covariances of the various shocks hitting the economy, on the real side, on the monetary side, on the fiscal side (for an attempt along these lines, see Fornari et al., 1995). Although it is difficult to assess it econometrically, in the Italian case the issue of the link between fiscal imbalances, expectations on fiscal policy, inflation and the exchange rate will have to be addressed to further understand the nature of the disturbances to the exchange rate. Anecdotal evidence based on higher frequency data suggests that, in 1995, "news" regarding the domestic fiscal situation was a key determinant of exchange rate fluctuations, although it is hardly measured by some simple indicator, like the debt/GDP or deficit/GDP ratios.

All in all, the above results indicate that:

- the uncovered interest parity condition is a useful tool in modelling the determination of the exchange rate, even in the post-1992 period;
- the risk premium on short-term Italian interest rates is positively correlated with the volatility in the exchange rate market. It was constantly positive after 1992. Its unexplained component is nonetheless large;
- the effect of changes in the interest rate differential on the spot rate has the expected sign;
- in the short run, the strong adaptive characteristics of the estimated equation for exchange rate expectations tend to amplify the effect of a shock on the spot rate and to increase its persistence.

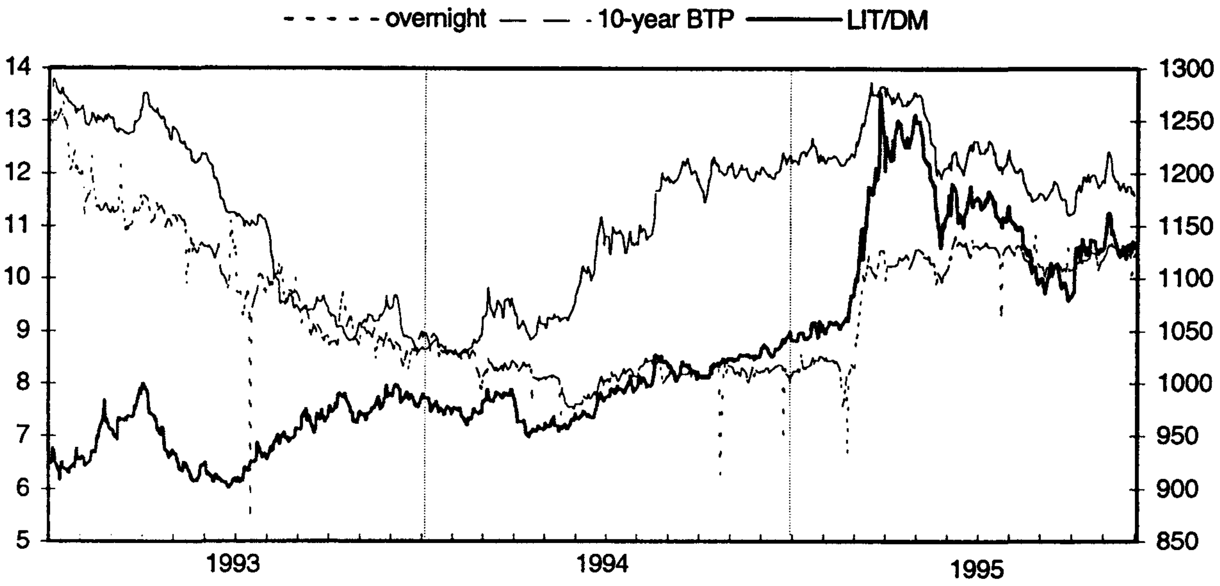
3. Long-term interest rates

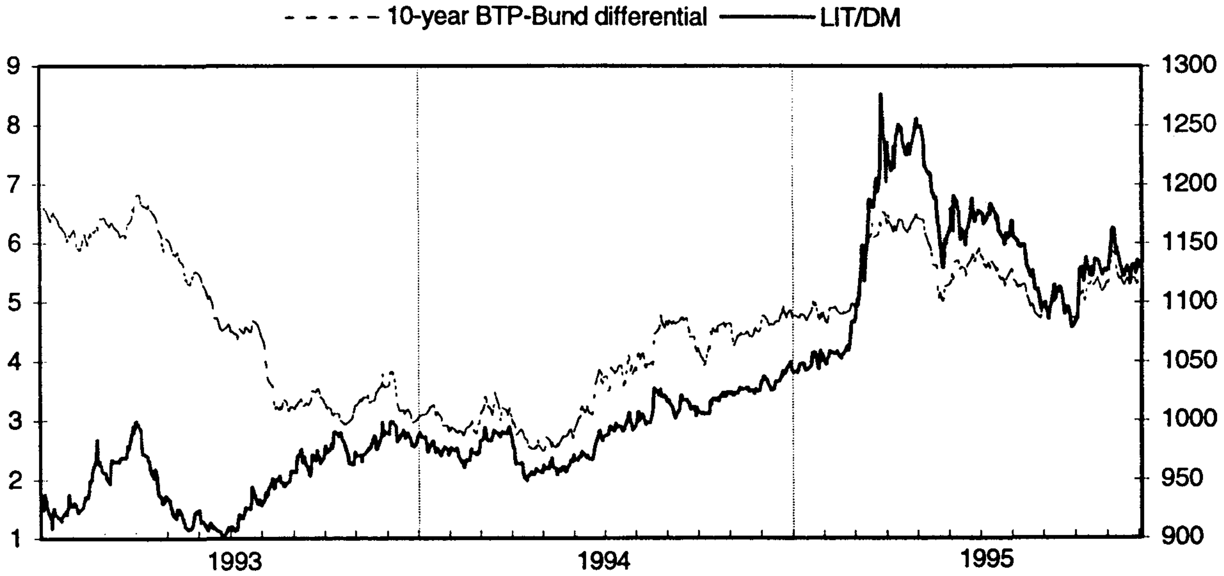
In recent years, the determination of long-term interest rates in Italy was significantly affected by the growth of a large and efficient securities market, that took place mostly in the first part of the 90s.[25] The speed of adjustment of market rates and their reaction to shifts in expectations increased substantially.

Some facts about the behaviour of long-term rates in the 1992-1995 period are shown in Figure 4. The relation between the domestic financial markets and the currency market strengthened: the short-term movements of bond yields and those of the exchange rate were clearly positively correlated; the same correlation showed up between the exchange rate and international interest differentials. On the contrary, movements in the interest rates directly controlled by monetary policy were often not reflected in bond yields (a positive correlation can be observed in 1993, while in 1995, as short rates increased, bond yields followed a decreasing trend).

25 On the primary market, the practice of setting a floor-price (a maximum yield) at the auctions for long term securities was abandoned in 1992, leaving the market free to determine the yields. The screen-based market for State securities (MTS) was established in 1988; new maturities for long-term securities were introduced in the following years (7, 10 and 30 years BTPs, respectively in 1990, 1991, 1993); futures markets on BTPs were created in 1991 in London and Paris; a domestic futures market started operating in 1992. In the same period, as a consequence of the full liberalisation of international capital movements completed in 1990, non-resident investors entered the market. For a description and institutional details, see Passacantando (1995).

Figure 4
Long-term interest rates and the exchange rate





Recent research for other EU countries (Fell, 1995) suggests that the relative importance of movements in short term rates, on the one hand, and of foreign yields, on the other, in determining domestic bond yields changed in the last decade: in the second part of the eighties and in the nineties, international linkages between bond markets increased, while the effect of policy rates on the term structure became less direct, possibly due to the different responses of inflation expectations.

The approach followed in previous versions of the model (e.g., Nicoletti et al., 1995) is based on the expectation theory of the term structure, according to which the yield of an m-period bond is given by:[26]

$$R_t(m)=\frac{1}{m}\sum_{j=0}^{m-1} r^e{}_{t+j/t}+\phi_m \qquad (5)$$

26 (5) holds for discount bonds. The general relation also includes terms for duration. For a survey, see Shiller (1990).

where r^e are expected one-period rates and ϕ is a term premium. Under the assumption that expected real rates and the inflation rate follow an autoregressive process, the long rate is modelled as a distributed lag of past short rates and inflation rates (Modigliani-Shiller, 1973); the shape of the lag structure may be used to test assumptions on the autoregressive process used to forecast interest rates. This way to model long yields, however, implies a constant effect of policy rate changes on long-term rates, which seems at odds with some of the stylised facts above. Moreover, the expectations hypothesis in (5) abstracts from international linkages between presented bond and currency markets.

An improvement is possible by explicitly modelling inflation expectations, using survey data to estimate them, and introducing an effect of foreign bond yields; the latter may either represent a short-run effect or, more fundamentally, derived from the tendency of real yields to converge in the long run.

