Oxford Economic Papers 44 (1992), 791–816

THE EUROPEAN MONETARY SYSTEM: CREDIBLE AT LAST?

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1. Introduction

The exchange rate mechanism of the European Monetary System (EMS) began in 1979 as an arrangement among eight European countries to limit fluctuations among their currencies. Intra-European exchange rates would be allowed to fluctuate only within official limits, to be defended by exchange market intervention. Such an arrangement is called an exchange rate target zone.

Much research has modelled the target zone, beginning, in the case of the theoretical research, with Krugman (1991). Yet empirical research has been unable to fit the European data to the standard target zone model. Flood, Rose and Mathieson (1990) examine many implications of the basic target zone model and find little evidence in its favor. Perhaps the most telling finding is the simple test of target zone credibility proposed by Svensson (1990b): expected future exchange rates—constructed using the uncovered interest parity assumption—were found to lie nearly always outside current EMS target zones for the period 1979 through early 1990. This result suggests that the market during this period usually perceived a strong probability of realignment of the official exchange rate bands.

We update the tests of EMS credibility, focussing on the period 1987-91. Our main methodological innovation is the use of survey data, supplementing interest differentials as a measure of market expectations. The potentially important advantage of using survey data is immunity to errors introduced by exchange risk premiums.[1] We investigate the hypothesis, suggested by the apparent stabilization of the EMS and by institutional developments within the European Community, that the EMS target zones have recently experienced a significant gain in credibility. The findings, based both on survey data and interest differentials, tend to support this view for most EMS currencies' relationship against the German mark (DM). We do not reject the hypothesis that the Dutch guilder has been credible all along; for the other currencies, we

* This paper represents the views of the authors and should not be interpreted as reflecting the views of any of the above institutions. We thank Robert Flood, Alberto Giovannini, David Romer, Andrew Rose and Lars Svensson for helpful comments. For support we thank the Institute for International Economics and the Institute for Business and Economic Research at the University of California. The paper is a revised and condensed version of NBER Working Paper # 3819.

[1] Much has been written on the question of whether the exchange risk premium is large and variable enough to render the forward discount rate or interest differential a deficient measure of the expected future spot rate. Studies such as Fama (1984), Hodrick and Srivastava (1986), Cumby and Obstfeld (1984), and Giovannini and Jorion (1989) find what they consider to be evidence of a large and variable risk premium. Studies such as Frankel (1982), Froot and Frankel (1989), and Svensson (1990a), on the other hand, argue that the risk premium may be small in magnitude or variability. For a recent discussion of risk premia within the EMS, see Giovannini (1990).

generally find evidence of increasing credibility, especially since January 1990. Evidence from 1991 suggests that the credibility of the EMS, while still imperfect, is the highest in the system's history. With regard to policy implications, we note that the interesting effects of exchange rate target zones—such as the 'honeymoon effect' demonstrated in theory by Krugman (1991)—are dependent on the credibility of the regime. It may be that the EMS is at last in a position to enjoy such a honeymoon.

In addition to testing target zone credibility, we also consider whether the empirical failure of the standard target zone model—first documented by Flood, Rose and Mathieson (1990)—might reflect only an erroneous assumption of uncovered interest parity. However, our findings using survey data lead us to dismiss this possibility. We are instead attracted to a new explanation, based on time-varying credibility, recently advanced by Bertola and Svensson (1990). Indeed, our analysis suggests that time-varying credibility would be particularly relevant during the period we study. Returning to the credibility question, we use the Bertola-Svensson framework to estimate the expected rate of realignment. Although based on the overall expected rate of change of the exchange rate, this construct may be a superior indicator of credibility because expected mean-reversion within the target zone has been filtered out. We find ample evidence of changing credibility.

The organization of the paper is as follows. The next section briefly describes the sample and data. Section 3 provides background on EMS operation, recapitulating the evidence against the credibility of the target zones during the period 1979-86. In Section 4 we use survey data to assess the credibility of the current regime, established in January 1987. We address the empirical failure of target zone models in Section 5. After reviewing the elements of the standard model, we use both survey data and interest rate data to test its most fundamental implication. In Section 6 we use the time-varying credibility framework of Bertola and Svensson to estimate the expected rate of realignment. Section 7 summarizes and concludes.

2. Sample and data

The currencies we study are those of all current participants of the Exchange Rate Mechanism (ERM) of the EMS.[2] These include the seven original participants (Belgium,[3] Denmark, France, Germany, Ireland, Italy, and the Netherlands) as well as Spain and Britain (which joined in June 1989 and October 1990, respectively).

In practice the EMS operates as a bilateral parity grid. With nine currencies now participating, a total of 36 bilateral currency relationships is implied.

[2] Membership in the European Monetary System (EMS) does not require participation in its ERM. However we follow popular terminology and refer to the exchange rate mechanism as 'the EMS'.

[3] Belgium and Luxembourg, both EMS members, are joined in a currency union. For brevity we will refer only to Belgium and the Belgian franc.

Official 'central' rates are established for each relationship. Around these central rates fluctuations are limited to ±2.25% (±6% for newcomers Spain and Britain, and formerly for Italy). We focus on the eight exchange rates with respect to the German mark (DM).

In addition to readily available data for spot exchange rates and Eurocurrency interest rates, we use exchange rate expectations survey data reported in the monthly *Currency Forecasters' Digest* (hereafter, '*CFD*').[4] We focus on forecasts of exchange rates at horizons of 12 months, but also examine five-year forecasts (available quarterly). The survey data span the period February 1988 through Septembet 1991. Note that no realignments have occurred during this period.[5]

3. The background: EMS Operation, 1979-86

The inception of the EMS in 1979 was greeted skeptically by many. The break-up of the prior 'Snake' regime did not inspire confidence in governments' willingness or ability to keep major European currencies together, and there was considerable divergence in the policies and performance of the participants. Yet the EMS did not break apart: in contrast to the record under the Snake, no currency has ever left the system. The EMS survived its turbulent first years through a sequence of realignments of central rates, always taking the form of devaluations against the DM.

Until recently realignments were a basic fact of EMS operation, with 11 occurring during the first eight years. The history of these realignments is summarized in Figure 1, which presents plots of (log) central rates against the DM.[6] Only the Dutch guilder was able to maintain a nearly fixed rate against the DM, undergoing only two small devaluations (and none since 1983). The other currencies experienced cumulatively large devaluation against the DM. However, more recent years have seen more stability. The regime established in January 1987 with the twelfth (and perhaps final) EMS realignment is the longest to date.

Low credibility: evidence from interest rates

Prior research suggests that the announced target zones had little credibility during much of EMS history. Here we review the evidence on this point based on interest rate differentials. If uncovered interest parity holds, interest differentials can be combined with contemporaneously observed exchange rates to calculate expected future exchange rates. We construct one-year expected

[4] These data are proprietary with *CFD* of White Plains, New York. The survey has apparently been conducted for some years, but the subscription of the Institute for International Economics only extends back to 1988.

[5] In January 1990 the bands for the Italian lira were narrowed from ±6% to the norm of ±2.25%. The transition was accomplished by lowering the upper band limit and leaving the lower limit unchanged.

[6] For each currency, the March 1979 central DM rate has been standardized to unity, so that its natural logarithm equals zero.

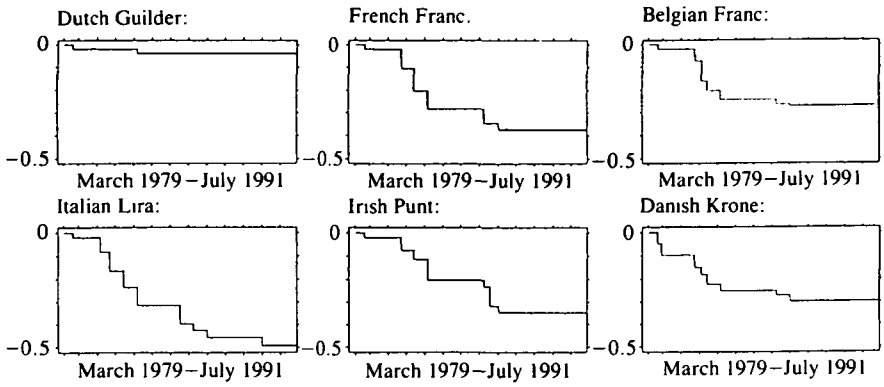

FIG. 1.

