A Simple Test of the Effect of Exchange Rate Defense

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November 2005†

ABSTRACT: High interest rates to defend the exchange rate signal that a government is committed to fixed exchange rates, but may also signal weak fundamentals. We test the effectiveness of the interest rate defense by disaggregating into the effects on future interest rates differentials, expectations of future exchange rates, and risk premia. While much previous empirical work has been inconclusive due to offsetting effects, tests that "disaggregate" the effects provide significant information. Raising overnight interest rates strengthens the exchange rate over the short-term, but also leads to an expected depreciation at a horizon of a year and longer and an increase in the risk premium, consistent with the argument that it also signals weak fundamentals.

JEL numbers: F31, F33
Keywords: currency crises, interest rate defense, speculative attacks, signaling

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† An earlier version of (part of) this paper was previously circulated under the title, "Mixed Signals in Defending The Exchange Rate: What Do the Data Say?" We wish to than seminar participants at the Bank of Israel, the Research Department of the IMF, Southampton University, Tel Aviv University, the University of Maryland, and the 5th Conference of the Analysis of International Capital Markets Research Training Network for helpful comments on the earlier paper. Financial support from the Yael Chair in Comparative Economics, Tel-Aviv University is gratefully acknowledged.

1. Introduction

Raising the short-term interest rate is often used to defend a currency under attack. The interest rate defense has had both successes and failures, some quite spectacular. Hong Kong increased overnight rates to several hundred percent and successfully defended its currency in October 1997 against speculative attack. Sweden similarly increased its interest rate by several hundred percent in its currency defense in September 1992, but the success was short-lived. Other cases of both success and failure can be cited, so that even a first look at episodes leaves very much open the question of the effectiveness of an interest rate defense.

Formal econometric tests of this question are also inconclusive. As Kraay (2003, p. 297) puts it, in speculative attacks in developed and developing economies, there is "a striking lack of any systematic association whatsoever between interest rates and the outcome of speculative attacks." Hence, we really have no clear answer to the question: Is raising the interest rate effective in defending a currency?

This leads to a more fundamental question, namely: Why do high interest rates deter speculation? The standard argument is that they increase the opportunity cost of speculation. When speculators borrow domestic currency to speculate against a fixed exchange rate (when they "short" the domestic currency), high short-term interest rates make such borrowing very costly. However, this argument runs into a simple "arithmetic" problem. If the horizon over which devaluation is expected is extremely short, interest rates must be raised to extraordinarily high levels to deter speculation even when the expected devaluation is small. For example, even if foreign currency assets bore no interest, an expected overnight devaluation of 0.5 percent would require an annual interest rate of over 500% ($((1.005^{365}-1)*100=517)$) to make speculation unprofitable. (See, for example, the discussion in Furman and Stiglitz [1998].)

This reasoning has called into question how effective very high overnight interest rates can be in deterring an attack, and has been used to explain why the interest rate defense may be ultimately unsuccessful. Though the "arithmetic problem" addresses the question of why "spectacular" defenses may have only limited effects, it raises other questions. On the one hand, why then is the interest rate defense sometimes successful, especially when the interest rate used to defend is *not* spectacularly high? And, why do short-lived increases in interest rates often appear to have much longer-term effects? On the other hand, why does an interest rate defense sometimes appear to lead to even *greater* speculative pressures against the currency? The effects of raising interest rates must reflect more a simple cost-of-borrowing effect.

In this paper we investigate these questions by decomposing the effects of an increase in the interest rate on the short-run expected exchange rate into a number of (potentially offsetting) effects. Our focus is empirical, but one suggested by a specific conceptual approach to the effectiveness (or ineffectiveness) of interest rate defense. We argue that the effects of high interest rates may reflect the *information* that increasing interest rates provides to market participants. If so, the direct cost implications of high interest rates for speculators may be secondary to the signal they provide. By raising interest rates, a government signals that it is committed to fixed exchange rates, but it may also signal weak fundamentals. Hence, a key empirical implication is that raising interest rates leads to the expectation that future rates will be high, but may also increase the probability speculators assign to collapse. Hence, the net effect may be ambiguous.

A key argument is that if the effects of high interest rates reflect the expectations they engender about future policy (via the signal about unobserved government characteristics under asymmetric information), then these effects should appear in expectations of future exchange and interest rates. Hence, tests of the effectiveness of the interest rate defense looking at these forward-looking variables should be informative. Empirical testing along these lines is the focus of this paper.

Our main conclusion is that while tests looking at the effect of high interest rates on "summary measures" like the outcome of an attack (or the very short-term expected exchange rate) are often inconclusive, tests that "disaggregate" these effects both across different time horizons and across different determinants of short-term expected exchange rates (interest differentials, risk premia, and long-term expectations) provide significant information. The inconclusiveness of tests using summary measures may be due to *offsetting* effects, with tests on disaggregated measures displaying some clear regularities to explain these offsetting effects. Raising overnight interest rates strengthens the exchange rate over the short-term for most countries in our sample via its effects on short-term interest rate differentials, consistent with signaling commitment to defend. However, raising overnight interest rates leads to an expected depreciation at a horizon of a year and longer, consistent with the argument that it also signals weak fundamentals. High overnight rates also weaken the exchange rate via an increase in the risk premium, consistent with the argument that they increase the risk of default.

The plan of the paper is as follows. In the next section, we quickly review standard empirical tests of the interest rate defense, in which probability of the fixed rate regime being maintained is related to the stance of monetary policy. Given the inconclusiveness of the tests, we argue that an alternative approach is required. In section 3, we consider tests of the effects of the interest rate defense via the term structure of exchange rate expectations and interest rates, using data from eight European countries. We show that disaggregating the effect of raising overnight interest rates in the way outlined in the previous paragraph provides significant information that is hidden in a test on a summary measure. These results are consistent with the signaling hypothesis, but also in part with other arguments, as we will outline. Section 4 presents a summary of our main findings, as well as concluding comments.