Under the expectations hypothesis, the following long run condition must hold:

$$R(m)=r+\phi_m \tag{6}$$

while a real interest parity, RIP (that holds if both the uncovered interest parity and ex-ante purchasing power parity hold in the long run), would imply:

$$R(m)=R*(m)+\pi^c-\pi^c*+\omega \tag{7}$$

where π is the long run expected inflation rate, ω is a real exchange rate premium and an asterisk denotes foreign variables.

Conditions (6) and (7) may both hold in equilibrium.[27] We estimated a model for the long rate that admits both (6) and (7) as equilibrium solutions. In Tables 3 and 4, the return on fixed income long-term bonds (*TBTP*)[28] is regressed on the yield on long-term German securities (*TBUND*), the 3-month interbank rate on the domestic market (*TIB3*) and on proxies for unobservable variables as expected domestic and foreign inflation and the risk premia. The premia are modelled using currency market volatility (the coefficient of variation of daily observation in each month, *EXCVOL*)[29] and, as a fiscal variable, the debt/GDP ratio. German long-run inflation was approximated with an interpolation of past realised inflation, following the approach in Jahnke (1995).

A relevant issue is how to model long-term inflation expectations. Unfortunately, the *Forum-ME* survey only reports short-term (one or two quarter ahead) forecasts, not long-term expectations. In some macro-models, some econometric techniques to estimate long-term expectations have been used; however, they usually make use of some - at least partial - survey evidence to perform the estimation; so, for instance, for the U.S. and (Tarditi, 1995 and Kozicki, Reifschneider and Tinsley, 1995) for Australia for the United States. Our approach is to assume that expected long-term inflation is a function of both past inflation rates (*INFL*) and current short-term survey-based inflation expectations (*EXPINFL*); through the latter variable some forward-looking elements are introduced.

27 Fell (1995) tests the impact of both short-term rates and foreign rates on long yields for a number of EU countries (Italy is not included) by estimating autoregressions that include both equilibrium conditions.

28 As pointed out in Nicoletti et al. (1995), the data series on BTP yields is not homogeneous through the whole period. Only since 1988, with the opening of the screen-based market, are data on constant maturity medium and long term bonds available; before this date, the existing series is a weighted average of one to ten year bonds quoted in the stock market, whose average maturity varies over time. In the estimation, we used the yield on 9 to 10 year bonds on the screen based market since after they were available (1990), and the "average" data series before this year.

29 Implied volatility in currency options prices may be considered a better measure of market opinions than actual volatility; however, such data are available for the lira/DM exchange rate only since 1994. The implied volatility, however, seems to follow actual volatility (with a lag) very closely.

Table 3
Long-term interest rate
(general model)
Instrumental variables estimates
Sample: 1985.2 - 1994.4
Dependent variable: *TBTP*

	Lag: 0	Lag: 1	Sum	F test on exclusion
Constant	–8.10	–	–	–
	(1.95)			
TBTP	–	0.41	–	–
		(2.9)		
TIB3	0.19	0.06	0.26	1.6
	(1.1)	(0.6)	(1.7)	(23.4%)
EXPINFL	0.45	0.12	0.58	8.5
	(3.9)	(0.8)	(3.0)	(0.1%)
INFL	–0.22	0.31	0.09	0.87
	(0.8)	(1.3)	(0.5)	(43%)
TBUND	0.81	–0.50	0.30	5.8
	(3.4)	(2.6)	(1.8)	(1%)
INFLG	–0.29	–0.24	–0.53	1.7
	(0.1)	(0.1)	(1.5)	(19%)
DEBT/GDP	0.56	–0.49	0.07	2.1
	(1.4)	(1.3)	(0.3)	(15%)
EXCVOL	18.4	16.3	34.7	0.26
	(0.5)	(0.5)	(0.7)	(76.9%)

Corrected R2: 0.94
SEE: 0.36
Autocorrelation: F(1.21) = 0.65 (0.43)
Normality: $\chi^2(2) = 2.34$ (0.31)

Simultaneity problems may arise when using contemporaneous short-term rates on the RHS of the equation, since shocks to expected inflation or risk premia may produce both an increase in long rates and a policy reaction. The contemporaneous short rate was, therefore, instrumented using its past values and changes in the German three-month rate.

The estimates (including the current value and one lag of each variable (Table 3)) indicate that expected inflation and foreign rates do significantly affect the long-term rate, both dynamically (this is shown by the F-tests on the exclusion of all lags on each variable in the last column) and in equilibrium (the test on the sum of the coefficients of each variable is reported in the third column). In particular, expected inflation outperforms past actual inflation, which is no longer significant when the former is included among the regressors. The short term rate is significant, but only marginally. Expected German inflation is not statistically significant, although it has the right sign and dimension. The tests for the coefficient[5] on currency market volatility and the debt/GDP ratio suffer from collinearity between these two variables in the sample period; after the selection procedure, the first proved to be significant.

We tested the restrictions derived from both (6) and (7) and imposed them in the final specification[30] (Table 4): all the interest rates on the right hand side are homogeneous of degree one; the sum of the coefficients on foreign and domestic inflation is zero; the steady-state coefficient on inflation is one.

30 Selection proceeded from general to specific, according to the methodology in Hendry (1989).

Table 4

Long-term interest rate
(reduced model)

Instrumental variables estimates

Sample: 1985.2 - 1994.4

Dependent variable: TBTP

	Unrestricted	**Restricted**
C1 - *Constant*	−1.48	−0.03
	(1.68)	(0.33)
C2 - *TBTP* (−1)	0.47	0.56
	(4.61)	(8.52)
C3 - *TBUND*	0.91	0.83
	(5.04)	(4.81)
C4 - *TBUND* (−1)	−0.49	−0.50
	(−2.42)	(2.62)
C5 - *EXPINFL*	−0.32	−0.33
	(3.4)	(5.87)
C6 - *TIB3Q*	0.21	0.11
	(2.17)	(1.59)
C7 - *INFLG* (−1)	0.06	0.33
	(0.25)	(5.87)
C8 - *EXCVOL*	61.9	84.1
	(2.76)	(4.64)
Corrected R2:	0.94	0.93
SEE:	0.38	0.39
DW:	1.78	1.77
Autocorrelation:		F(1.28) = 0.07 (0.80)
Normality:		$\chi^2(2) = 1.07$ (0.59)
Heteroscedasticity:		$\chi^2(1) = 0.03$ (0.85)
Tests on restrictions:	**C2+C3+C4+C6=1**	**C2+C5+C6=1**
	F(1.30) = 1.36 (0.25)	F(1.30) = 2.49 (0.12)
	C5+C7=0	**Test on joint restrictions:**
	F(1.30) = 0.0004 (0.98)	F(3.30) = 1.12 (0.36)

The final specification in Table 4 may be rewritten as:

$$\begin{aligned} \Delta TBTP \ = \ & -0.03+0.83\Delta TBUND+0.15\Delta TIB3Q+0.33\Delta EXPINFL \\ & -0.11(TBTP_{-1}-TIB3Q_{-1}) \\ & -0.33(TBTP_{-1}-TBUND_{-1}-EXPINFL_{-1}+INFLG_{-1}) \\ & +84.1\,EXCVOL_{-1} \end{aligned}$$

The long-run solution of the equation is a combination of the expectations hypothesis (6) and of the RIP (7), with a risk premium correlated with exchange rate volatility[31]. The coefficient on RIP is both larger in value and more significant in statistical terms; this seems to suggest a proportionately bigger impact of foreign interest rates in determining domestic yields. Since exchange

31 Only short-term expectations enter the equation above; however, if one assumes that long-term expectations follow a partial adjustment process on short-term expectations, it is straightforward to show that their lagged level enters the RIP term in brackets with unit coefficient, and that their change enters the equation with coefficient 0.33/α (where α is the partial adjustment coefficient).

rate variability increased dramatically after the exit of the lira from the ERM of the EMS in 1992, its inclusion in the equation has the effect of permanently increasing, given other factors, the interest rate differential (the estimated effect is about one and a half percentage points).

The short-run behaviour of long yields is driven by expected inflation, that has an immediate impact on long rates of around 0.3, and by the German long rate, whose impact is about 0.8.

The equation directly links the domestic yields to foreign asset markets, to expected inflation and to the uncertainty on the currency market; correspondingly, the direct effect of current short rates on long rates is much lower. These results are similar to those obtained for other EU countries, mentioned above. A stronger, indirect effect of changes in policy rates on long yields is transmitted via inflation expectations (determined in the model along the lines discussed in section 4 below); depending on this effect, an increase in policy rates does not necessarily imply a rise in bond yields. Although no direct effect of the exchange rate on long rates is included in the equation, in a simulation of the whole model, a shock to the risk premium does generate common movements in the two variables.

In this formulation, the final effect of short-rate movements on long yields depends on the effect on inflation expectations. To close the model, one needs to specify the expectations formation mechanism.