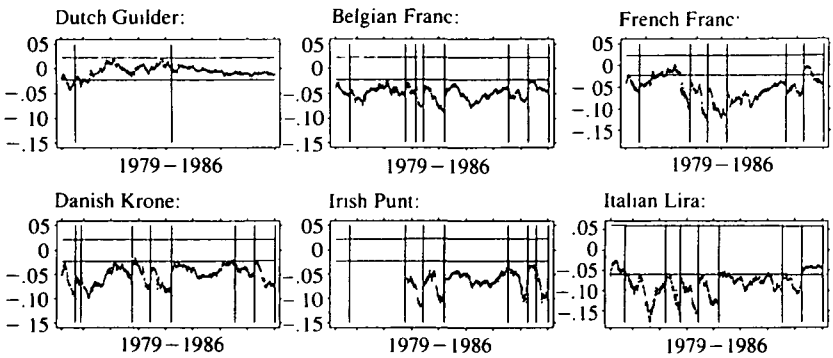

FIG. 2.

exchange rates by using interest differentials on 1-year assets. Our purpose is to determine whether these expectations lie within the current bands.[7] In Figure 2, expected future exchange rates are plotted as deviations from then-current central rates. Vertical lines indicate dates of realignment against the DM, while the horizontal lines indicate the target zone limits. The period is March 1979 through the last general EMS realignment in January 1987.

Figure 2 provides striking evidence on the historical credibility of the EMS. At a one-year horizon, the Dutch guilder is nearly always expected to remain inside its current band. However, the other five currencies are nearly always expected to violate their current DM limits. This evidence supports the view that the EMS had low credibility during its first eight years. The many devaluations during this period apparently did not come as a surprise.

[7] This basic test of target zone credibility was instituted by Svensson (1990b) for the Swedish krone. Here we replicate the findings of Flood, Rose and Mathieson (1990) for the EMS. We thank these authors for access to their data. Giovannini (1990) conducts an equivalent test for the French franc and Italian lira.

4. The current EMS Regime: Credibility at Last?

The period since the 1987 EMS realignment has produced a sequence of institutional developments which may have enhanced the credibility of the current target zones. (An extensive chronology is provided in the appendix.) Most notably, a process toward some form of more rigid monetary union has begun. There has also been progress on convergence; e.g., differences in inflation rates have narrowed.[8]

We consider whether these developments and the apparent stabilization of the EMS—the four-year absence of realignments—have been accompanied by a change in expectations. Has the EMS finally achieved credibility? To what degree, and when? Survey data on exchange rate expectations help answer these questions. We also consider evidence based on interest rate differentials in the manner of Svensson (1990b). The sample is extended to include the currencies of newcomers Spain and Britain.

On the definition and testing of target zone credibility

A target zone is *perfectly credible* if the probbability distribution of the future exchange rate perceived at time t lies within the target zone boundaries:

$$\text{Prob}[s^L \leqslant s_{t+k} \leqslant s^U] = 1 \quad \text{(for all } k > 0) \tag{4.1}$$

where s is the exchange rate and s^L and s^U are the lower and upper target zone boundaries.

Since it is not possible to observe the entire probability distribution of the future exchange rate, we examine the weaker conditions:

$$s^L \leqslant E_t(s_{t+k})_{uip} \leqslant s^U \tag{4.2a}$$

$$s^L \leqslant \text{FCST}_t(s_{t+k}) \leqslant s^U \tag{4.2b}$$

where $E(s)_{uip}$ is the expected value of s implied by uncovered interest parity, and FCST(s) is the forecast computed from the *CFD* survey.

Note that although one may fail to find evidence to reject (4.1), one does not 'find' perfect credibility. Even if (4.2a) and (4.2b) are satisfied, part of the probability distribution of the future exchange rate could lie outside the target zone. Furthermore, a forecast placing future s exactly on s^L or s^U would be inconsistent with perfect credibility: unless the forecast variance were zero, such a forecast must reflect some non-zero probability attached to values outside the band.

The power of the test defined by conditions (4.2a) and (4.2b) is influenced by several factors. First, the greater is k, the forecast horizon, the greater the power. Second, for a given forecast horizon, the power will be greater the further is s_t from the center of the band. As it happens, low power seems not to be a problem during the period studied. The exchange rate is often close to the band

[8] For an argument that 1987 marked the beginning of a 'New EMS' see Giavazzi and Spaventa (1990).

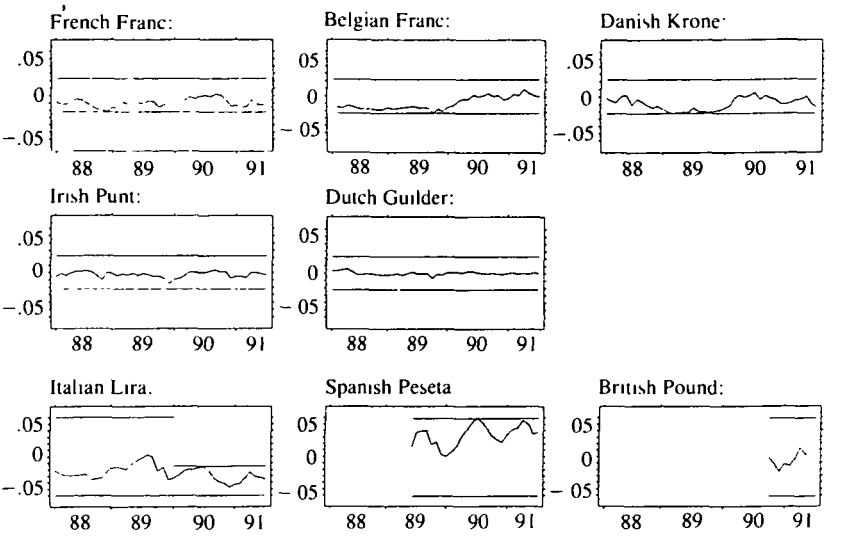

FIG. 3.

limits. Also, by focussing on k of 12 months or longer, we find that conditions (4.2a) and (4.2b) have often been violated.

Indeed, the concept of perfect credibility may be too strict to be of interest. More interesting may be the degree of credibility. An informal (and inverse) indicator of credibility is $E_t(s_{t+k})_{uip} - c_t$, or $\mathrm{FCST}_t(s_{t+k}) - c_t$, where c is the official central rate.[9] Of course, the degree of credibility may vary over time. We next investigate whether the EMS target zones have recently experienced an increase in their credibility.

Credibility of the current EMS target zones

We begin by presenting actual spot exchange rates over the period February 1988 through July 1991. Again, all rates are natural logs of the DM price of the currency in question.[10] The eight spot rates are shown in Figure 3, together with lines indicating the official DM limits. While the Dutch guilder has remained close to its central rate,[11] the other currencies have shown more variation, and several have come close to their lower DM limits. The strength of the Spanish peseta within its DM target zone is atypical.

To assess the credibility of the current EMS target zones, we first consider Svensson's test, computing the 12-month exchange rate expectations which would be implied by uncovered interest parity. Figure 4 presents such 12-month

[9] In Section 6 we consider a related but possibly superior measure. For an alternative approach to the meaning and measurement of EMS credibility, see Weber (1991).

[10] The data are normalized so that c, the natural log of the central DM rate, equals zero. We follow this practice for the remainder of this paper.

[11] The Dutch seem to use a DM target zone much narrower than the standard EMS bands of $\pm 2.25\%$. The data since 1983 suggest bands of only about $\pm 0.5\%$.

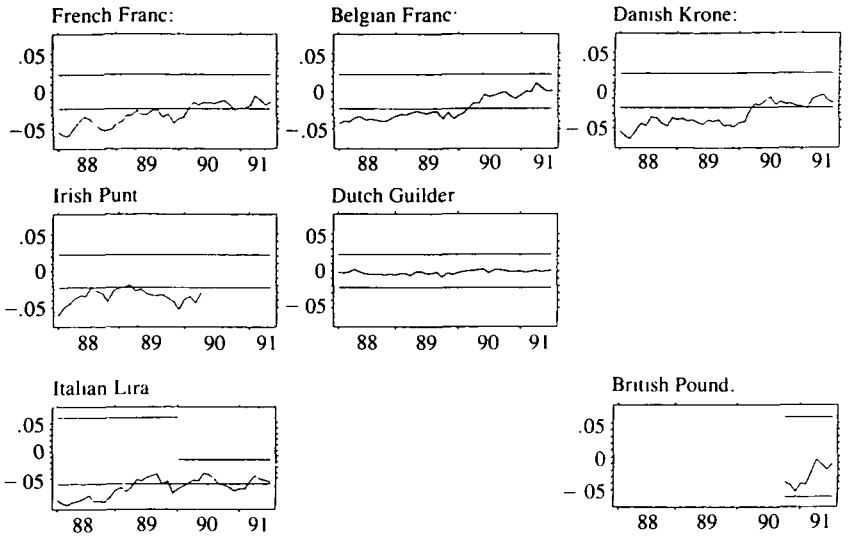

FIG. 4.

expectations for February 1988 through September 1991 and may be compared to the earlier Figure 2 for the 1979-1986 period. All currencies show smaller expected deviations from current central rates than during the pre-1987 regimes. Table 1 compares sample means from the two periods; *t*-statistics indicate a statistically significant increase in credibility for the currencies of Belgium, Denmark, France and, from January 1990, Italy. The change in the guilder's credibility is less clear, perhaps reflecting that there existed less room for improvement.