2. Testing the Effectiveness of Interest Rate Defense

We begin by reviewing the evidence on tests of the effectiveness of raising the interest rate to defend against speculative attack, as well as conceptual arguments on why such tests may be inconclusive. The most obvious test is to relate some measure of the level of interest rates or monetary policy to attack outcomes. Recent empirical literature has produced a number of empirical tests of the effectiveness of interest rate defense of this sort.

The best known paper is probably that of Kraay (2003), who studies a large cross-country sample of fixed exchange rate crises, and relates the stance of monetary policy to the outcome of the crisis (collapse or survival of the peg). He uses an instrumental variable probit technique to control for the endogeneity of the interest rate, since both the degree to which a country raises interest rates and the probability that an attack succeeds (for given interest rates) are likely to depend on the amount speculative pressure it faces. Hence, heavy speculative pressure may lead a country to raise interest rates sharply but may also make failure likely, so that there is a correlation between interest rates and attack outcomes that has nothing to do with the effectiveness of interest rate defense *ceteris paribus*, that is, when speculative pressure or characteristics are controlled for.[1] As indicated above, he finds little significant relationship between monetary policy and attack outcomes one way or the other. Other studies of this sort include Goldfajn and Gupta (1998) and Dekle, Hsiao, and Wang (1999), who find more support for the conventional view. On the whole, the evidence is inconclusive.

Theoretically, the inconclusiveness of tests should not be surprising. To see why, consider the uncovered interest parity condition

$$i_t = i_t^* + S_{t+1,t} - S_t + P_t \qquad \textbf{(1)}$$

where i and i^* represent the domestic and international interest rate, respectively, and S is the (log of the) exchange rate in terms of domestic per unit of foreign currency. $S_{t+k,t}$ denotes the expectation with respect to period $t+k$, formed in period t (so that $S_{t+1,t} - S_t$ is simply the one-period ahead devaluation expectation). P, the residual from uncovered interest parity, captures a currency and a default risk premium.

Speculative pressure on S_t would be reflected in increases in the expected one-period ahead exchange rate $S_{t+1,t}$ or in the risk premium P_t, so that interest rate defense could be thought of as the policy of letting i increase along with devaluation pressure on the right-hand side to leave S_t unchanged. Hence, for a given amount of speculative pressure (the right-hand side components of (1) other than i^* and S), a high enough nominal interest rate will successfully defend the peg in the very short term, that is, it will ensure that interest rate parity holds.

However, one cannot hold other components of (1) constant. Put another way, a failure of the policy of raising interest rates must reflect higher i_t increasing speculative pressure against the exchange rate, reflected in a positive effect on $S_{t+k,t}$ or P_t, a possible "perverse" feedback effect.[2] Hence, instead of relating interest rates to exchange rate outcomes, one really needs to

[1] For example, Hubrich (2001) shows that high-inflation countries are more likely to face a successful speculative attack, *and* are more likely to resort to an interest rate defense when facing an attack. Thus, high interest rates are associated with successful attacks (a failed defense) in a cross-country study, even though interest rate defense may have been effective on a per-country basis, controlling for inflation.

[2] One must distinguish an attack that succeeds due to the failure of a defense from an attack that succeeds because the government chooses not to defend. If defense requires an extremely high interest rate maintained over some period of time, the government may find it too costly to defend.

examine whether there are *feedback effects* from interest rates back to speculative pressure.[3]

Why might raising interest rates have the effect of raising speculative pressure? One argument is that high interest rates *cause* the fundamentals themselves to deteriorate, an argument suggested by Drazen and Masson (1994). For example, if pressure against a currency reflects the belief that a weak fiscal position means that debt will have to be monetized, then raising interest rates only worsens the fiscal position, raising expectations of further monetization. This argument is explored in detail by Lahiri and Végh (2003). Alternatively, higher interest rates may destabilize an already weak banking system, leading to the belief that defense of the fixed exchange rate must soon be abandoned (see, for example, Furman and Stiglitz [1998] or Radelet and Sachs [1998]).

A different type of argument is suggested by Drazen (2000, 2003), namely, *signaling* of unobserved government characteristics. That is, there are unobserved characteristics of the government that affect the probability that a defense will be mounted or continued, with policy choices being correlated with these characteristics. Hence, with imperfect information about these government characteristics, speculators use observed policy choices to make inferences about them and hence form (that is, update) the probability they assign to a devaluation. Raising interest rates therefore may affect speculator's behavior because it serves as a signal of the government's willingness or of its ability to defend the exchange rate. (This argument may be seen as more generally concerning exchange rate intervention.)

The signaling view suggests not only why raising interest rates may increase speculative pressures, but also why the effect may be ambiguous, leading to inconclusive empirical tests. The effect of raising interest rates on speculative pressure depends on *what* speculators believe it is signaling. If very high interest rates are taken as indicating the government's determination to defend the exchange rate (no matter what the cost, one is tempted to add), then high interest rates may succeed in lowering speculative pressure. This is certainly the signal governments that engage in "spectacular" defenses would like to send. However, very high interest may be taken to indicate very weak fundamentals (or, more generally, "panic"), in which case there will be a

[3] Hubrich (2001) proposes to look not at the relationship between interest rates and exchange rate outcomes, but at that between interest rates and speculative pressure (as identified through a structural econometric model), and to estimate the *feedback* effects implied by different models.

“perverse” effect – raising interest rates would only encourage speculation.