4. Monetary policy and inflation expectations

Expected consumption price inflation, as collected by the *Forum-Mondo Economico* survey, actual inflation and forecast errors are shown in Figure 5.

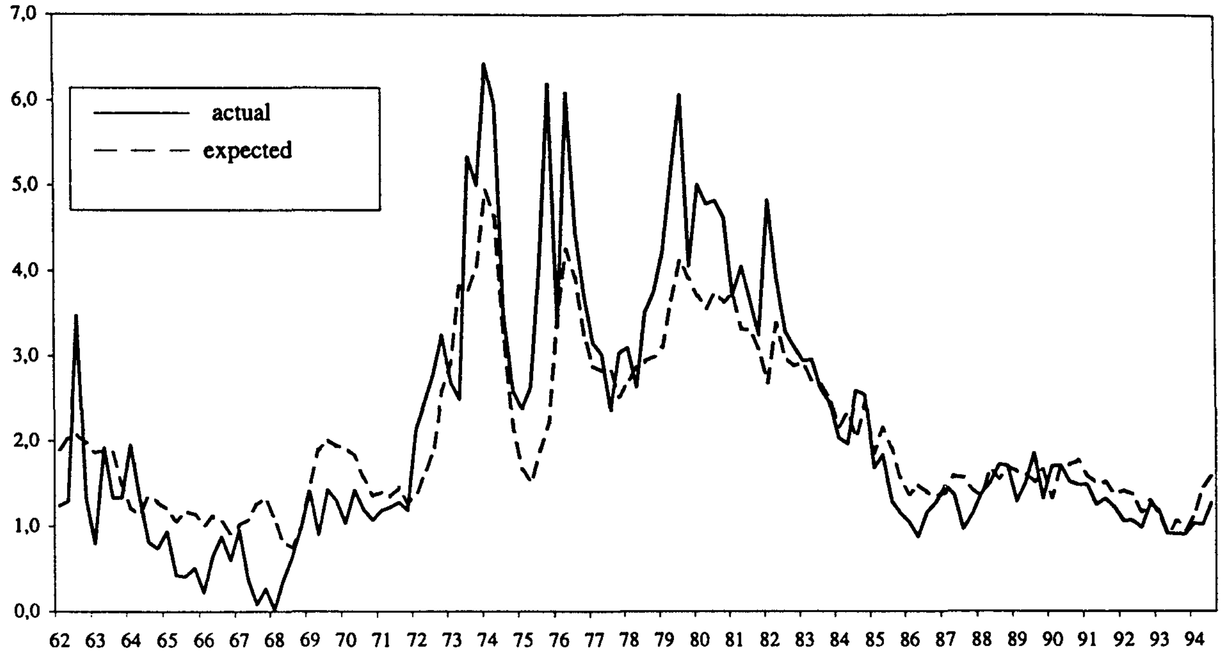
Previous work has shown that the inflation forecasts are systematically biased and inefficient during the periods of high and volatile inflation (from 1973 to the mid-eighties) while forecast errors are very small (even if, statistically, unbiasedness is rejected by the data) and not correlated with available information during the periods of low and relative stable inflation[32]. Purely extrapolative and/or regressive models of price expectations have little explanatory power.

An equation describing the expectation formation mechanism was recently estimated in Nicoletti-Altimari (1995), to which we refer for a more detailed analysis. It is there assumed that to forecast inflation, the agents use the variables included in the reduced form of the price-wage block of the BIQM, namely the rate of change of the effective exchange rate $\dot{e}$; the deviation of the capacity utilisation rate from its "normal" value $\left(CPU-\overline{CPU}\right)$; the unemployment rate U; the foreign inflation rate, $\pi *$ (the rate of change of average prices of manufactured goods of fourteen competitors of Italy, weighted using Italian imports shares); the rate of change of energy prices $\dot{p}e$. To ascertain the possibility of an autonomous effect of monetary policy on inflation expectations the official discount rate r is included in the above list.

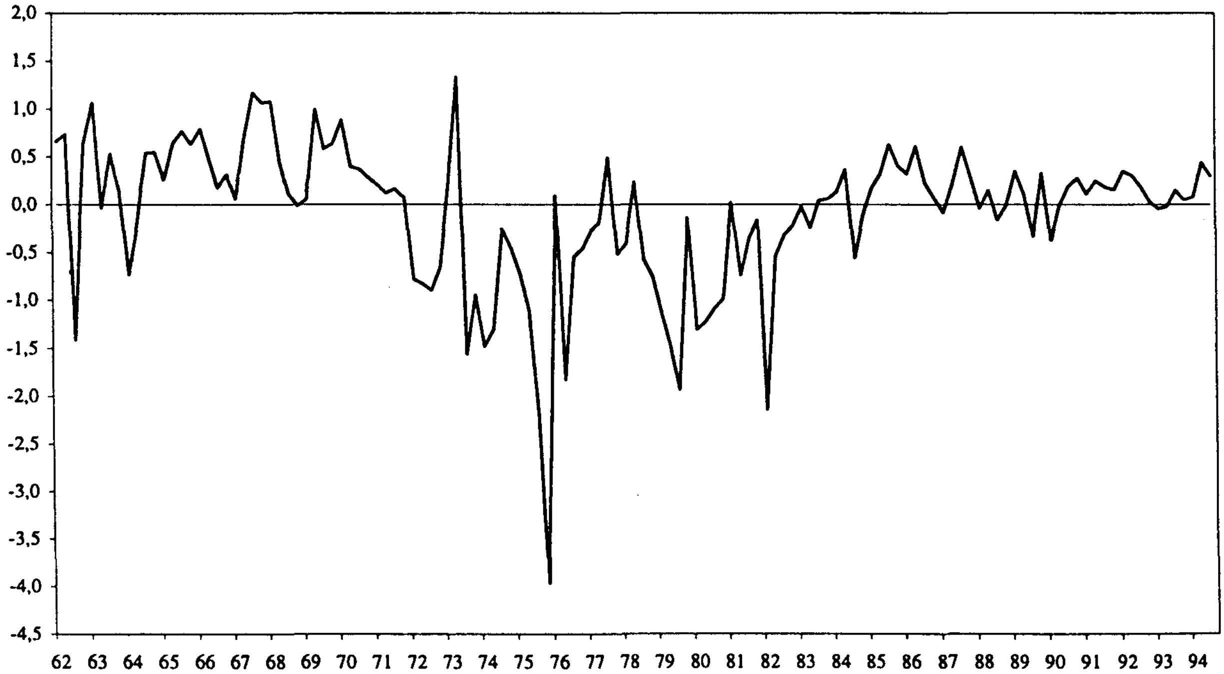
The parameters of the equation estimated with OLS are not stable over time when using the test on the constancy of parameters proposed by Granger and Terasvirta (1993) and Lin and Terasvirta (1994). Using the technique proposed by the same authors, the degree of nonlinearity of the parameters is assessed and modelled using smooth transition functions. The final estimates are reported in Table 5. All parameters have the expected sign. One sixth of the previous period's forecast error is incorporated in the revision of inflation expectations. Important effects on expectations are

32 A thorough analysis of direct observations on inflation expectations in Italy collected in the Forum-Mondo Economico survey is contained in Visco (1984 and 1987) and, for the more recent period, in Nicoletti-Altimari (1995).

Figure 5
Actual and expected inflation
Consumption prices



Forecast errors



exerted by the exchange rate, the unemployment rate, the capacity utilisation rate and the foreign inflation rate.

Two sources of instability of the estimated coefficients were detected. The first one, captured by the transition function *LN* (Figure 6), "transfers" the model from a specification that does not satisfy the necessary condition for rational expectations in a hypothetical long-run equilibrium to one that does[33]; we interpreted it as learning. In the seventies, the economic agents were continuously surprised by innovations in the inflationary process (the two oil shocks in 1974 and in 1979, the introduction of a formal indexation mechanism in 1976), which most likely slowed the speed of the learning process. According to this interpretation, a fast convergence of the learning process is observed afterwards.

The second change in parameters, modelled by the transition function *MP*, signals the emergence of a positive impact of monetary policy, measured by changes in official rates, on inflation expectations; according to the estimates, this effect was not present before the end of 1984. Most likely, this reflects the passage from direct to indirect instruments of monetary policy (completed in 1983). Moreover, since the early eighties, inflation became the primary concern of monetary policy, and movements in official rates signalled the determination to defend the EMS parity, viewed as the main instrument to keep inflation under control[34].