TABLE 1
Mean 12-Month Expectations (from interest rates) as Deviations from DM Central Rates

currency	*Mar 1979–Dec. 1986*	*Feb. 1988–July 1991*	*difference of means*	*t-test of inequality*
France	−5.57%	−3.00%	+2.57	+5.40
Belgium	−4.95	−2.16	+2.79	+10.53
Denmark	−5.17	−2.18	+1.89	+5.57
Netherlands	−0.531	−0.186	+0.345	+1.98
Italy	−8.40	−7.42	+0.98	+1.49
		−2.02**	+6.38	+13.19
Ireland	−6.50*	NA	NA	NA

Percentages approximated as log deviations times 100.

* Irish interest rate data available for 1982–1986 only

** The central rate of the lira shifted with the narrowing of the target zone in January 1990. February 1988—December 1989 mean was −7.42%; January 1990—July 1991 mean was −2.02%.

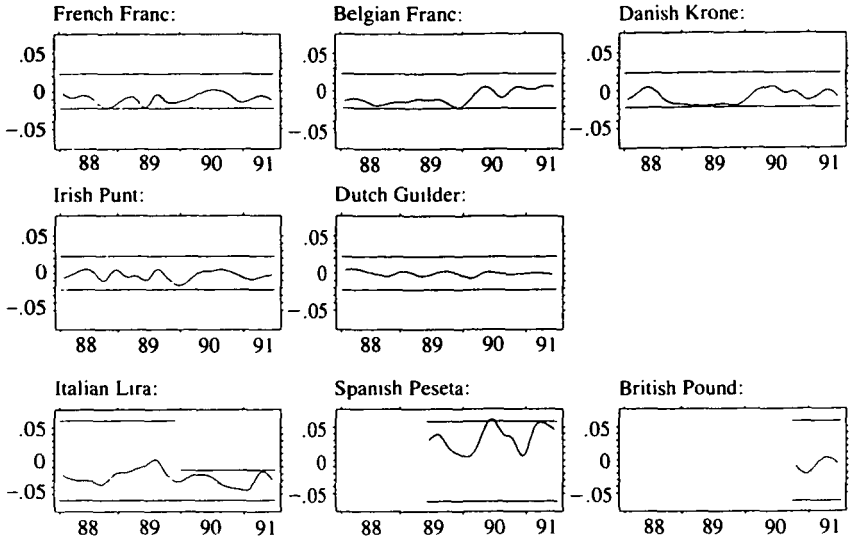

FIG. 5.

Within the recent period, we note an upward trend in the 12-month expectations for most currencies. From early 1990 to the end of the sample, most values were within the target zones, a remarkable finding by EMS historical standards. Throughout the period, the guilder forecasts are close to the center of the target zone.

However, conclusions about target zone credibility based on evidence from interest differentials are only valid under the assumption of uncovered interest parity. We therefore turn to an alternative measure of exchange rate expectations.

The CFD forecasts

We now examine the credibility of the current regime by considering evidence from the *CFD* survey of exchange rate forecasts.[12] For the period February 1988 to July 1991, Figures 5, 6 and 7 present plots of the exchange rates forecasted for horizons of one, three, and 12 months, respectively. Figure 8 does the same for a horizon of five years.[13]

The one-month forecasts typically lie within the official limits; by the second quarter of 1988, the same may be said of the three-month forecasts. At both

[12] More precisely, we use the 'combined consensus' forecasts reported in *CFD*. These are the harmonic means of the forecasts of approximately 45 contributors. The *CFD* forecasts are given in terms of currency units per US dollar. We form an estimate of the implied forecast of intra-EMS exchange rates using the ratio of the relevant forecasts against the dollar.

[13] Since the data in these figures are computed from ratios of forecasts, the original *CFD* forecasts cannot be measured from these graphs. To further protect the confidentiality of the original data, we have applied a data-smoothing technique to the series plotted in these figures. The qualitative conclusions seem to us unaffected by this procedure.

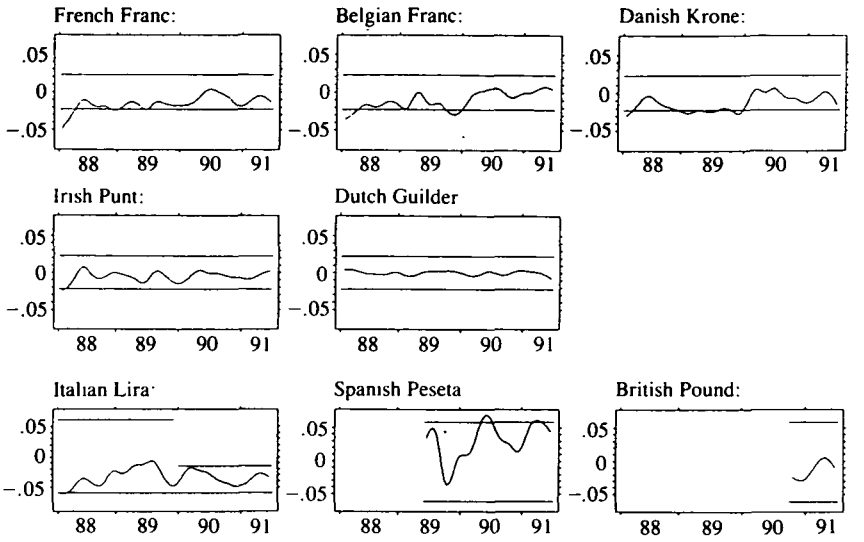

FIG. 6.

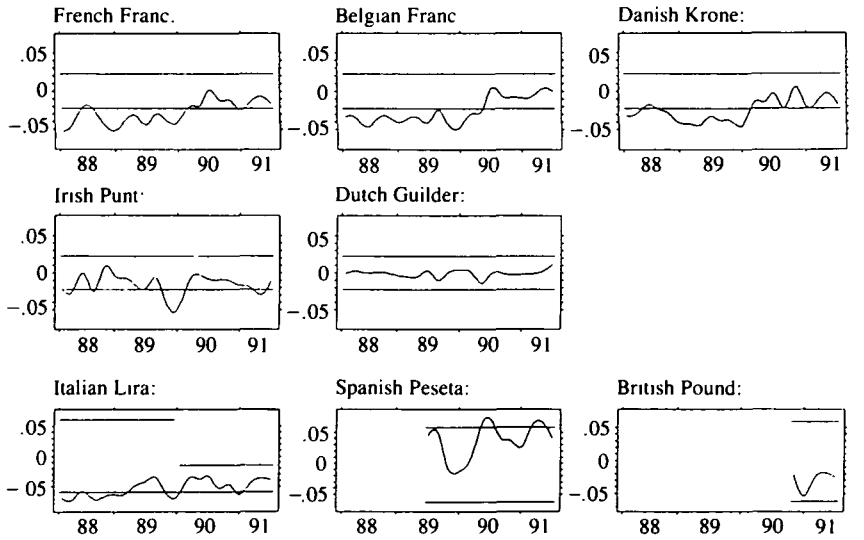

FIG. 7.

horizons, forecasts for the Dutch guilder are relatively stable and tend toward the center of the band. Forecasts for other currencies have often been close to their lower limits, a symptom of imperfect credibility.