If the signal content of high interest rates is important, empirical tests in a cross section of countries may be inconclusive if different things are being signaled in different countries. Moreover, even within a country at a point in time, the effect may be ambiguous if the signal is mixed or unclear, that is, if speculators infer that both willingness to defend and weak fundamentals are being signaled, or if they are unsure what is being signaled. It may also be that different unobserved characteristics are being signaled at different horizons, a point that we stress in our empirical tests.

A further implication of the signaling approach is that there may be “disproportionalities” in the effect of interest rates on speculative activity. Raising interest rates may dampen speculation far more than an “arithmetic” argument may suggest or may have little effect. To the extent that it sends a negative signal, it may actually increase speculative pressures. If a “persistent” fundamental is signaled, then a short-lived increase in interest rates may have a much longer-term effect. Finally, the effects may be not only of different strengths at different horizons, but also of different signs, raising interest rates strengthening the exchange rate in the very short term, but weakening it at a longer horizon. We now turn to empirical assessment of interest rate defense on the basis of these insights.

3. The Effect of Raising Interest Rates at Different Horizons

A natural direct test of these ideas consists of relating exchange rate expectations and risk premia at different horizons to interest rate policy. Therefore this section uses a set of survey data for exchange rate forecasts at different horizons to study the effect of interest rates on exchange rate expectations during the 1992/3 ERM crisis.

The analysis is geared towards investigating a number of possible effects. First, the impact of interest rates on exchange rate expectations is allowed to be non-linear, consistent with the argument that the information content of the policy may not be proportional to the level of the interest rate. Second, signaling models also suggest that temporary policies have longer-run effects, in that the signaling effect of high interest rates may outlast the high interest rate policy itself. This can be examined by looking at the ‘term structure’ of exchange rate expectations: Does interest rate policy affect exchange rate expectations similarly at all horizons, or does it only have an impact on short-term expectations? The more the effect is spread out across the term structure, the more it would seem that something 'fundamental' is being signaled. In addition, the analysis enables us to distinguish between the effects of policy on future interest rates and those on risk- and term premia (with the effect on exchange rate expectations being the sum of both).

A. Empirical Framework

Recalling that $X_{t+j,t}$ refers to the expectation of the value of *X* at time *t+j* as formed at time *t* (the current value is denoted $X_t \equiv X_{t,t}$), we write the interest parity condition (1) as:

$$di_t^k = S_{t+k,t} - S_t + P_t^k \qquad \textbf{(1a)}$$

Here *k* denotes the maturity of the underlying asset (in other words, we are looking at, say, a *k*-month money market rate). di_t^k is the interest rate differential $i_t^k - i_t^{*k}$ and P_t^k is the risk premium (which may include a term premium, a currency risk premium, and a default risk premium) from *t* to *t+k*.

Using monthly data for exchange rate expectations and money market rates at the 1, 3, 6 and 12-month horizon, we can use (1a) to decompose next month's expected exchange rate $S_{t+1,t}$ into:

$$S_{t+1,t} = (S_{t+1,t} - S_{t+3,t}) + (S_{t+3,t} - S_{t+6,t}) + (S_{t+6,t} - S_{t+12,t}) + S_{t+12,t}\ , \qquad \textbf{(2)}$$

where

$$S_{t+1,t} - S_{t+3,t} = (P_t^3 - P_t^1) - (di_t^3 - di_t^1) \qquad \textbf{(3a)}$$

$$S_{t+3,t} - S_{t+6,t} = (P_t^6 - P_t^3) - (di_t^6 - di_t^3) \qquad \textbf{(3b)}$$

$$S_{t+6,t} - S_{t+12,t} = (P_t^{12} - P_t^6) - (di_t^{12} - di_t^6) \qquad \textbf{(3c)}$$

In other words, the above allows us to decompose next month's expected exchange rate $S_{t+1,t}$ into the accumulated effects of interest rate expectations and risk over four different horizons. (Note that $i_t^{k+j} - di_t^k$ is the interest rate over the *j*-month interval from *t+k* to *t+k+j*, so that $di_t^{k+1} - di_t^k$ is the one-month interest differential at *t+k*. Other differences in (3) have similar interpretations.) As interest rates increase and risk decreases, the exchange rate components decrease (*i.e.*, the exchange rate appreciates). This represents the common intuition underlying the interest parity condition that higher interest rates will appreciate exchange rates, while increases in risk premia (if not matched by interest rates) will lead to a depreciation.

A key notion to take away from this decomposition is that $S_{t+1,t}$ is essentially a sum that we can break down into seven individual components along two dimensions – term and the components of interest rates versus risk premia. This is illustrated by the following matrix:

TABLE 1

Determinants of the Expected Exchange Rate $S_{t+1,t}$

Term / Component	2-3 mo.	4-6 mo.	7-12 mo.	12+ mo.	**Sum**
Interest Rates	$di_t^1 - di_t^3$	$di_t^3 - di_t^6$	$di_t^6 - di_t^{12}$		$di_t^1 - di_t^{12}$
'Risk'	$P_t^3 - P_t^1$	$P_t^6 - P_t^3$	$P_t^{12} - P_t^6$		$P_t^{12} - P_t^1$
Long-Term				$S_{t+12,t}$	$S_{t+12,t}$
Sum	$S_{t+1,t} - S_{t+3,t}$	$S_{t+3,t} - S_{t+6,t}$	$S_{t+6,t} - S_{t+12,t}$	$S_{t+12,t}$	$S_{t+1,t}$

By examining how each of the inner components reacts individually to interest rate policy (identified as changes in a very short-term money market rate), we hope to better understand the effects of raising interest rates and to be able to distinguish signaling effects from other, competing hypotheses. In general, we would expect that if interest rate policy bears an information content that outlasts the policy itself, then interest rate policy should have longer-term effects. These would show up in the above decomposition as decreases in the interest rate components (representing increases in interest rate expectations) that are spread out across the different horizons.