Table 5

Inflation expectations

Non-linear least squares estimates

Sample period: 1971.2 - 1995.1

$$\pi_{t/t-1}-\pi_{t-1/t-2} = \underset{(3.84)}{1.351}LN - \underset{(-4.38)}{0.485}\left(\pi_{t-2/t-3}LN\right) + \underset{(2.67)}{0.152}\left(\pi^{i}_{t-1}-\pi_{t-1/t-2}\right)$$

$$+\underset{(2.52)}{0.019}\Delta\dot{e}_{t-2} + \underset{(1.74)}{0.053}\Delta\left(CPU_{t-2}-\overline{CPU}\right) - \underset{(-2.19)}{0.215}\Delta U_{t-2}$$

$$+\underset{(1.81)}{0.041}\Delta\pi^{*}_{t-2} + \underset{(2.48)}{0.005}\Delta\dot{p}e_{t-2} - \underset{(-2.55)}{0.107}\left(\Delta r^{1}_{t-1}MP\right)$$

$$LN = \exp\left(\underset{(-2.89)}{-0.004}(t-\underset{(10.02)}{29.365})^2\right)$$

$$MP = 1 - 1/\left(1+\exp\left(-0.97(t-\underset{(6.84)}{59.487})\right)\right)$$

$\bar{R}^2 = 0.51$ $\qquad \sigma_\varepsilon = 0.260$ $\qquad D.W. = 2.25$

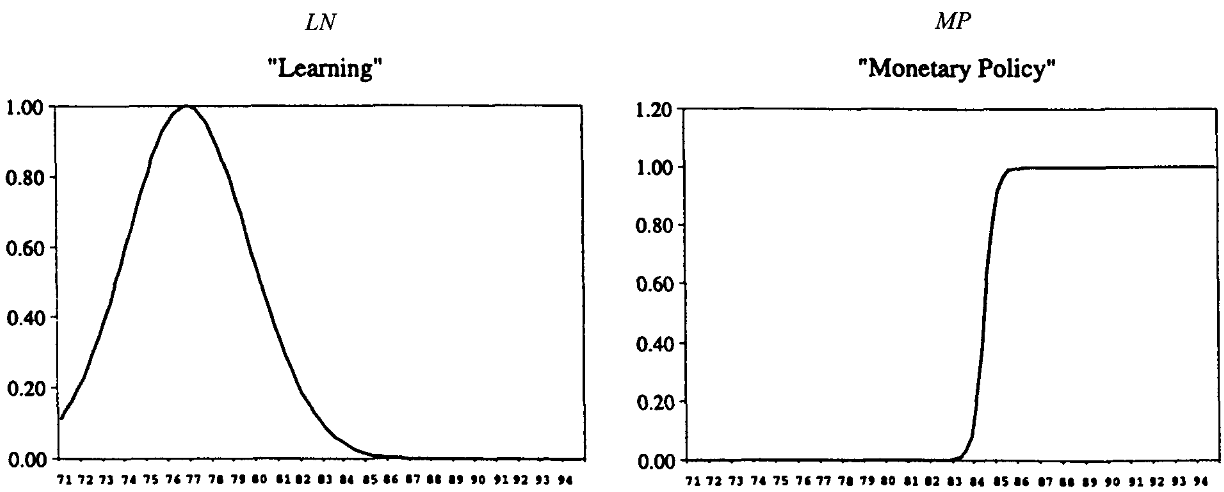
Note: White's t-statistics in parentheses.

Autocorrelation (1-4)	:	$F(4.80)$	=	1.333	(0.265)
Heteroscedasticity	:	$\chi^2(1)$	=	5.486	(0.019)
Normality	:	$\chi^2(1)$	=	0.439	(0.802)
Functional Form	:	$F(3.80)$	=	1.140	(0.338)

33 Essentially the condition of cointegration of actual and expected inflation, with cointegrating vector (1, -1).

34 See Angeloni and Gaiotti (1990).

Figure 6
Transition functions



The estimated impact of monetary policy on expectations is substantial: an increase in the official discount rate of 100 basis points decreases inflation expectations by about 0.4 percentage points on an annual basis.

The equation remains stable for the period after 1992, notwithstanding the changes that took place in the exchange rate regime and in the labour market.[35]

5. Simulations

In this section, we present simulations of the model under the estimated expectation mechanism as described above (hereafter EE, estimated expectations), comparing it with a "benchmark" version, where inflation expectations are modelled by a simple adaptive scheme, monetary policy has no effect on the spot exchange rate and interest rates expectations are backward-looking (hereafter BC, benchmark case); we also perform a simulation based on the rational expectations hypothesis for inflation, the exchange rate and forward rates (hereafter RE, rational expectations).

In the first exercise we analyse the consequences of a monetary policy shock under the three expectations formation schemes described above; both the risk premium and the volatility of the exchange rate are kept constant in this case. In the second exercise we analyse the effects of increased uncertainty in the currency markets by shocking both the volatility and the risk premium by an amount that takes into account the results obtained in Section 2 on the relation between them; this second case is analysed only under the EE expectations mechanism.

35 Some evidence of overprediction is actually evident in the survey for those years: agents may have been excessively prudent with respect to those innovations and not incorporated them fully in the model. From the estimates with recursive least squares it appears however that some of the coefficients, mostly those linked to foreign shocks, have decreased somewhat after 1992. An attempt was made to introduce a third transition function for those coefficients related to the change of the degree of indexation of wages to inflation. This attempt was, however, unsuccessful.

5.1 A monetary policy shock

The first exercise consists of an increase in the policy-controlled interest rates (the overnight rate and the discount rate in the BIQM) of one hundred basis points, sustained for one year.[36] In the RE case, a return of the nominal exchange rate to the baseline value at the end of the simulation period was assumed as a terminal condition, in line with Nicoletti et al. (1995).[37]

The effect on *real activity* is very similar in all cases (Figure 7a). In the EE case, the decrease in GDP is, however, slightly stronger and longer-lasting; this reflects mainly the different behaviour of the exchange rate and long-term interest rates in the different scenarios.

Differences are substantial in the response of *consumption prices* (Figure 7b). In the BC version prices are virtually unaffected. There is, in fact, no direct link in the BIQM from monetary policy to prices, aside from the exchange rate: prices slowly adjust through a mark-up over average costs, where the latter are a function of unit labour costs. Since productivity in this mechanism is expressed as a long distributed lag of past productivity (due to the putty-clay nature of capital) and changes slowly, unit labour cost in the short run, mainly reflect changes in nominal wages. The latter are, however, very small, since employment and unemployment move slowly (as a consequence of both labour hoarding and the slow adjustment towards equilibrium) and the backward-looking inflation expectations do not move at all.

In the EE and RE scenarios, the dynamics of prices are very different. The initial effect is stronger under RE; the decrease in prices under EE builds up more slowly, but it is eventually stronger and more persistent, about 0.6 percent below the baseline.

The price behaviour mainly reflects the different responses of the *exchange rate* (Figure 7c) to the policy shock and, to a smaller extent, the different responses of inflation expectations. In the RE case, the typical overshooting pattern for the exchange rate is observed: given the (exogenous) terminal condition, the exchange rate has to appreciate in order to generate expectations of a depreciation equal to the difference in the interest rates. After an appreciation of one percent in the first period the exchange rate returns smoothly to the baseline value in the following two years. Under EE, the exchange rate keeps appreciating during the whole period of the shock as a result of the interplay between the adaptive expectation formation and the working of the UIP; afterwards, the convergence to the PPP starts to operate (Figure 7d). However, since the response of prices to the exchange rate is much faster than the response of the exchange rate to prices,[38] the PPP tends to be reestablished at a lower level of both prices and the exchange rate. The downward movement of inflation expectations after the policy shock, on the other hand, pushes down wages, reinforcing the disinflationary process in the economy.

The behaviour of *long term interest rates* is shown in Figure 7e. In the EE case, the impact of monetary policy on long rates is low, and amounts to only few basis points: this reflects the pattern of inflation expectations, that adjust immediately to the increase in official rates and then keep decreasing, following the actual trend in prices. By lowering inflation expectations, the monetary tightening can leave long-term rates almost unaffected. After the third period the pattern of the long rates under EE coincides with that under RE; after six periods all three cases are very similar. The lower effect on long-term rates under EE implies lower *net interest payments on public debt* (Figure 7f); however, this shows up only after the second year of simulation, given the average maturity of the Italian public debt.

36 Initial conditions for the simulation are those of the first quarter of 1993.

37 Here we will focus essentially on the differences of results under the different expectational schemes. For a complete description of the transmission channels of monetary policy in the BIQM the reference is Nicoletti et al. (1995).

38 Particularly the response of export prices that are the ones relevant in our specification. The downward movement of domestic prices is the result of both the decrease of prices of imported goods and raw materials and of the loss of competitiveness of domestic producers which narrows the mark-up.