A more stringent test of target zone credibility comes with consideration of longer forecast horizons. Figure 7 shows that 12-month forecasts were often

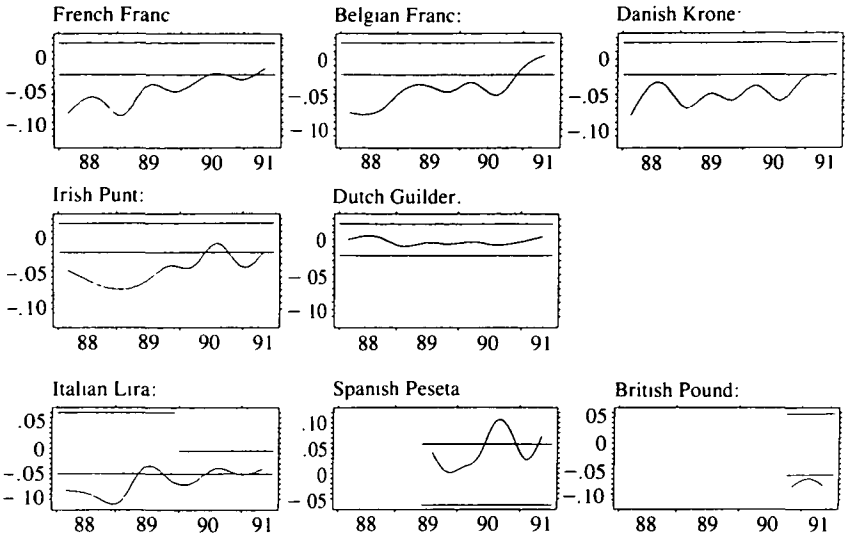

FIG. 8.

outside the target zone: prior to 1990, the forecasts for the currencies of France, Denmark, Belgium, and Italy were typically one to three percentage points below their lower DM limits. However, in January 1990 forecasts for these four currencies began to strengthen, crossing inside the band limits by the second quarter of that year. In the last year of the sample, these 12-month forecasts were typically inside the target zone. Note that the survey data-based forecasts of Figure 7 are not unlike the interest differential-based forecasts of Figure 4 for the same period and 12-month horizon.[14] However, with the *CFD* data, even the Irish pound seems much more credible: since mid-1988, most of its 12-month forecasts are inside the DM target zone.

Figure 8 presents (quarterly) forecasts for a horizon of five years. Most of these forecasts have been several percentage points below the lower limits; however, some show an upward trend. Several have recently approached (and at times crossed) the lower DM limit.[15] Nevertheless, even the most recent data indicate some doubt that the EMS has experienced its final realignment. The guilder and the Belgian franc are the exceptions.

With credibility apparently greater than ever before, today's EMS might seem more likely to conform to the basic target zone model developed by Krugman and others. In the next section we re-examine this question using the recent data.

[14] The (unsmoothed) survey data forecasts are more volatile, and tend to be somewhat more supportive of target zone credibility.

[15] Some observations suggest an expected revaluation of the peseta against the DM. This fact is remarkable in that the DM has never been devalued against any currency during the EMS period.

5. Reassessing the performance of target zone models

Previous attempts to apply models of exchange rate target zones to European data have yielded disappointing results. An unexamined possibility is that mismeasurement of exchange rate expectations is to blame: previous studies have all assumed uncovered interest parity. In this section we use data from the *CFD* survey to re-examine the most fundamental implication of the target zone model.

We find no evidence that mismeasurement of exchange rate expectations is to blame for the empirical failure of target zone models. If anything, the survey-based results are even less supportive than the interest rate-based results we also provide. We thus confirm the empirical failure of the standard target zone model for the EMS (first demonstrated by Flood, Rose and Mathieson (1990)), despite our use of two different expectations measures, and despite our use of more recent data from the EMS' apparently most credible period. Dismissing mismeasurement of expectations as a likely explanation of this failure, we are led to consider, in Section 6, the variable-credibility framework proposed by Bertola and Svensson (1991).

Empirical testing of target zone models

It is useful to briefly review the essentials of target zone modelling.[16] The theoretical literature on target zones begins with the asset-pricing relationship:

$$s_t = f_t + \alpha E_t(\mathrm{d}s/\mathrm{d}t) \tag{5.1}$$

where f_t is an indicator summarizing current exchange rate 'fundamentals.' For example, in the flexible-price monetary model (assumed implicitly in most of the literature) these fundamentals would be relative national money supplies and incomes; the constant α would be the interest semi-elasticity of money demand.

Key to obtaining a solution is the assumption that f_t evolves exogenously.[17] The distribution of s_t, and thus also of $E_t(\mathrm{d}s/\mathrm{d}t)$, is driven by this single state variable. Typically f_t is assumed to follow the continuous-time version of a random walk, possibly with drift:

$$df_t = \eta\,\mathrm{d}t + \sigma\,\mathrm{d}z_t \tag{5.2}$$

Here η and σ are constants, and $\mathrm{d}z_t$ is a standard Wiener process. This f_t process is subject to occasional regulation, i.e., exchange market intervention (which alters relative money supplies) keeps f_t within limits. As a result, the exchange rate is also kept within a target zone.

[16] For more detail, see for example Krugman (1991).

[17] It is for this reason that sticky-price models are not usually considered in the target zone literature.

In this framework, the general solution for the exchange rate in terms of current fundamentals is as follows:

$$s_t = h(f_t) = \alpha\eta + f_t + B_1 \exp(\lambda_1 f_t) + B_2 \exp(\lambda_2 f_t) \tag{5.3}$$

where λ_1 and λ_2 depend on the parameters α, η, and σ.

The solution (5.3) differs from the usual free-float solution in the presence of the final two terms, reflecting the influence of expected intervention on the relationship between s and its fundamentals. In a perfectly credible target zone, the signs of the constants of integration B_1 and B_2 are such that the $s = h(f)$ function has a flattened S-shape. The interesting policy implication is the 'honeymoon effect' emphasized by Krugman: stabilizing expectations mean that given fundamentals bands can support narrower exchange rate bands. Imperfect credibility may lessen the effect, but the solution (5.3) remains valid.[18]

Empirical failure of the model: interpretations

The first rigorous and comprehensive empirical evaluation of the target zone solution is that of Flood, Rose and Mathieson (1990). In studying the EMS through May 1990, these authors find neglible evidence in favor of the specification (5.3) over the simpler linear ('free float') specification. Their results apparently cannot be attributed to the low credibility of the EMS during most of its history: in extending this methodology to an apparently more credible regime, the Mini-Snake of the 1970s, Phillips [1990] finds similar results.[19] However, these negative results might reflect several problems. The target zone solution requires several restrictive auxiliary assumptions about the f_t process and its regulation. In addition, estimation of this equation faces several problems. For example, the Flood, Rose and Mathieson methodology requires knowledge of the parameter α; however, it does not yield precise estimates of this parameter.[20]

We therefore do not estimate the target zone solution equation.[21] Instead, we focus on the basic prediction of target zone theory: a negative relationship between the exchange rate's position within the band and its expected rate of change. This relationship is the basis for the honeymoon effect.

In the model described above, the implicit relationship between s_t and

[18] See for example Bertola and Caballero (1990).

[19] However, Phillips (1990) has some success in examining several distributional implications which can be tested using only exchange rate data. This difference might suggest that mismeasurement of expectations is to blame and thus provide a motivation for the use of survey data.

[20] Flood, Rose and Mathieson conduct a sensitivity analysis and find that their generally negative results are robust to the value of α chosen. They also examine a number of other predictions of the standard target zone model but find little supporting evidence, despite their dependence on fewer auxiliary assumptions.

[21] Another problem is that the methodology of Flood, Rose and Mathieson probably requires data of greater frequency than the *CFD* surveys.

TABLE 2
Correlation Coefficients: Spot Position in Band and Expected Change over 12-month Horizon

	February 1988–July 1991		*January 1990–July 1991*	
	survey data	*interest differential*	*survey data*	*interest differential*
Belgium	+.654	+.801	+.579	+.805
	(.000)	(.000)	(.024)	(.000)
Denmark	+.248	−.089	+.232	−.059
	(.139)	-.575)	(.406)	(.810)
France	+.321	+.201	+.063	−.322
	(.053)	(.202)	(.822)	(.179)
Ireland	+.129	NA	+.180	NA
	(.447)		(.521)	
Netherlands	−.309	−.294	−.499	−.326
	(.063)	(.059)	(.059)	(.174)
Italy	−.059*	+.491*	−.182	−.249
	(.794)	(.017)	(.516)	(.305)

Marginal significance levels in parentheses.

* Through December 1989 only.