To make this clearer, suppose first that an increase in the overnight policy rate is seen as providing *no* information about future interest rate policy. (Assume for simplicity of exposition that term premia are zero, so that the *k*-month interest rate is simply the sum of expected one-month interest rates from t to $t+k$.) If the central bank raises the overnight interest rate r_t (the policy rate) in response to an attack, this might raise interest rates at very short horizons, but in the absence of information effects, there would be no significant effect on interest rates beyond the term over which the policy rate is kept high. Consequently, only the analogous short-term components of $S_{t+1,t}$ in (3) would improve.

For example, suppose it is believed that a high overnight rate at t will be maintained for a week to fend off an attack and then brought back down. The interest rate differential at t, di_t^k, for every horizon k will increase, but the interest rates for periods beyond the week (that is, $di_t^3 - di_t^1$, $di_t^6 - di_t^3$, *et cetera* in the monthly data) would be unchanged. By equations (3) the expected exchange rate beyond the one-week horizon (the left-hand side of the equations) would also be unchanged. Since $S_{t+1,t}$ is simply the sum of these terms as in (2), it would be unaffected as well in the absence of information or signaling effects.

In contrast, now suppose that the temporary policy signals a permanent change in the policy stance in the sense of a commitment to supporting the exchange rate. This translates in permanently higher expectations of the one-month interest rate ("permanent" as long as this commitment is believed to hold), so that the interest rate components at *all* horizons in (3a)-(3c) will decrease, thus appreciating exchange rate expectations across the board and resulting in a much stronger appreciation of their sum $S_{t+1,t}$ than the above non-information based effect would imply. (As discussed above, this is the signal a defense is meant to send.)

Finally, the decomposition of the exchange rate term component into an interest rate term and a risk term allows us to analyze separately the effect on the risk- and term premia. For example, if the Sachs-Stiglitz argument is correct (whereby higher interest rates may weaken the banking sector), we should detect an increase in the risk components in response to an interest rate policy hike, as risk premia increase.[4] This would be another "perverse feedback" effect.

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[4] As data are available for exchange rate expectations and interest rates over different horizons, we are able to obtain data for P_t^k as the residual from interest rates and exchange rate expectations at the different horizons, essentially using (2). If interest rate forecasts and k-month forward rates were consistently available as well, we could also decompose P_t^k into its three components (compare (3)). Interest rates forecasts were indeed available for a small subset of the data, and were used for a cursory exploration of

B. Data and Regression Equations

To perform the decomposition implied by equations (2) and (3) as illustrated in the matrix, we use monthly data for nine European countries – Germany, Belgium, France, Italy, Denmark, Sweden, Norway, Ireland and Spain – for the time period around the 1992/3 ERM crisis to construct monthly time series for those seven components. During this period those countries essentially had their exchange rates fixed against the benchmark country Germany.[5] These data permit to construct the four exchange rate series on the right-hand side of (2), thus permitting us to look at the term structure of exchange rate expectations without being able to distinguish between interest rates and ‘risk’ as in (3a)-(3c).

Exchange rate forecasts were published monthly in the *Financial Times Currency Forecaster*. This is a ‘combined consensus forecast’, the geometric mean of a sample of professional currency forecasts from commercial banks and other multinational corporations.[6] The reference currency for these forecasts is the US Dollar, so we used the US Dollar/DM forecast has been used to construct exchange rate forecasts relative to the DM. The forecasts come out monthly on the fourth Thursday of the month, from data gathered earlier in the week. *k*-month interest rate differentials (with respect to Germany) are represented through money market rates (from the day of the exchange rate forecast) that were obtained from Bloomberg or Datastream. The 'risk' data could then be backed out as the residual, according to (3a)-(3c).[7]

The following seven equations were estimated for each country (one for each cell in the above matrix), where for convenience we define $X_t^{j,n} \equiv X_t^j - X_t^n$:

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the role of term premia, available from the authors. Forward rate data were available throughout – we refrained, however, from using them to make a distinction between currency and default risk since this distinction is not the focus of our present work.

[5] Technically, with the exception of Norway and Sweden, these countries were part of the EMS system where each country agreed to fix its currency to within a band around a weighted basket of all other participating currencies. Treating Germany as the (sole) benchmark country simplifies the analysis, and is justified in light of the fact that the DM had the biggest weight in that basket.

[6] Optimally, one would like to use expectations at a higher (say weekly) frequency to examine the very short-run effects of interest rate increases on the expected exchange rate. Unfortunately, such data do not exist, at least for this set of currencies in this time period.

[7] This implies of course a relation between the effects of a change in the policy rate on the three difference terms in each of the equations (3a) to (3c). Specifically, using the equations below,

$$di_t^{1,3} = c_1 + a_1 dr_t + b_1 (dr_t)^2 + f_1 S_t + \varepsilon_{1t} \quad \textbf{(4a)}$$

$$di_t^{3,6} = c_2 + a_2 dr_t + b_2 (dr_t)^2 + f_2 S_t + \varepsilon_{2t} \quad \textbf{(4b)}$$

$$di_t^{6,12} = c_3 + a_3 dr_t + b_3 (dr_t)^2 + f_3 S_t + \varepsilon_{3t} \quad \textbf{(4c)}$$

$$P_t^{3,1} = c_4 + a_4 dr_t + b_4 (dr_t)^2 + f_4 S_t + \varepsilon_{4t} \quad \textbf{(4d)}$$

$$P_t^{6,3} = c_5 + a_5 dr_t + b_5 (dr_t)^2 + f_5 S_t + \varepsilon_{5t} \quad \textbf{(4e)}$$

$$P_t^{12,6} = c_6 + a_6 dr_t + b_6 (dr_t)^2 + f_6 S_t + \varepsilon_{6t} \quad \textbf{(4f)}$$

$$S_{t+12,t} = c_7 + a_7 dr_t + b_7 (dr_t)^2 + f_7 S_t + \varepsilon_{7t} \quad \textbf{(4g)}$$