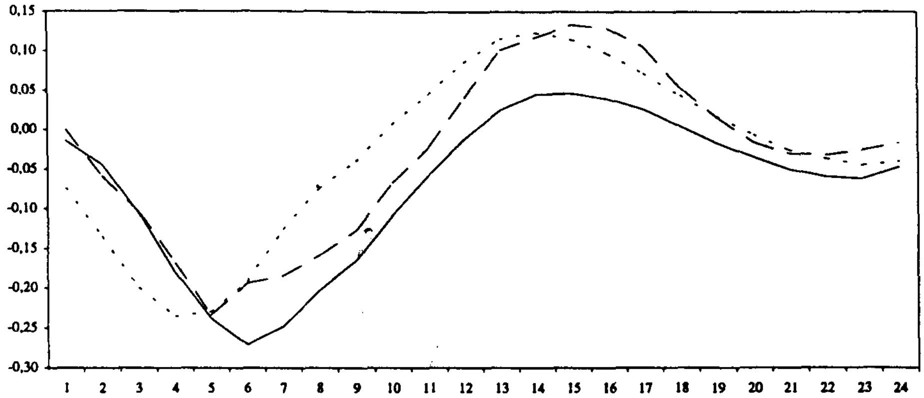
Figure 7

Effects of a one-year increase in the policy-controlled interest rate

———— Endogenization of observed expectations
· · · · · · Rational expectations
— — — — Adaptive expectations and fixed exchange rate

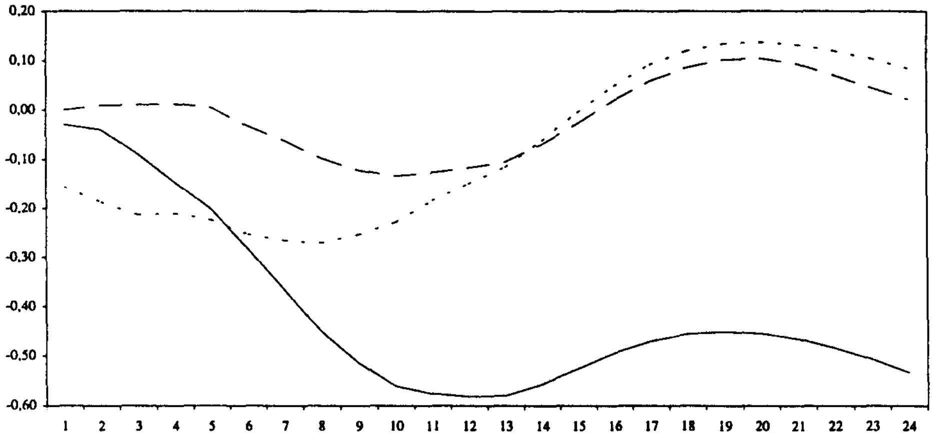
GDP **Figure 7a**

(Percentage deviations from the baseline)



Consumption Prices **Figure 7b**

(Percentage deviations from the baseline)



LIRA-DM **Figure 7c**

(Percentage deviations from the baseline)

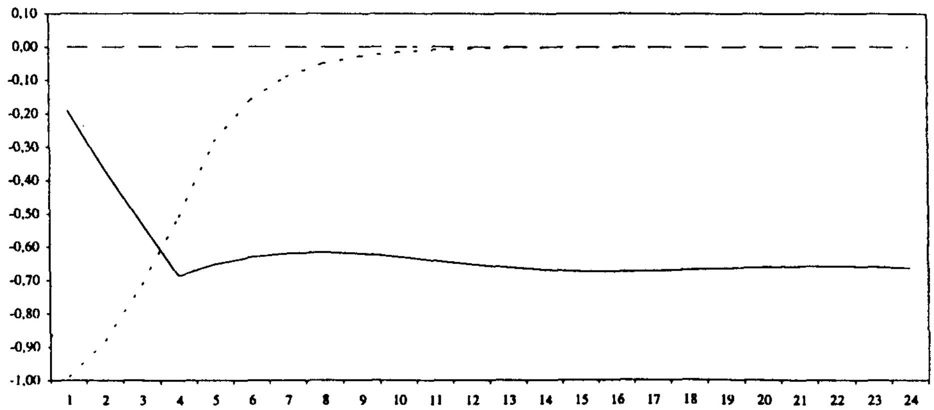
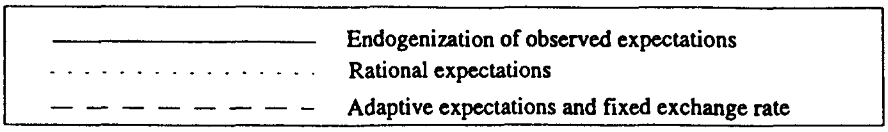


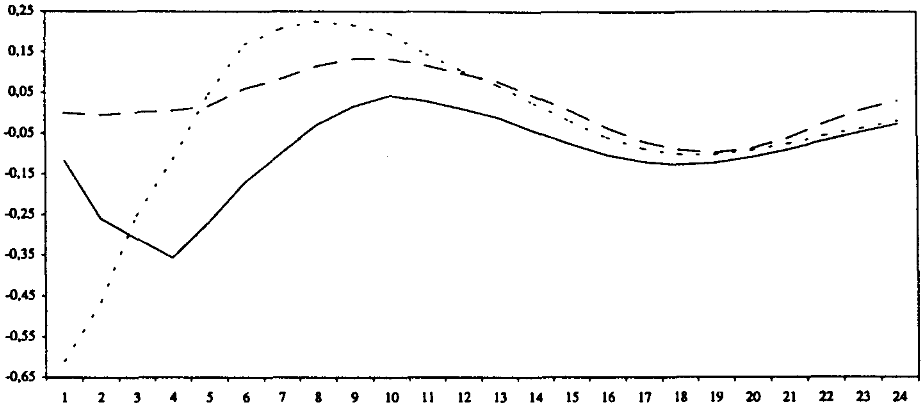
Figure 7 (cont.)

Effects of a one-year increase in the policy-controlled interest rate



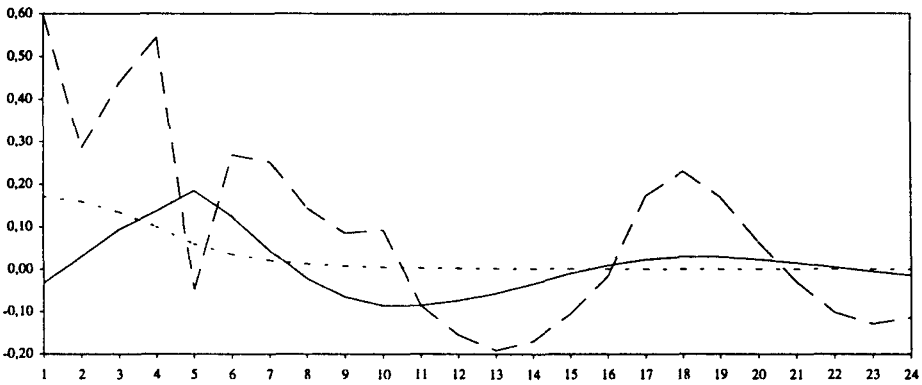
Purchasing Power Parity **Figure 7d**

(Percentage deviations from the baseline)



Ten years bond rate **Figure 7e**

(Absolute differences from the baseline)



Net interest Payments on Public Debt **Figure 7f**

(Percentage deviations from the baseline)

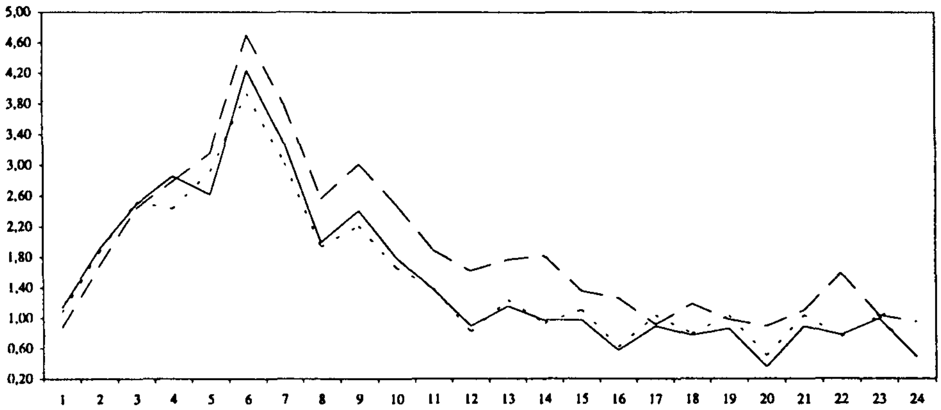
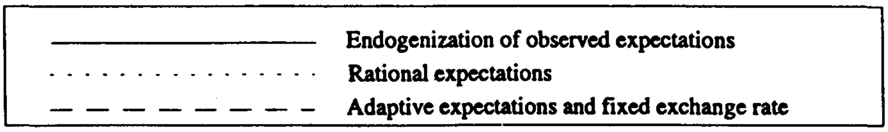