$E_t(\mathrm{d}s/\mathrm{d}t)$ is deterministic and can be simulated using plausible parameter values. The relationship is nonlinear and monotonically negative.[22] As mentioned, however, the deterministic relationships predicted by the standard target zone model reflect a number of auxiliary assumptions. More generally one might expect a negative correlation between s_t and $E_t(\mathrm{d}s/\mathrm{d}t)$. We therefore examine this most basic implication of a target zone, using both *CFD* surveys and interest differentials to measure expectations.

Table 2 presents findings for two sample periods. We see little evidence in favor of a negative correlation (let alone the deterministic relationship implied by most models) between the exchange rate and its own expected rate of change. Indeed, positive correlations are often found. Only for the guilder do we find statistically convincing evidence of a negative correlation.

Thus the empirical failure of the standard target zone model continues even in the very recent data from the EMS' most credible period. More importantly, it appears that this failure cannot be attributed to mismeasurement of expectations: results using survey data are no more supportive than those using interest differentials. We therefore turn to another possible explanation of the data, based on the recent model of Bertola and Svensson (1990).

[22] Svensson (1990d) analyzes how the relationship depends on the forecast horizon being considered. The longer the horizon, the more linear is the relationship and the smaller is its slope (in absolute value).

The Bertola-Svensson model: time-varying credibility

While a good 'fit' of a target zone model does not require perfect credibility, it does require that the degree of credibility be stable over the sample period. In the Bertola-Svensson framework, credibility is imperfect *and* time-varying; there is then no general implication for the relationship between the exchange rate's position within the zone and its expected rate of change. If the probability of realignment is non-zero but fairly stable, their analysis yields the standard prediction of a negative correlation between s_t and $E_t(\mathrm{d}s/st)$. However, if the realignment probability is highly variable, a positive correlation may emerge. Intuitively, a change in the perceived probability of a realignment is of course reflected in the overall expected rate of change of s_t, but it also moves the current level of s_t in the same direction. Thus the pattern of covariation between these variables will depend on the relative variability of the probability of realignment.

The Bertola-Svensson framework is appealing for several reasons. First, the usual assumption of constant credibility seems implausible. Indeed, the analysis in Section 4 suggests that credibility of the EMS target zones has generally been improving in recent years. Second, the Bertola-Svensson model is consistent with the failure to find a deterministic negative relationship between s_t and $E_t(\mathrm{d}s/\mathrm{d}t)$ and the occasional findings of a positive correlation (as in Table 2). It is particularly encouraging that the best evidence of a negative correlation is found for the guilder. In light of our earlier analysis, a plausible explanation is that the guilder's target zone is nearly perfectly credible and has remained so over the sample period. On the other hand, the positive correlation found for the French franc suggests that credibility has been changing (presumably improving) over the period.

6. Estimation of the expected rate of realignment

In this section we return to the question of the degree of target zone credibility, using the Bertola-Svensson framework to estimate the expected rate of realignment.[23] This measure is based on the overall expected rate of change of the exchange rate, but differs in that expectations of mean-reversion within the target zone have been filtered out, leaving a potentially superior measure of target zone credibility.

Let s_t denote the log exchange rate at time t. As exchange rates are being measured as DMs per currency unit in question, we will refer to rates of change of s_t as rates of appreciation. Begin with the following decomposition of s_t:

$$s_t \equiv c_t + \bar{s}_t \tag{6.1}$$

[23] Rose and Svensson (1991) were first to implement the Bertola-Svensson model; see their paper for a more extensive investigation. These authors study the French franc/DM target zone over the period March 1979 to May 1990, using interest differentials to measure expectations. For the same period, Svensson (1991) extends the procedure to five other EMS currencies.

where c_t is the official central rate at time t, and $\bar{s}_t$ is the deviation of s_t from that value, the position of the exchange rate within the band. Except at moments of realignment, all variation in s_t reflects (mean-reverting) variation in $\bar{s}_t$. The c_t process is a jump process: c_t jumps at the instant of realignment but is otherwise constant.

A complicating issue concerns the position of the exchange rate within the band before and after realignment. Let z_t denote the size of the jump in the exchange rate when a realignment occurs. If c_t also jumps by z_t at realignment, then $\bar{s}_t$ is unchanged. In general, however, $\bar{s}_t$ also jumps at realignment.[24]

Consider (average) expected rates of change over an interval of discrete length k,

$$E_t \Delta s_{t+k}/k \equiv E_t \Delta c_{t+k}/k + E_t \Delta \bar{s}_{t+k}/k \tag{6.2}$$

Thus the total expected rate of appreciation is the sum of two components: $E_t \Delta c_{t+k}/k$, the expected rate of *realignment* of the central rate c_t; and $E_t \Delta \bar{s}_{t+k}/k$, the expected rate of appreciation *within the band*. It is the former term we seek as a measure of target zone credibility. In a perfectly credible target zone, $E_t \Delta c_{t+k}/k = 0$.

On measuring the expected rate of realignment $\mathrm{E_t \Delta c_{t+k}/k}$

It is convenient to re-write (6.2) as

$$E_t \Delta c_{t+k}/k = E_t \Delta s_{t+k}/k - E_t \Delta \bar{s}_{t+k}/k \tag{6.3}$$

In (6.3) the term $E_t \Delta s_{t+k}/k$ may be measured using either the interest differential or survey data, together with the contemporaneous value of s_t. If $E_t \Delta \bar{s}_{t+k}/k$ could be estimated, one could simply combine terms to form the desired estimate of $E_t \Delta c_{t+k}/k$. However, as Svensson (1991) points out, estimation of $E_t \Delta \bar{s}_{t+k}/k$ would be complicated by the possibility of jumps in $\bar{s}_t$ at realignment. ($E_t \Delta \bar{s}_{t+k}/k$ is the expected rate of appreciation within the band *inclusive* of possible jumps in the position within the band at realignments.) On the other hand, it is straightforward (using a method discussed below) to estimate $E_t[\Delta \bar{s}_{t+k} | \text{no rlgn.}]/k$, the expected rate of appreciation within the band *conditional on no realignment occurring* during the next interval of length k. We therefore construct a variable q_t,

$$q_t \equiv E_t \Delta s_{t+k}/k - E_t[\Delta \bar{s}_{t+k} | \text{no rlgn.}]/k \tag{6.4}$$

as an approximation of $E_t \Delta c_{t+k}/k$, the expected rate of realignment in (6.3).

It remains to analyze the relationship between q_t and $E_t \Delta c_{t+k}/k$. While analytically different, the two may be nearly equal as longer forecast horizons are considered. Let p_t denote the probability that a realignment will occur sometime during the next interval of length k. Thus $(1 - p_t)$ is the probability

[24] Indeed, during some EMS realignments s_t has remained unchanged, the jump in $\bar{s}_t$ exactly offsetting the jump in c_t.

that no realignment occurs. The expected change in the (total) exchange rate may then be written as follows:[25]

$$E_t\Delta s = p_t E_t \Delta c|\text{rlgn.} + (1 - p_t)E_t\Delta c|\text{no rlgn.} + p_t E_t \Delta\bar{s}|\text{rlgn.} + (1 - p_t)E_t\Delta\bar{s}|\text{no rlgn.} \quad (6.5)$$

or, noting that $(1 - p_t)E_t\Delta c|\text{no rlgn.} = 0$, and rearranging,

$$E_t\Delta s - E_t\Delta\bar{s}|\text{no rlgn.} = p_t\{E_t\Delta c|\text{rlgn.} + E_t\Delta\bar{s}|\text{rlgn.} - E_t\Delta\bar{s}|\text{no rlgn.}\} \quad (6.6)$$

Let $v_t \equiv p_t/k$ denote the (average) probability intensity of a realignment over the next interval of length k. Dividing (6.6) by k and recalling (6.4),

$$q_t = v_t[E_t\Delta c|\text{rlgn.}] + v_t m_t \quad (6.7)$$

where

$$m_t \equiv E_t\Delta\bar{s}|\text{rlgn.} - E_t\Delta\bar{s}|\text{no rlgn.}$$

Alternatively, since $E_t\Delta c/k = p_t[E_r\Delta c|\text{rlgn.}]/k + (1 - p_t)0$,

$$q_t = E_t\Delta c/k + v_t m_t \quad (6.7')$$

Thus q_t, the measure of credibility we use, differs from the expected rate of realignment by the term $v_t m_t$. To understand this difference, rewrite m_t:

$$m_t \equiv [E_t\bar{s}_{t+k}|\text{rlgn.}] - [E_t\bar{s}_{t+k}|\text{no rlgn.}] \quad (6.8)$$

Thus m_t is the difference between the expected position within the band conditional on a realignment occurring and the expected position within the band conditional on no realignment occurring. In general, these conditional expectations will not be equal, so $m_t \neq 0$. As Svensson (1991) notes, as the length of the interval k approaches zero, the two conditional expectations of $\bar{s}_{t+k}$ will differ by an amount which approaches the expected jump of $\bar{s}_t$ at realignment.