The main regressor is an overnight or one-day money market rate differential $dr_t \equiv r_t - r_t^*$, which presumably reflects the degree to which the government chooses to engage in an interest rate defense. Some of the governments in the sample actually increased overnight rates to engage in interest rate defense, which should be picked up well by these very short-term rates. Other governments merely engaged in interest rate defense to the extent that they chose not to intervene, and "let" money market rates be driven up by devaluation expectations. This interest differential is obtained as the average (from daily observations) between two exchange rate forecasts, expressed in percentage points. It is allowed to enter squared as well, in order to assess non-linearities related to signaling.

The only other regressor (aside from a constant) is S_t, the actual observed exchange rate at the time of the forecast. This regressor was included to try to control for, at least partially, potential biases stemming from the endogeneity of the policy measure $dr_t \equiv r_t - r_t^*$. It is likely that the same factors that affect policy (the onset of a crisis, speculative pressure etc.) also have a direct effect on the dependent variable through the error term *e*, which leads to an endogeneity bias in the coefficients *a* and *b*. To the extent that these factors also lead to movements of the actual exchange rate (within its band [8]), including the exchange rate can control for this effect.

$a_1 + a_4 = a_8$, $a_2 + a_5 = a_9$, *etc.*

[8] During the 1992-3 crisis, there were substantial fluctuations within the band, and periods of strong

We have made no attempt has been made to treat endogeneity more formally (using, e.g., instrumental variables), so that we cannot be entirely certain that the estimation is free of biases stemming from endogeneity.

In order to be able to focus on the term structure (without distinguishing between interest rate and 'risk' components), the following three equations were also estimated (the implied equation for $S_{t+12,t}$ is identical to (4g)):

$$S_{t+1,t} - S_{t+3,t} = c_8 + a_8 dr_t + b_8 (dr_t)^2 + f_8 S_t + \varepsilon_{8t} \quad \textbf{(5a)}$$

$$S_{t+3,t} - S_{t+6,t} = c_9 + a_9 dr_t + b_9 (dr_t)^2 + f_9 S_t + \varepsilon_{9t} \quad \textbf{(5b)}$$

$$S_{t+6,t} - S_{t+12,t} = c_{10} + a_{10} dr_t + b_{10} (dr_t)^2 + f_{10} S_t + \varepsilon_{10t} \quad \textbf{(5c)}$$

Before running the actual regressions, we explored the time-series properties of the data with a battery of unit-root tests. We found that for the majority of the series we could reject the unit root hypothesis at the 10% level, using augmented Dickey-Fuller tests that included a constant term but no trend. Most failures to reject the unit-root hypothesis occurred for interest rate series, where we could reject the unit-root only for about 50% of the series. Since non-stationary interest rates are difficult to conceptualize economically, we attribute these failures to the weakness of the tests due to the generally small sample size for the regressions. Therefore, being aware of the problems involved with over-differencing the data, we decided to run the regressions in levels as laid out above.

C. The Basic Results

Since the policy variable of interest, $dr_t \equiv r_t - r_t^*$, enters the regression quadratically, the point estimates of the coefficients are difficult to interpret. Therefore in tables 2-9 we report, for each country, two blocks of results. The top block of each table shows the estimated coefficients *a* and *b* for the various regressions in (4a)-(4g) and (5a)-(5c), which reflect the (possibly non-linear) impact of the policy variable on the corresponding component. The bottom block then

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speculative attacks were often characterized by the fact that the exchange rate under attack hit the boundary of the band. In addition, there were realignments and widening of bands during the estimation period. Including the actual exchange rate as a regressor is a natural way of trying to control for such events.

focuses on the economic meaning of the point estimates, as we discuss below.

Since either equations (4a)-(4g) or equations (5a)-(5c) were estimated simultaneously (using Seemingly Unrelated Regression, or SUR), the top block also reports about some Wald tests of certain cross-equation restrictions. In the last column of the table we shows tests against the null hypothesis that all the coefficients *b* in the regression are equal to zero, in effect testing for the overall non-linearity present in the regression. It turns out that linearity is rejected throughout, with the exception being regressions (5a)-(5c) (looking only at the term structure) for Italy and Ireland. For these two countries, linearity was rejected when looking at the interest rate and ‘risk’ components separately. At the bottom of the top block, we show tests of the importance of splitting up a given term component into an interest rate and a ‘risk’ component. For that split, it tests whether the coefficients *a* and *b* are identical across interest rate and 'risk' equations. While equality sometimes cannot be rejected for individual coefficients, especially for the early 2-3 month term, it is generally rejected for both coefficients combined, especially when all terms are considered simultaneously. To summarize, the Wald tests reject both the linearity of the impact of the policy rate, and the equality of that impact across interest rate versus ‘risk’ components. This points towards the non-linearities to be expected from a signaling environment, and it suggests that the distinction between interest rate and ‘risk’ components will yield additional insight.

In the bottom block of each table, we use the point estimates to calculate the impact of an increase in the policy rate at different horizons. A negative value implies that increasing the interest rate reduces the term component, and therefore appreciates $S_{t+1,t}$. In particular, positive signaling (for example, with high interest rates signaling strong commitment to defend) would imply a negative entry in the case of *S* or *di*.