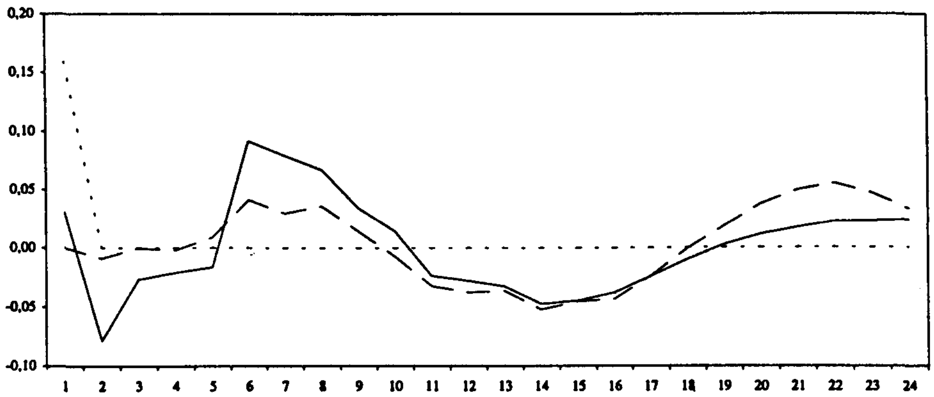
Figure 7 (cont.)

Effects of a one-year increase in the policy-controlled interest rate



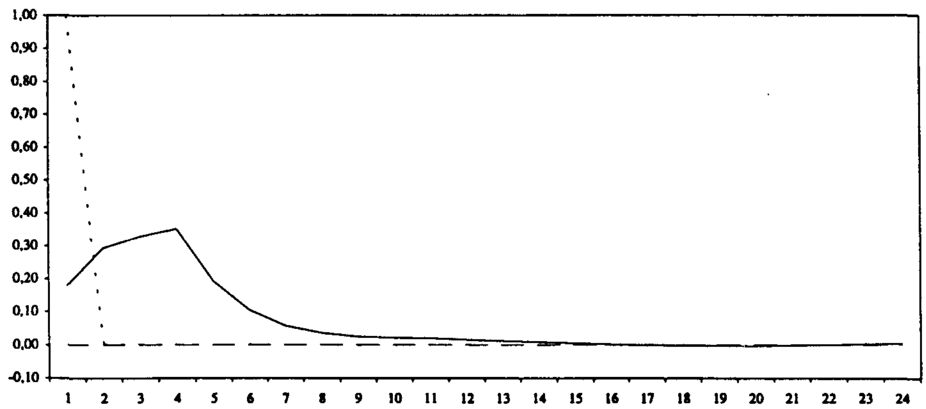
Inflation forecast errors **Figure 7g**

(Absolute differences from baseline)



Exchange rate forecast errors **Figure 7h**

(Percentage deviations from the baseline)



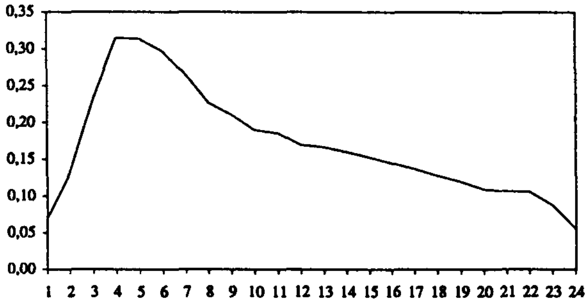
As far as *forecast errors* are concerned (Figures 7g and 7h), it is seen that errors are not white noise under EE (persistence); they reproduce the historical behaviour of expectation errors (see Figures 1a and 4 above). Expectations errors are bigger under EE than under BC; it must, however, be considered that in the latter case the underlying price profile is much less volatile than in the first case.

5.2 A shock to the risk premium

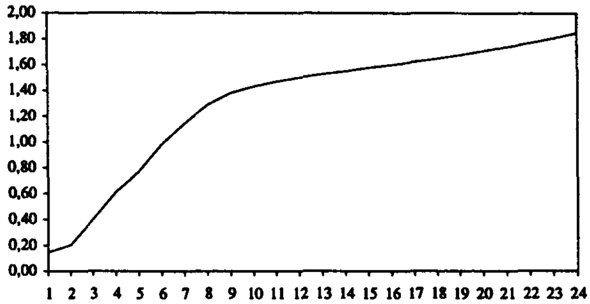
In a second exercise, limited to the EE case, the effects of an increase in uncertainty in the currency market, represented by an increase in the monthly coefficient of variation of the lira/DM exchange rate, were simulated. In performing the exercise, the coefficient of variation was shocked by an amount corresponding to a 1 percent increase of the risk premium in the UIP (annual basis), as estimated in Section 2.

Figure 8
Effects of an increased uncertainty in the currency markets

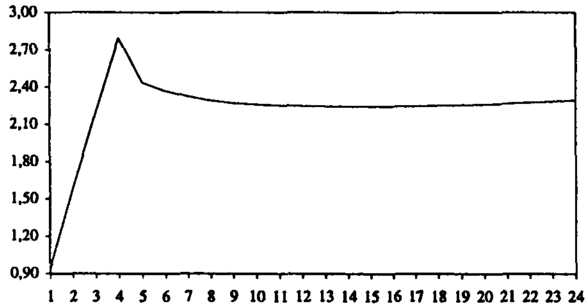
GDP
(percentage devations from the baseline)



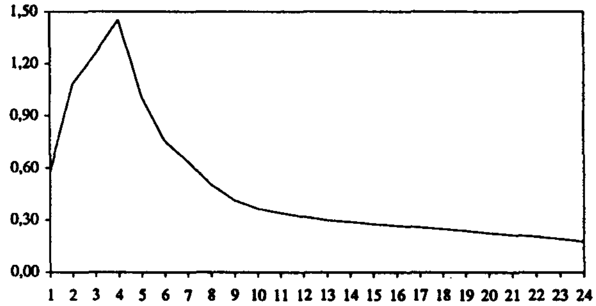
Consumption Prices
(percentage devations from the baseline)



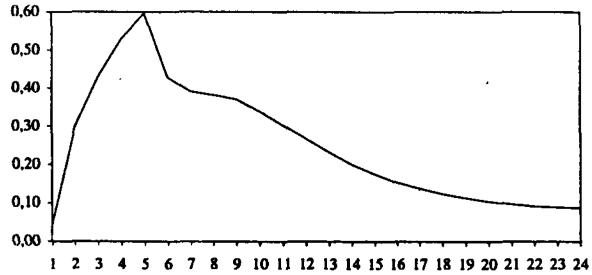
LIRA-DM
(percentage devations from the baseline)



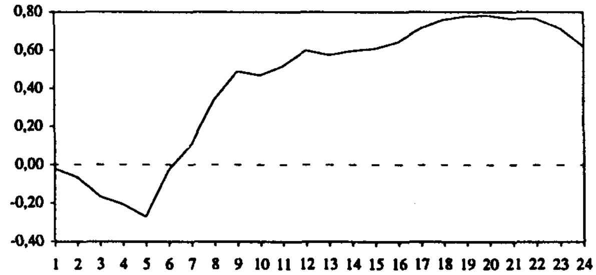
Purchasing Power Parity
(percentage devations from the baseline)



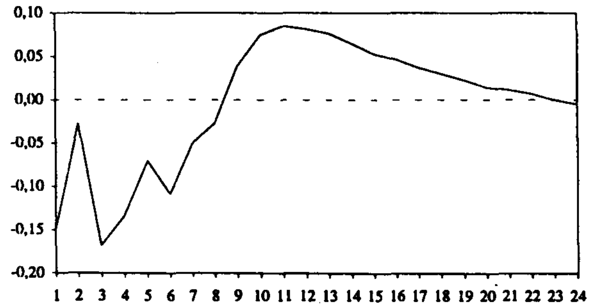
Ten years Bond-Rate
(absolute differences from the baseline)



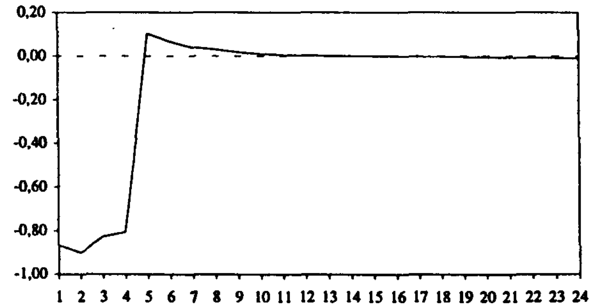
Net Interest payments on Public Bebt
(percentage devations from the baseline)



Inflation Forecast Errors
(absolute differences from the baseline)



Exchange Rate Forecast Errors
(percentage devations from the baseline)



The results are shown in Figure 8 (in evaluating them, it must be kept in mind that they are conditional on the assumption of no reaction of the policy rates to the depreciation in the exchange rate and to the increase in inflation). The exchange rate depreciates by almost three percent during the first year of simulation; afterwards, it slowly returns towards its new equilibrium. The real exchange rate initially depreciates, by up to 1.5 percent; subsequently, it returns to the baseline by the end of the simulation period; as prices increase after the exchange rate shock, this happens at a higher level of both prices and the nominal exchange rate. The increased risk premium, on the other hand, exerts an upward pressure on the long-term interest rate, as described in Section 3: the yield on ten-year bonds increases by 60 basis points by the beginning of the second year, declining steadily afterwards. As a result, a co-movement of the exchange rate and long-term interest rates is observed. If not contrasted by a monetary policy action, a higher level of inflation (by 0.4, 0.7, 0.4 percent in the first three years, and 0.1 afterwards) is observed through the whole simulation period. In the first year, the real exchange depreciation generates a stronger GDP growth, up to above 0.3 percentage points. The level of real activity tends to go back to that of the baseline simulation in the following years, as the gain in competitiveness starts shrinking.