In applying this framework to data one must consider forecast horizons of discrete length. How is m_t influenced by the horizon k? For k greater than zero, m_t does not represent the expected jump in $\bar{s}_t$ at realignment. (The reason is that any discrete interval allows time for ongoing mean-reversion of $\bar{s}_t$, regardless of whether a realignment occurs.) Importantly, the value of m_t becomes smaller as longer k are considered. Longer k allows more mean-reversion of $\bar{s}_t$, *regardless* of whether a realignment occurs during the interval. At the end of the interval, the two conditional expectations of $\bar{s}_{t+k}$ may both be near c_t, the unconditional mean of the current band, so that their difference will be small.[26]

In summary, we will construct a variable

$$q_t \equiv E_t\Delta s_{t+k}/k - E_t[\Delta\bar{s}_{t+k}|\text{no rlgn.}]/k$$

[25] Henceforth Δ represents the change in the variable over a horizon on length k. Thus $\Delta s_t = s_{t+k} - s_t$.

[26] This point was first made in Svensson (1991).

as an approximation of $E_t\Delta c_{t+k}/k$, the expected rate of realignment. The technique may be thought of as a filter: by removing a measure of expected change within the band from the overall expected change, one may obtain a more refined measure of target zone credibility. With both interest differentials and survey data available to measure the overall expected rate of change, the remaining requirement is an estimate of the expected rate of appreciation within the band.

Estimating expected appreciation within the band

The key to estimating appreciation within the band is the rational expectations methodology: actual changes in s_t (observed during a sample period with no realignments) may be substituted for the unobserved expected changes in $\bar{s}_t$. The issues then are the explanatory variables and functional form to be used to forecast these changes. In the continuous time model developed by Bertola and Svensson, both s_t and $E_t(d\bar{s}/dt)$ are driven by the exogenous state variable, f_t, the indicator summarizing exchange rate fundamentals. An implicit deterministic relationship exists between s_t and $E_t(d\bar{s}/dt)$, each being a sufficient statistic for the other.[27] Therefore s_t is the only explanatory variable needed in a forecasting regression of actual changes in $\bar{s}_t$.

With regard to functional form, the relationship between expected appreciation within the band and the exchange rate's position within the band is known to be non-linear and monotonically negative. Svensson (1990d) shows that it may be well-approximated by a linear relationship, particularly for longer forecast horizons. We therefore consider the following linear relationship:[28]

$$E_t(\bar{s}_{t+k} - \bar{s}_t) = \beta_0 + \beta_1\bar{s}_t + e_t \tag{6.9}$$

where e_t arises from the failure of this linear approximation to match the non-linear relationship implied by theory (or from the failure of the theoretical relationship to match the true process). The inclusion of an unrestricted intercept term allows for the possibility that the actual target zones may differ from official announcements.[29]

Rational expectations then imply:

$$(\bar{s}_{t+k} - \bar{s}_t) = \beta_0 + \beta_1\bar{s}_t + e_t + u_t \tag{6.10}$$

where

$$u_t = \bar{s}_{t+k} - E_t(\bar{s}_{t+k})$$

[27] Note this similarity to the standard target zone model discussed in the previous section. The difference here is that the relationship involves $E_t(d\bar{s}/dt)$, not $E_t(ds/dt)$.

[28] In the working paper version we also consider a non-linear approximation but do not find strong evidence in its favor.

[29] More precisely, $\bar{s}_t$ may revert to a mean other than zero, the official central rate. Inspection of the spot rate data suggests that most EMS currencies do not make use of the upper (stronger) part of their DM target zones.

Thus we seek to predict k-month changes in the exchange rate as a function of the exchange rate's own current position within the target zone. Mean-reversion within the band will be reflected in a value of β_1 which is less than zero.

We estimate equation (6.10) using OLS for horizons of $k = 1$, 3, 6 and 12 months. These horizons correspond to those of the *CFD* surveys. Since the data are monthly, the issue of overlapping observations arises for $k > 1$ month.[30] Conventional standard errors are therefore inappropriate. Accordingly we use Newey-West covariance estimators which should be robust to the structure of the errors arising from overlapping observations. For example, for the regressions of six-month differences we use Newey-West covariance estimators allowing for five lags.

Note that estimation of (6.10) requires data for spot exchange rates only. We therefore are able to use data for the entire period of interest, beginning when the current EMS target zones were established in January 1987.[31] As is well known, sample span is key to investigating mean reverting relationships. Thus we do not attempt to estimate (6.10) for the currencies of EMS newcomers Spain and Britain. For the lira, we limit the sample to the period before the narrowing of its target zone in January 1990.

Table 3 presents results of OLS estimation of equation (6.10) for horizons of one, three, six and 12 months. Before discussing these results, we note that rational expectations would imply that u_t, the error in forecasting the exchange rate, should not be correlated its own lagged values. Even with rational expectations, autocorrelation of the regression residuals could still emerge as a result of the e_t errors from our linear approximation. It is therefore of interest to test for such autocorrelation. For the regressions based on one-month horizons, Q-tests find significant evidence of autocorrelation only in the case of the Belgian franc.[32]

The β_1 estimates in Table 3 are satisfactory in a number of respects. All are negative, as expected. With the exception of Belgium, the estimates are large in relation to their standard errors.[33] Also as expected, the β_1 estimates for each currency are larger in absolute value the longer is the horizon considered (the single exception is the 12-month Irish forecast). It appears that within the recent EMS target zones, the current exchange rate gives a reasonable linear predictor of its own future change. (The possible exception is the case of Belgium.) As a further check, we also estimate the following alternative specification:

$$(\bar{s}_{t+k} - \bar{s}_t) = \beta_0 + \beta_1 \bar{s}_t + \beta_2 \bar{s}_t^2 + \beta_3 \bar{s}_t^3 + v_t \qquad (6.11)$$

[30] Intuitively, a single unanticipated shock or event will appear in a number of consecutive forecast errors. The result is that the error term follows an MA process of order $(k - 1)$.

[31] Recall that the survey data are available only from February 1988.

[32] For horizons longer than one month, Q-tests strongly reject the null of no autocorrelation, as one would expect when overlapping observations are used.

[33] The hypothesis $\beta_1 = 0$ corresponds to the case in which $\bar{s}_t$ is a random walk. As we are concerned with the behavior of s_t within band limits we dismiss the random walk hypothesis *a priori*. (Even if that hypothesis were of interest, it might also be rejected empirically: indeed, many of the estimates would reject $\beta_1 = 0$ using the Dickey-Fuller test.)

TABLE 3
Expected Mean Reversion Within the Band: Estimates of β_1

currency of		*k = 1 mo. (54 obs)*	*k = 3 mo. (52 obs)*	*k = 6 mo. (49 obs)*	*k = 12 mo. (43 obs)*
Belgium	β_1	−.0704	−.168	−.343	−.799
	std. err.	(.0623)	(.126)	(.273)	(.248)
Denmark	β_1	−.139	−.407	−.846	−1.05
	std. err.	(.0643)	(.192)	(.179)	(.194)
France	β_1	−.165	−.472	−.814	−0.959
	std. err.	(.0767)	(.172)	(.197)	(NA)
Ireland	β_1	−.420	−.933	−1.34	−0.724
	std. err.	(.115)	(.135)	(.0665)	(.153)
Netherlands	β_1	−.381	−.748	−1.11	−1.16
	std. err.	(.139)	(.207)	(.112)	(.208)
Italy	β_1	−.154	−.523	−.727	−1.37
	std. err.	(.0775)	(.146)	(.187)	(.122)

Based on monthly observations, January 1987 through July 1991 (through December 1989 for Italy). Standard errors based on Newey-West covariance estimators.