We show, for each estimated equation, the impact of three different size interest rates increases in the policy interest rate on the dependent variable, taking into account the non-linearity inherent in the point estimates of *a* and *b* – an increase in the policy rate by one percentage point over the sample mean; an increase by half the difference between the sample mean and the sample maximum; and, finally, an increase all the way to the sample maximum. In the latter two cases the change in the dependent variable was divided by the size of the increase in order to get the effect per percentage point increase, which in turn allows us to compare the three numbers. The dependent variable is measured as 100 x ln(.), while the policy measure is expressed in percentage points. Therefore the table entries can be interpreted as elasticities, giving the percentage change in a $S_{t+1,t}$ component per percentage point increase in the overnight interest rate differential.

For any size interest rate increase, the overall effect on exchange rate expectations across the term (*S* in the bottom rows) can be decomposed into an interest rate effect *di* and a 'risk' effect *P*, the first and second rows, as in Table 1 above. By construction, the entry in the *S* rows is the sum of the corresponding *di* and *P* entries. (See footnote 7.) Corresponding to the sum row in Table 1, the effect of raising the overnight interest rate on the one-month-ahead expected exchange rate $S_{t+1,t}$ is the arithmetic sum of three components – the effect on the interest rate over the twelve-month horizon, the effect on risk premia over the twelve-month horizon, and the effect of the expected exchange rate at a horizon of greater than twelve months. We use this below in interpreting the results.

Looking down the rows for one component in a block, one can identify (and quantify) non-linearities in the interest rate effect. A perfectly linear relationship (b = 0) would yield identical entries in each row. By contrast, a concave relationship (where small interest rate increases already have large effects, but additional increases have little additional effects) would have the entries decreasing in absolute value as we are going down.

Looking across the columns for one component in a block, we can examine the term structure of interest rate effects. The leftmost column represents the nearest term (the next two months), and the term increases as we move to the right. The far right column (labeled "1 month") reports the cumulative effect across all terms (corresponding to the far-right cells in Figure 1).

D. Interpretation of Results

In interpreting our results, we focus primarily on the common traits across countries, where there are some clear patterns in the sample.

First, and especially striking, for every country in the sample, at every horizon and for every size change in the interest rate, the interest rate effects are always significant with an increase in the overnight interest rate leads to an increase in the interest rate at all horizons, which in turn strengthens the exchange rate. (Note that this is *not* an arithmetic shifting of the whole term structure, since the columns represent the *j*-month interest rate from at *t*+*k* to *t*+*k*+*j*.) This is consistent with increases in the overnight interest rate signaling an unobserved characteristic, such as commitment to defend the exchange rate.

Second, this strengthening of the currency via the interest rate component generally does *not* however correspond to a higher one-month-ahead exchange rate forecast $S_{t+1,t}$, as seen in the southeast corner of the lower block in each table (the entries under "1 month" for expected exchange rates). The effect of raising the overnight interest rate on $S_{t+1,t}$ is usually insignificantly different from zero (Denmark, France, Italy, Norway, and Sweden). In two cases raising overnight rates actually leads to an expected depreciation one month out (Belgium and Ireland). In only one of the eight countries, Spain, does raising the overnight rate lead to an expected strengthening one month out. Even in this case, the expected appreciation is far less than what the interest rate effect alone would predict.

The reason that high interest rates do not lead to an expected appreciation in our sample countries is that the interest rate effect is generally offset by a risk effect (at horizons greater than one month) of the opposite sign. This phenomenon is observed in six of the eight countries – Denmark, Ireland, Italy, Norway, Spain, and Sweden. (In the first three cases, an expected depreciation at horizons of twelve months or greater contributes to the offsetting effect.) It is striking that the interest rate components *di* and the 'risk' components *P* almost always have significant movements of the same size, but in opposite directions. Interest rate defense therefore does increase interest rate expectations and *ceteris paribus* appreciates $S_{t+1,t}$, but this is offset by an adverse increase in risk premia in most countries.

The two exceptions to this pattern are Belgium and France, where increases in the overnight interest rate do *not* lead to a significant increase in the 'risk' term. One possible explanation is that these countries were argued to be "core" countries in the ERM, and therefore may have been believed to have had a greater ability to borrow reserves.[9] This would be consistent with the model in the sense that increases in the policy interest would be less likely to be taken as a sign of low reserves. In both cases, the positive interest rate effect was offset by a higher expected depreciation at horizons of twelve months or greater as a result of the increases in the overnight rate, as was also found in Denmark, Ireland, and Italy.

Both the interest rate and the risk terms are usually stronger in the longer term, thus revealing important long-term effects for the usually short-term interest rate policy. The joint occurrence of these two effect leads to a much smaller, more ambiguous effect on the exchange rate expectations (the *S* rows) across the horizon. The "average" effect on exchange rate expectations seems to be a small appreciation (a decrease) in the short term, coupled with a deterioration in the long-term components, yielding a slightly positive and often insignificant overall effect, usually on the order of less than 0.05%. In other words, it appears that interest rate expectations dominate in the short run, while 'risk' dominates the long run, and the two cancel out much of each other along the way.

Finally, regarding non-linearities, it is often the case that – for any of the components *S*, *di* or *P,* the larger interest rate increases have different effects than the smaller ones. The direction of that non-linearity, however, varies considerably across countries in the sample.