Conclusion

The analysis in this paper is still tentative. However, some conclusions may be drawn.

The study of survey data on exchange rate and inflation expectations suggests that the exchange rate in the short run is characterised by a strong adaptive behaviour; it is also affected by a risk premium correlated with currency market volatility. Long-run interest rates react to changes in inflation expectations; they are also strongly affected by foreign yields and volatility on the currency market. A monetary policy tightening has a significant effect on inflation expectations; it affects the exchange rate through the UIP condition.

Monetary policy transmission

A more careful modelling of expectations may substantially alter the way monetary policy works its way through the economy in the macroeconomic model of the Banca d'Italia. Two effects were examined in this paper. The first, and by far the more important, effect deals with the endogenisation of the exchange rate; to the extent that an increase in interest rates is not compensated by an increase in the risk premium or by depreciating expected exchange rate, it can induce a spot appreciation. An adaptive expectation formation can then in the short run generate a virtuous circle of exchange appreciation and lower inflation.

The second effect deals with the impact of a monetary tightening on inflation expectations and, consequently, on long-term rates. The evidence we present shows that, under proper conditions, it is not unrealistic to imagine that an increase in short rates diminishes inflation expectations and leaves long rates unaffected (what has been defined the "dream of a central banker"). However, beyond the framework of the model, the occurrence of this possibility depends on a number of conditions to ensure that the monetary policy announcement is perceived as credible by the market.

A third effect, not discussed here although to some extent connected with the former two, will have to be addressed to assess the effectiveness of monetary policy through the expectations channel. It deals with the interaction between monetary and fiscal policy in determining expectations of debt sustainability and their feedback on long-term inflation expectations and the exchange rate; the issue of the need for coordinating monetary and fiscal policy in pursuing exchange rate and price stability is connected to this effect. The positive effect of monetary policy on inflation expectations described above may be seen as a first indication that a tight monetary policy is perceived as inducing also more fiscal discipline, and that the "unpleasant monetarist arithmetic" does not hold[39]; the issue, however, deserves further research.

Effect of uncertainty on the currency market on domestic monetary conditions

Domestic monetary conditions are seen to be dependent on the uncertainty originating in the currency market, via its effect on both the spot exchange rate and long-term yields. If not counteracted by a monetary tightening, an increase in the volatility results in an exchange rate depreciation, higher inflation and higher long-term rates

Effect of different mechanisms of expectation formation

As far as the comparison of the effects of different expectation mechanisms are concerned, RE and EE give rather similar results, although expectations under EE are not unbiased. A major difference, however, lies in the absence of an exogenous terminal condition for the nominal exchange rate, hence for prices, under EE. For given policy rates, this opens the possibility of a price-exchange rate spiral, that increases the effect on prices of both monetary policy and external shocks.

All in all, the endogenous determination of the exchange rate and long term rates makes monetary policy more effective, and it opens the possibility of an exchange-price virtuous circle. However, it makes the economy more vulnerable to external shocks. Changes in the risk premium may adversely affect long rates and the exchange rate; if not offset by monetary policy, they have permanent effects on prices.

39 Using a VAR approach for Italy and Ireland (two high-debt countries), Lane and Prati (1995) recently found that a monetary restriction both reduces inflation and induces an improvement in the primary balance in the long-run, concluding that the "unpleasant monetarist arithmetic" does not hold.

References

Altissimo, F., G. Bruno and S. Nicoletti-Altimari, 1995, "Aspettative di cambio, modelli di apprendimento e soluzione del modello econometrico della Banca d'Italia", Banca d'Italia, *mimeo.*

Angeloni, I. and E. Gaiotti, 1990, "Note sulla politica monetaria negli anni ottanta", Banca d'Italia, *mimeo.*

Carlson, J.A. and M. Parkin, 1975, "Inflation Expectations", *Economica,* May, 42, pp. 123-138.

Evans, G.W. and S. Honkapohja, 1995, "Adaptive Learning and Expectational Stability: An Introduction", in Kirman, A. and M. Salmon (eds.), *Learning and Rationality in Economics*, Basil Blackwell, Oxford, pp. 31-52.

Fell, J., 1995, "The Role of Short Rates and Foreign Long Rates in the Determination of Long Term Interest Rates", European Monetary Institute, *mimeo*, May.

Fisher, P.G., D.S. Turner and K.F. Wallis, 1992, "Forward Unit Root Exchange Rate Dynamics and the Properties of Large-Scale Macroeconometric Models" in C.P. Hargreaves (ed.), *Macroeconomic Modelling of the Long Run*, pp. 207-228, Aldershot: Edward Elgar.

Fornari, F., C. Monticelli and O. Tristani, 1995, "Interest Rate Differentials and Foreign Exchange Risk Premia. A Model-Based Empirical Analysis", prepared for the CEPR Workshop, *Monetary Policy and Exchange Rates in Europe*, Milan, 24/25 November.

Frankel, J.A. and K.A. Froot, 1987, "Short-Term and Long-Term Expectations of the Yen/Dollar Exchange Rate: Evidence from Survey Data", *Journal of the Japanese and International Economies*, Vol. 1, No. 3, pp. 249-274.

Froot, K.A. and J.A. Frankel, 1988, "Forward Discount Bias: Is It an Exchange Risk Premium?", *Quarterly Journal of Economics*, 104, pp. 139-161.

Galli, G., D. Terlizzese and I. Visco, 1989, "Short and long run properties of the Bank of Italy quarterly econometric model", in *Dynamic Modelling and Control of National Economies*, N. M. Christodoulakis (ed.), Pergamon Press, pp. 379-86.

Garratt, A. and S. Hall (1994), *E-Equilibria and Adaptive Expectations: Output and Inflation in the LBS Model,* London Business School, *Discussion Paper* no. DP 13-94, May.

Giorgianni, L., 1995a, "Unbiasedness and Efficiency of Exchange Rate Expectations: a Cointegrating Approach", *Ente per gli studi monetari bancari e finanziari "Luigi Einaudi"*, Temi di Ricerca, n.10.

Giorgianni, L., 1995b, "Premio al rischio sulla lira: l'impatto della politica fiscale", Banca d'Italia, October.

Granger, C.W.J. and T. Terasvirta, 1993, *Modelling Non linear Economic Relationships*, Oxford, Oxford University Press.

Gressani, D., L. Guiso and I. Visco, 1988, "Disinflation in Italy: an Analysis with the Econometric Model of the Bank of Italy", *Journal of Policy Modelling*, Vol. 10, No. 2, pp. 163-204.

Hendry, D.F., 1989, PC-GIVE: *An Interactive Econometric Modelling System*, University of Oxford, January.

Jahnke, W., 1995, "Long-term Interest Rates and Exchange Rates in the Bundesbank Macroeconomic Model of the German Economy", this Volume.

Kozicki, S., D. Reifschneider and P. Tinsley, 1995, "The Behaviour of Long-Term Interest Rates in the FRB/US Model", this Volume.

Lane, T. D. and A. Prati, 1995, "Does Public Debt Constrain Monetary Policy? Some Tests of Unpleasant Monetarist Arithmetic", November, *mimeo.*

Lin, C.F. and T. Terasvirta, 1994, "Testing the Constancy of Regression Parameters against Continuos Structural Change", *Journal of Econometrics*, vol. 62, pp. 211-228.

Marcet, A. and T.J. Sargent, 1989, "Convergence of Least Squares Learning Mechanisms in Self Referential Stochastic Models", *Journal of Economic Theory*, 48, pp. 337-68.

Modigliani, F. and R.J. Shiller, 1973, "Inflation, Rational Expectations and the Term Structure of Interest Rates", *Economica*, 157, pp. 12-43.