The inclusion of the square and cube of the exchange rate (suggested by Rose and Svensson (1991)) is intended to capture non-linearities in the relationship between $E_t(\bar{s}_{t+k} - \bar{s}_t)$ and $\bar{s}_t$. This functional form may permit a better approximation to this relationship than equation (6.10). Table 4 reports marginal significance levels of chi-square tests of the joint hypothesis $B_2 = B_3 = 0$. A number of the test statistics are significant at the 5% level; however, except for Belgium we do not find overwhelming evidence against the restriction $B_2 = B_3 = 0$. We therefore proceed using the results from the simpler linear regression (6.10).

TABLE 4
Test of $B_2 = B_3 = 0$: Marginal Significance

currency	*k = 1 mo.*	*k = 3 mo.*	*k = 6 mo.*	*k = 12 mo.*
Belgium	.000**	.000**	.000**	.050**
Denmark	.344	.528	.211	.000**
France	.357	.123	NA	.252
Ireland	.526	.152	.307	NA
Netherlands	.000**	.002**	.351	.687
Italy	.954	.919	NA	NA

Chi-square (2) test of $B_2 = B_3 = 0$, based on Newey-West covariance estimators.

** denotes significance at the 5% level; NA denotes computational problems.

Estimates of the expected rate of realignment

The changes predicted by the fitted values of (6.10), divided by k, provide estimates of $E_t[\Delta\bar{s}_{t+k}|\text{no rlgn.}]/k$. The final step is to subtract this series from a series measuring $E_t\Delta s_{t+k}/k$, the overall expected rate of change of s. The result is q_t, an approximation of the expected rate of realignment.

We focus on results based on a horizon of $k = 12$ months, the longest horizon for which monthly *CFD* survey data are available. As discussed, m_t will be smaller for longer horizons, so q_t will more closely approximate the expected rate of realignment. Furthermore, there are two reasons why error in estimating $E_t[\Delta\bar{s}|\text{no rlgn.}]/k$—and resulting error in estimating q_t—will be smaller at longer horizons. First, recall that we use a linear approximation to estimate $E_t[\Delta\bar{s}|\text{no rlgn.}]/k$. Svensson (1990d) shows that the relationship being approximated comes close to being linear for longer horizons. Second, as the horizon length is extended, the *true* value of $E_t[\Delta\bar{s}|\text{no rlgn.}]/k$ must approach zero, since $E_t\Delta\bar{s}$ is bounded. horizon length itself acts as the needed filter: at longer horizons, the component to be removed from $E_t\Delta s/k$ becomes relatively small. Thus error in measuring expected appreciation within the band (arising from sampling error or specification error) may be relatively unimportant at longer horizons.

Figure 9 presents results of applying this procedure to data from the current EMS regime, based on 12-month forecast horizons and using *CFD* survey data to measure $E_t\Delta s/k$. As expected, the q_t estimates for the guilder tend to be close to zero, suggesting a low probability of realignment (or a very small realignment). For the other currencies, the q_t estimates are most often negative, indicating

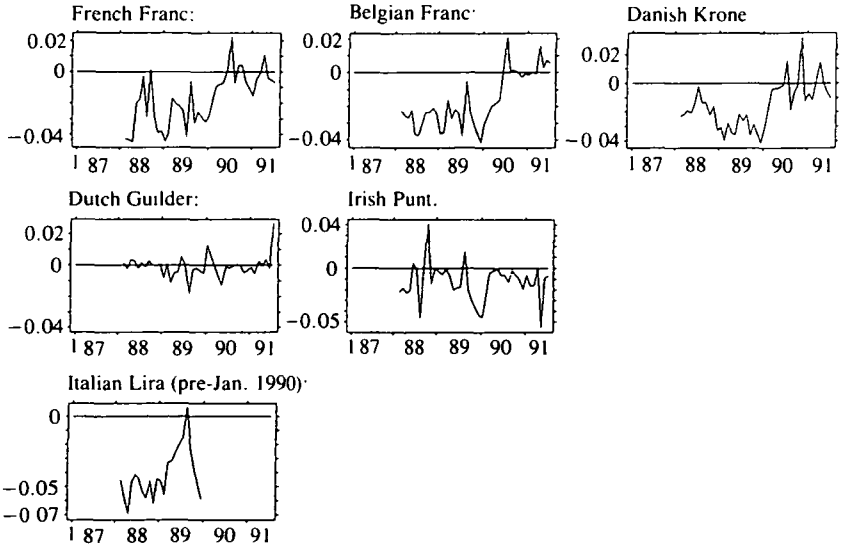

FIG. 9.

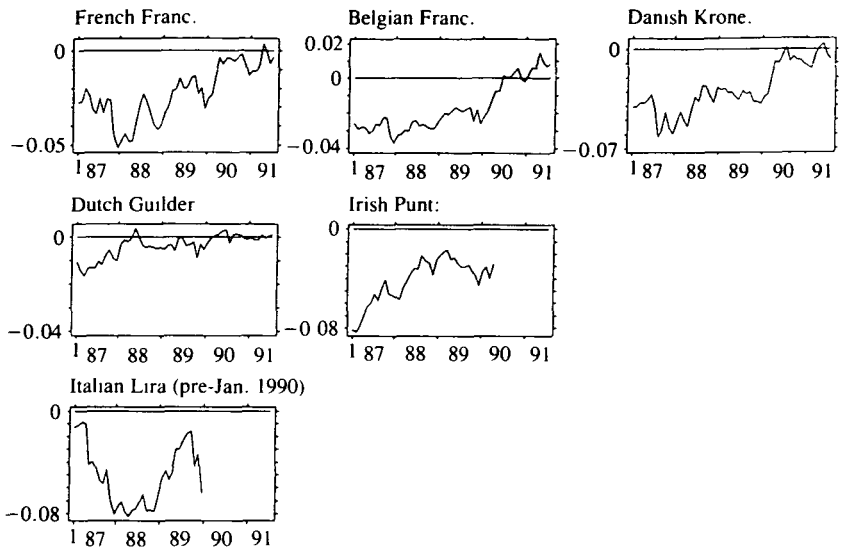

FIG. 10.

expected devaluation of the central rate against the DM. Except for the Irish case, q_t estimates of -5 to -2% per year were typical prior to 1990; since early 1990, values greater than -2% are typical. Indeed the estimates have at times indicated positive realignment (an appreciation of the zone) against the DM. For the Irish currency, q_t estimates of -2 to 0% have been the rule throughout the period.[34] Overall, there seems ample evidence of time-varying credibility.[35]

Figure 10 is analogous to Figure 9, the difference being that interest differentials are used instead of *CFD* surveys to measure $E_t\Delta s/k$. We are thus able to estimate q_t beginning just after the last EMS realignment in January 1987. As in Figure 9, we note an improvement after early 1990 in the credibility of those currencies for which q_t estimates are available. However, the results in Figure 10 differ from those of Figure 9 in several respects. For example, the Irish currency seems less credible over 1988-1989 than Figure 9 suggests. Also, the availability of earlier q_t estimates allows one to see that the Irish pound and even the Dutch guilder experienced proportionately large increases in credibility during 1987.

Because expected mean-reversion within the band has been filtered out of the overall expected change, the estimated q_t series may be superior to $E_t\Delta s/k$

[34] On the basis of evidence at other horizons it is likely that the May 1991 q_t for Ireland reflects a data error.

[35] For insight into the interpretation of these estimates, suppose that the expected size of a realignment against the DM is -4%. A q_t estimate of $-.02$ (i.e., -2% per year) would then imply that the probability intensity of a realignment is 50% a year (or that the expected time to realignment is two years).

TABLE 5
Magnitude of Expected Rates of Mean-Reversion
(as annualized percentages)

currency	*mean*	*mean absolute*	*min.*	*max.*
Belgium	−0.02%	0.56%	−1.47%	1.13%
Denmark	−0.27	0.85	−2.66	1.33
France	−0.28	0.62	−1.78	1.06
Ireland	0.001	0.23	−0.43	0.89
Netherlands	0.01	0.18	−0.70	0.81
Italy	0.67	1.69	−4.46	2.25

Approximate percentages based on log differences. Based on OLS estimation of equation (6.10) for the period January 1987 through July 1991 (through December 1989 for Italy).

as an indicator of credibility. The importance of this distinction depends on the relative magnitude of the expected rate of appreciation within the band. Table 5 provides summary statistics for the estimated $E_t[\Delta\bar{s}|\text{no rlg.}]/k$ series for $k = 12$ months. Not surprisingly, the sample means of the $E_t[\Delta\bar{s}|\text{no rlgn.}]/k$ series are close to zero. Mean absolute values for the currencies using $\pm 2.25\%$ bands range from 0.2 to 0.9% per year.