Taken as a whole, this pattern suggests that certainly more is going on than the mere "arithmetic", opportunity cost-based effects of interest rate defense. We argue that these results are consistent with a signaling argument. Short-term interest rate policy has strong effects on the interest rate expectations embedded in long-term interest rates, with the sign of these effects suggesting that an increase in overnight interest rates is taken as a signal to defend the exchange rate over a longer horizon. Moreover, these effects are often non-linear in nature. These findings point towards information effects triggered by interest rate policy. Note here that the signaling hypothesis would support both concavities (larger increases have smaller relative effects) and convexities. Concavities could arise when the mere "activation" of interest rate policy, even only a mild increase, signals the general preparedness of the government to use monetary policy in defense of the exchange rate. Convex relationships, by contrast, could arise

[9] We are indebted to Richard Portes for pointing this out.

when only unusually or unexpectedly high, “extreme” interest rates signal news about the policy. The evidence gives more support to the former, whereby the (informational) effect of interest rate increases is largely captured by small changes.

An alternative argument for non-linear effects is that suggested by Lahiri and Végh (2001). They stress the interaction between the direct effect of higher interest rates on demand for domestic currency – higher interest rates worsen the fiscal position and induce the expectation of greater future monetization. The first effect strengthens the domestic currency, while the second weakens it. In their set-up, they find that the first effect dominates for small increases in the interest rate, while the second dominates for large increases. The effects differ over the horizon, with the first effect being stronger in the short-term, the second in the long-term.

It is also interesting to note that risk premia react as well, and almost as strongly, to interest rate policy. This could be associated with the Sachs-Stiglitz argument, grounded in the adverse effects of high interest rates on the domestic banking sector, and increasing default risk premia accordingly. However, it might also be associated with a “negative” signaling story along the lines of high policy interest rates signaling low reserves (or the lack of alternatives to an interest rate defense). In that case, the peg may appear weaker than previously thought, which would increase currency risk premia.

4. Conclusions

In this paper we have considered both why high interest may be effective in deterring speculation against a currency and how one may empirically test the effectiveness of the interest rate defense. We have summarized one explanation for the effectiveness of high interest rates in deterring speculation, namely that high interest rates serve as a signal of the government’s willingness or ability to defend the exchange rate. We also presented several types of econometric evidence consistent with the signaling approach.

Our key empirical findings are as follows. First, the effects of changes in overnight interest rates are clearly non-linear, often significantly so, and these effects may be either concave or convex. This is in contrast to the simple “arithmetic” argument for the effect of raising interest rates, but consistent with the signaling explanation (as well as some other explanations). Second, there is little or no clear statistically significant effect of raising interest rates on next month's expected exchange rate $S_{t+1,t}$. (Belgium and Ireland show some evidence of an adverse effect.) However, this masks significant effects on different components of $S_{t+1,t}$ and at different horizons. Certain regularities are observed across countries. There are effects at longer horizons, in contrast to what the simple arithmetic argument would imply. More specifically, there is some evidence of a positive (*i.e.*, appreciating the exchange rate) short-term effect, coupled with a negative longer-term effect, at horizons of 12 months or longer. In terms of the three determinants of next month's expected exchange rate $S_{t+1,t}$ listed in table 1 (interest rates and risk premia at horizons up to twelve months, and the twelve-month-ahead exchange rate forecast), an increase in overnight interest rates often induces an increase in the *n*-month ahead rate relative to the *k*-month ahead rate ($n > k$), thus implying an appreciation of $S_{t+1,t}$, but also an increase in risk premia and $S_{t+12,t}$, the twelve-month-ahead exchange rate forecast, implying a depreciation.

We argued that these results are consistent with the signaling hypothesis. First, the existence of longer term, non-linear effects in themselves suggest that something more than the arithmetic effect is at work. The sign of short-term interest rate policy on interest rate expectations suggests that interest rate increases are taken as a sign of commitment to defend. The deterioration over longer horizons may indicate that weak fundamental are being signaled. As indicated, some of the results are also supportive of other models. Perhaps the most important conclusion that tests looking at the effect of high interest rates on "summary measures" like the outcome of an attack are inconclusive due to offsetting effects, which become clear when one disaggregates the effects of raising interest rates across different time horizons and across different determinants of short-term expected exchange rates.

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TABLE 2

Term Structure Regressions BELGIUM

Estimated Coefficients

Dependent Variable	Horizon: 2-3 months a	2-3 months b	4-5 months a	4-5 months b	6-11 months a	6-11 months b	12+ months a	12+ months b	Nonlinearity Null: all b=0
$S^{j,k}$	-0.086	0.073	-0.779 ***	0.2339 ***	-0.3184 **	0.0401	1.266 ***	-0.2664 ***	S: ***
$di^{j,k}$	-0.1478 ***	0.0196 ***	-0.2165 ***	0.0476 ***	-0.2817 ***	0.0555 ***			di: *** all: ***
$P^{k,j}$	0.0618	0.0534	-0.5626 ***	0.1863 ***	-0.0367	-0.0155			P: **
Equality across di, P	a: - a, b: *	b: -	a: - a, b: *	b: **	a: - a, b: -	b: -			Overall di, P Equality: *

Economic Impact on Exchange Rate Expectations

(increase in dependent variable implied by increase in policy interest rate, divided by size of increase)

Dependent Variable	**Mean Interest Rate**	**Changed Interest Rate**	Horizon: 2-3 months	4-5 months	6-11 months	12+ months	**1 month**
$di^{j,k}$	0.752	0.852	-0.987 ***	-0.0973 ***	-0.1426 ***		-0.3386 ***
		2.500	-0.0841 ***	-0.0616 **	-0.1011 ***		-0.2468 ***
		4.429	-0.0499 ***	0.0216	-0.0040		-0.0322
$P^{k,j}$	0.752	0.852	0.1955	-0.0961	-0.0754		0.0240
		2.500	0.2355	0.0433	-0.0870		0.1918
		4.429	0.3289	0.3690	-0.1141		0.5838
$S^{j,k}$	0.752	0.852	0.0968	-0.1934	-0.2181 *	0.5991 ***	0.2844 **
		2.500	0.1514	-0.0183	-0.1881	0.3998 **	0.3447 *
		4.429	0.2790	0.3906	-0.1181	-0.0660	0.4856

> Monthly data, sample period: 89:1-94:12

> Dependent variables are expressed as 100xln(.) and main regressor (overnight money market rate differential) is expressed in percentage points, so results can be interpreted in terms of percentage devaluations in response to percentage point changes in policy variable.