Muth, J.F., 1961, "Rational Expectations and the Theory of Price Movements", *Econometrica*, 29, pp. 315-35.

Nicoletti-Altimari, S., 1995, "Uno studio sulle aspettative di inflazione in Italia: 1970-1995", Banca d'Italia, *mimeo*.

Nicoletti-Altimari, S., R. Rinaldi, S. Siviero and D. Terlizzese, 1995, "Monetary Policy and the Transmission Channels in the Bank of Italy's Quarterly Econometric Model", in BIS, *Financial Structure and the Monetary Policy Transmission Mechanism*, Basle, March.

Parigi, G. and A. Prati, 1993, "Monetary Policy, Inflation and the Business Cycle: An Analysis with the Bank of Italy's Quarterly Econometric Model", in BIS, *Changes in the Business Cycle and the Implications for Monetary Policy*, Basle, April.

Passacantando, F., 1995, "Central Banks' Independence and Government Financing: The Case of Italy", paper presented at the BIS Seminar *Monetary Policy and Liquidity Management in Transition*, Basle, 16-18 January.

Pesaran, M.H., 1987, *The Limits to Rational Expectations*, Basil Blackwell, Oxford.

Sargent, T.J., 1994, *Bounded Rationality in Macroeconomics*, Clarendon Press, Oxford.

Takagi, S., 1991, "Exchange Rate Expectations: A Survey of Survey Studies", *IMF Staff Papers*, 38, pp 156-83.

Tarditi, A., 1995, "Exchange Rates. Long Bond Yields and Inflationary Expectations", this Volume.

Terlizzese, D., 1995, "Il modello econometrico della Banca d'Italia: una versione in scala 1:15", in *Ricerche quantitative per la politica economica, 1993*, Banca d'Italia.

Visco, I., 1984, *Price Expectations in Rising Inflation*, North-Holland, Amsterdam.

Visco, I., 1987, "The Use of Survey Data in the Analysis of Inflation Expectations", *Giornale degli Economisti e Annali di Economia*, Novembre-Dicembre.

Comments on paper by E. Gaiotti and S. Nicoletti-Altimari by Kostas Tsatsaronis (BIS)

The theorist who studies the modelling of financial asset prices is immediately confronted with the difficult question of how do economic agents form their expectations about future market developments. For the econometrician working on the same topic the problem is even more complex as he or she must also assign numerical values to something that is not directly measurable. The treatment of expectations in macroeconomics has been a contentious issue for more than thirty years now. The parallel history of attempts to incorporate explicit expectational assumptions in the building of empirical macroeconomic models (of any scale) has been at least as contentious.

One approach to deal with this issue has been to offer some rationale why expectation formation might obey a fixed general pattern or *ad hoc* rule and subsequently impose it on the empirical model before estimation. The problems with the internal consistency of the estimated model were pointed out by Robert Lucas in his famous critique. An alternative way was to bypass explicit estimation by using some clever trick which would allow to essentially sweep the problem under the carpet; and I tend to think of rational expectations assumptions in this way. Using the strong orthogonality restrictions suggested by rational expectations the empirical analyst can usually substitute the unobservable expectations component with some ex-post observable or "rational" quantity. This is not meant to minimise the contribution of rational expectations to economics. Quite the opposite, by posing the simple question: "If expectations are not rational then what are they?" rational expectations theorists have done the profession a big favour by enforcing a greater degree of intellectual discipline and internal consistency in both theoretical and empirical study.

The authors of this paper have taken yet a third route by proposing to ask the market participants directly about their expectations. They did so through the Forum Mondo-Economico, and then incorporated these expectations into the large scale Quarterly Model of the Banca d'Italia (QM). This is an interesting approach and one that this reader would encourage as we stand to learn a lot about the economic process from this kind of exercise. We economists are certainly guilty of projecting the assumptions that make our theoretical constructions elegant on human behaviour. Tests like the one at hand will either make us feel better about this practice, if we can indeed reconcile the existing theory with actual expectations, or force us to look in a different direction.

Having said that, we should also recognise the fact that survey data do not represent the magic solution of the problem of quantification of expectations. There are some obvious, and maybe some not so obvious, pitfalls in taking these data as representing what we call in our models "expectations". The main issues to be resolved have to do with the representativeness of these measures and of the characteristics of the market participants' expectations as forecasts of future developments. First there is the question of measurement. The number of different answers you will get if you ask the question of "what is inflation going to be one year from now?" will be bounded above only by the number of people you approach. This does not fit well the representative agent paradigm and therefore some way of condensing the information from the sample of answers to a single figure is necessary. What is the best way of extracting such a representative measure of expectations is very much an open question, and not much research has been done on this issue.

The second question has to do with the forecasting properties of survey measures of expectations. Are they accurate predictors of future realisations? Are they efficient? There is no reason why these forecasts would **have to** be "rational" in this sense, but it is important to subject them to the same tests we do put other statistical predictors, and examine whether they pass. In case that they fail the tests it is also interesting to investigate why. The paper goes some way in addressing this issue of validation in an indirect way when it tests the Uncovered Interest Parity condition as a modelling device for the exchange rate using the Mondo-Economico survey measures. The result is that expectations of the future path of the exchange rate are in line with this "arbitrage" restriction. This is quite encouraging as it complies with a notion of rationality that many would find uncontroversial, but I feel that further evaluation is necessary before one can feel comfortable using these data in econometric models. To cite an example of alternative tests I found the comparison in the Federal Reserve Board paper of the long-run model implied equilibrium with the survey expectations for the long-run inflation rate quite instructive.

Gaiotti and Nicoletti-Altimari examine the determination of the Lira/DM exchange rate and the interest rate on the long term Italian government bond yields. To accomplish this they employ one equation which determines the price of the respective asset and another which explains the expectation formation process. Subsequently they tie these equations together as a block to the QM and simulate the response of the economy to monetary policy and uncertainty shocks. I will briefly discuss each building block separately.

First, regarding the exchange rate block, my main problem is about the expectation formation equation. It is not clear to me why the particular specification was used, and in particular why was the PPP term included in the final specification given that it is not imposed on the exchange rate equation and that it is not statistically significant. The only interpretation I can give to this fact is that its inclusion is an indirect way of bringing the exchange rate block in line with the structure of the rest of the Quarterly Model. But in that case shouldn't there be an explicit accounting for PPP in the main exchange rate equation?

Another point which also applies to the bond rate equations regards the particular choice of volatility measure as a proxy for exchange rate risk. The DM/lira volatility may not be the best way of capturing the relative risk of Lira denominated assets compared to those denominated in DM because it cannot differentiate between the two currencies in terms of relative variability. High variability of the lira/DM exchange rate can be associated with either currency being relatively stable with respect to the rest of the world and the other being volatile. Consequently the sign of the risk premium is not clearly determined, at least in theory. Although one could argue that historically the DM has been the "anchor" currency and there have not been periods when the lira was the more stable member of the pair, a measure like the spread of the volatilities of the two currencies with respect to a third one (e.g. USD, CHF) would be a preferable alternative.

As far as the long rate block is concerned, I would have to raise the obvious concern with the fact that the survey measure of inflationary expectations refers to an interval significantly shorter than the maturity of the assets. This is a clear example of the possible problems involved in the incorporation of direct observation measures of expectations in statistical models, and one that will require serious attention before we can use them more extensively. We basically need some evidence to validate the assumption made by the authors that the one-period ahead expectations are good proxies for the expected inflation ten years into the future. Which implies that we need to extrapolate these one-year ahead expectations somehow; assuming that they are constant is a way of doing this extrapolation, but it will require validation.

The inclusion of the foreign bond yield in the equation is not uncontroversial but does not surprise me. I believe that cross-country correlation of the long rate process may not necessarily be compatible with the closed economy expectations hypothesis of the term structure. My concern has to do with the inclusion of *contemporaneous* foreign rates in view of the simulation exercise included in the paper. I am not familiar with the QM model but I suspect that it does not include the German long interest rate as an endogenous variable. This raises question of what is the assumed path of the German rate when the simulations were performed? And if in fact it is the interest rate spread that the researchers are interested in would it not be better to model it explicitly in the first place?

Regarding the simulation exercise I would not have much to say other than it provides a useful tool to perform a joint evaluation of the usefulness of the particular survey measure of expectations and the way they were incorporated in the Banca d'Italia Quarterly model. The discrepancies of the results from the different expectational assumptions need to be studied very carefully in order to assess the validity of these assumptions, and in this respect the paper is a step in the right direction which needs to followed up by more extensive research. Macroeconomic models represent an excellent framework for evaluating the usefulness of the information found in these surveys, and central bank economists which have access to such tools have a comparative advantage in performing those tests. I certainly hope that we can see more work on this subject.