Compared to historic levels of EMS interest differentials, such values seem relatively small.[36] The implication would be that observed interest differentials reflect mostly expected realignment and imperfect credibility. On the other hand, consider the minimum and maximum values also presented in Table 5. Furthermore, the very recent evidence (e.g., from 1991) indicates that the expected rate of realignment for several EMS currencies is becoming small in absolute value, often not far from zero. If so, expected mean-reversion within the band may now represent the larger portion of overall expected exchanges in a newly credible EMS.

7. Summary and conclusions

In this paper we use very recent evidence from a survey of exchange rate forecasts to examine a number of aspects of the EMS target zones. In light of recent institutional developments within the European Community, we have been particularly interested in the hypothesis that the EMS target zones have experienced an important increase in credibility.

The analysis in Section 4 suggests the following conclusions. The guilder's DM target zone is clearly the most credible. For most other EMS currencies, the survey data confirm earlier findings that their DM target zones have been less than perfectly credible. On the other hand, the survey evidence suggests

[36] During the 1979-1986 period, mean interest differentials for the currencies using $\pm 2.25\%$ bands ranged from about −4% for Belgium to about −7% for Ireland.

that credibility has increased over the 1988-1991 period, especially since early 1990. Consideration of exchange rate expectations constructed from interest differentials corroborates these findings and allows a comparison with earlier regimes: the current regime is significantly more credible. However, we still find some evidence against perfect credibility of most EMS target zones, even in 1991.

Turning attention to the previously documented failure of the standard target zone model to conform to EMS data, we consider whether mismeasurement of expectations is to blame. However, we find that results based on survey data are no more supportive than those based on uncovered interest parity. In our view, a more likely source of the model's failure is its implicit assumption of constant credibility. We are therefore attracted to the Bertola-Svensson model in which an expected rate of *realignment* is permitted to vary over time. We estimate this expected rate of realignment. Although based on the overall expected rate of appreciation, this series differs in that expected mean-reversion within the target zone has been filtered out, leaving a potentially superior indicator of target zone credibility. We find ample evidence of shifting credibility over the sample period; indeed, the results suggest conclusions about EMS credibility which are qualitatively similar to those based on direct examination of expected future exchange rates. During most of the sample period, expected realignment has often been a large component of overall expected rates of change of EMS exchange rates. However, the truth of this generalization seems to be fading: results from 1991 indicate that expected rates of realignment of several EMS currencies are often near zero.

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APPENDIX EMS DEVELOPMENTS, 1986–1991

1986

Feb.	Single European Act sets Dec. 31, 1992 as date for completion of internal market with free movement of goods, services, labor and capital within the EC.

1987

Jan. 12	EMS Realignment (the eleventh, and possibly final).
Jan.	France and Italy announce changes in their exchange rate management.
Sept.	Basle-Nyborg Agreement. Committee of Central Bank Governors agrees to strengthen the ERM by providing for intra-marginal intervention and more liberal short-term finance of intervention.

1988

June 13	Agreement to free capital movements in the EC. Germany softens previous opposition to EC central bank; France and Italy persuaded to remove major capital controls over next two years.
June 28	Hanover Summit Britain rejects proposal for European central bank and single currency; Delors Committee is created.
July 14	Bundesbank's president denies opposition to concept of a European currency.

1989

April 17	Delors Committee Report. Proposes a three-stage transition to economic and monetary union (EMU), without specifying a timetable:

Stage 1: Capital movements liberalized, ERM membership enlarged, more powers to EC Committee of Central Bank Governors. Realignments still permitted.

Stage 2: Exchange rate bands narrowed from ±2.25%, realignments permitted only in exceptional circumstances. Economic policy guidelines, not yet

binding, set at the Community level. European System of Central Banks (ESCB) set up, absorbing existing monetary arrangements.

Stage 3: Exchange rates irrevocably locked. ESCB replaces the national central banks. Adoption of single currency completes stage.

June 3	An editorial in *The Economist* calls for one last general devaluation against the German mark.
June 19	Spain joins the ERM.
June 27	European Council decides to begin Stage 1 of the Delors plan on July 1, 1990. (According to the Delors Report, 'a decision to enter upon the first stage should be a decision to embark on the entire process'.)
Nov.	Berlin Wall falls
Dec.	Strasbourg Summit. Agreement that by December 1990 an intergovernmental conference would convene to prepare changes in Treaty of Rome needed for EMU. Having favored a slower pace, West Germany agrees to this schedule as its EC partners give their stamp of approval to German monetary unification.
1990	
Jan. 8	Lira bands narrowed from $\pm 6\%$ to the standard $\pm 2.25\%$. Lower limit unchanged.
Feb. 6	Apparently sudden decision of Germany's Kohl in favor of rapid movement toward a German currency union.
March	France: minister announces French franc will never again be devalued in the EMS.
March	European Commission releases its plan for EMU; similar to Delors' report, but drops centrally-set rules for members' budget deficits. Plan to be discussed by EC finance ministers on March 31.
March 31	Ashford Castle meeting of EC finance ministers. Eleven of 12 ministers agree on main features of a new European Central Bank.
April	German governments agree on terms of monetary conversion and union, to be enacted July 2, 1990.
April 28	Dublin summit. Declaration that changes in Treaty of Rome relating to EMU must be ratified by end of 1992 (thus possible for Stage 2 to begin in January 1993). Dec. 14, 1990 chosen as date for conference on EMU
May 18	Treaty to unify the two Germanies signed. FRG agrees to set up DM 115 billion fund to support GDR through end of 1994.
June	Belgian central bank declares DM exchange rate as its main policy target.
July 1	Stage 1 of EMU begins.
July 1	Complete removal of capital controls, as previously scheduled. Exceptions: Ireland, Spain, Portugal, and Greece (deadline 1992).
July 1	German monetary unification.
August	European Commission finalizes its contribution to the upcoming Rome conference on EMU. (See March 1990.) Recommends the **ecu** replace existing currencies (rather than fixing permanent exchange rates among them). Proposes that Stage 2 should start in January 1993, leading after 'a short duration' to full monetary union.
Sept.	Meeting of finance ministers in Rome reveals large differences over timing of EMU. Belgium, France and Italy call for Stage 2 to start January 1993 and Stage 3 soon afterwards. Germany and Netherlands are against setting any deadlines, argue economic convergence must come first.
Oct. 8	Britain joins the ERM, using bands of $\pm 6\%$.
Oct. 22	Norway unilaterally links its currency to EMS.
Oct. 27	Rome Summit. Breakthrough in favor of EMU deadlines. Eleven of 12 agree that Stage 2 of EMU should begin January 1994 (subject only to mild conditions). European central bank to be set up at start of Stage 2, to begin conducting monetary policy in Stage 3. Timing of Stage 3 is vague, but apparently before 2000. Countries will be permitted to stay outside Stages 2 and 3 if they choose.

Nov. 13	EC central bankers unveil their draft statutes for a future European central bank: first objective is to be maintenance of price stability.
Nov. 22	U.K. Prime Minister Thatcher resigns.
Dec. 14	Rome Summit. Intergovernmental conference on EMU begins work on a treaty to be signed by October 1991. Draft treaty published by European Commission to be used as its working base.

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April	Spain removes virtually all capital controls.
April	Speculation that Britain and Spain will narrow their exchange rate bands to $\pm 2.25\%$.
May 13	*Financial Times* reports that many EMU negotiators have now accepted that a 'two-speed' transition to EMU is inevitable.
May 19	*The Economist* reports that EMU negotiators, after five months of little progress, now appear likely to accept compromises embodied in draft EMU treaty proposed by Luxembourg.
May 13	Reports that Bundesbank's president will resign; resignation officially announced on May 16.
May 17	Sweden unilaterally links its currency to EMS, using bands of $\pm 1.5\%$.
June 7	Finland unilaterally links its currency to EMS.
June 9	U.K. and German leaders agree they will try to slow the pace of EMU negotiations at upcoming summit.
June 30	Luxembourg Summit takes no significant new steps toward EMU; key remaining decisions are apparently postponed until Maastricht Summit in December 1991.
November 15	Finland devalues by 12.3% against ecu.
Dec. 9–10	Maastricht Summit.

Sources: *The Economist*, *The Financial Times of London*, Giovannini (1990), Haberler (1990), Weber (1991).