> Regressions also include current exchange rate as well as a constant term (not reported; see equations (7a)-(7g) and (8a)-(8d) in text).

> *, ** and *** stand for significance at the 10%, 5% and 1% level, respectively (based on heteroskedasticity-consistent standard errors).

TABLE 3

Term Structure Regressions DENMARK

Estimated Coefficients

Dependent Variable	Horizon: 2-3 months a		2-3 months b		4-5 months a		4-5 months b		6-11 months a		6-11 months b		12+ months a		12+ months b			Nonlinearity Null: all b=0
$S^{j,k}$	-0.1625	***	0.0125	***	-0.2531	***	0.0204	***	-0.1311	**	0.0118	***	0.5854	***	-0.0474	***		***
$di^{j,k}$	-0.1212	***	0.0037	*	-0.1535	***	0.0087	***	-0.2308	***	0.0116	**					di:	***
																	all:	***
$P^{k,j}$	-0.0413		0.0088	*	-0.0996	**	0.0116	***	0.0996		0.0003						P:	***
Equality across di, P	a: -		b: -		a: -		b: -		a: ***		b: -						Overall di, P Equality:	***
	a, b: ***				a, b: ***				a, b: ***									

Economic Impact on Exchange Rate Expectations

(increase in dependent variable implied by increase in policy interest rate, divided by size of increase)

Dependent Variable	Mean Interest Rate	Changed Interest Rate	Horizon: 2-3 months	4-5 months	6-11 months	12+ months	1 month
$di^{j,k}$	2.209	3.209	-0.1011 ***	-0.1061 ***	-0.1681 ***		-0.3754 ***
		7.833	-0.0840 ***	-0.0657 ***	-0.1146 ***		-0.2644 ***
		13.457	-0.0632 ***	-0.0166	-0.0496		-0.1293 *
$P^{k,j}$	2.209	3.209	0.0064	-0.0366	0.1012 **		0.0709
		7.833	0.0470 ***	0.0171	0.1025 ***		0.1666 ***
		13.457	0.0965 ***	0.0824 ***	0.1041 ***		0.2829 ***
$S^{j,k}$	2.209	3.209	-0.0948 ***	-0.1428 ***	-0.0669 *	0.3283 ***	0.0239
		7.833	-0.0370 **	-0.0487 ***	-0.0121	0.1090 ***	0.0112
		13.457	0.0333 *	0.0658 ***	0.0545 **	-0.1578 ***	-0.0042

> Monthly data, sample period: 89:1-94:12

> Dependent variables are expressed as 100xln(.) and main regressor (overnight money market rate differential) is expressed in percentage points, so results can be interpreted in terms of percentage devaluations in response to percentage point changes in policy variable.

> Regressions also include current exchange rate as well as a constant term (not reported; see equations (7a)-(7g) and (8a)-(8d) in text).

> *, ** and *** stand for significance at the 10%, 5% and 1% level, respectively (based on heteroskedasticity-consistent standard errors).

TABLE 4

Term Structure Regressions FRANCE

Estimated Coefficients

Dependent Variable	Horizon: 2-3 months a	2-3 months b	4-5 months a	4-5 months b	6-11 months a	6-11 months b	12+ months a	12+ months b	Nonlinearity Null: all b=0
$S^{j,k}$	-0.5980 **	0.1137	-0.9830 ***	0.2075 ***	-0.4411 **	0.0407	2.048 ***	-0.3581 **	**
$di^{j,k}$	-0.1917 ***	0.0191	-0.2446 ***	0.0275 *	-0.5421 ***	0.0833 ***			di: *** all: ***
$P^{k,j}$	-0.4063 *	0.0946	-0.7384 ***	0.1799 ***	0.1010	-0.0427			P: ***
Equality across di, P	a: - a, b: -	b: -	a: ** a, b: ***	b: ***	a: *** a, b: ***	b: *			Overall di, P Equality: ***

Economic Impact on Exchange Rate Expectations

(increase in dependent variable implied by increase in policy interest rate, divided by size of increase)

Dependent Variable	Mean Interest Rate	Changed Interest Rate	Horizon: 2-3 months	4-5 months	6-11 months	12+ months	1 month
$di^{j,k}$	1.211	2.211	-0.1262 ***	-0.1504 ***	-0.2569 ***		-0.5335 ***
		2.411	-0.1224 ***	-0.1448 ***	-0.2403 ***		-0.5075 ***
		3.611	-0.0995 ***	-0.1118 ***	-0.1403 ***		-0.3516 ***
$P^{k,j}$	1.211	2.211	-0.0826	-0.1227 **	-0.0451		-0.2503 *
		2.411	-0.0637	-0.0867	-0.0536		-0.2040
		3.611	0.0498	0.1292	-0.1048		0.0742
$S^{j,k}$	1.211	2.211	-0.2088 ***	-0.2730 ***	-0.3020 ***	0.8225 ***	0.0386
		2.411	-0.1861 **	-0.2316 ***	-0.2939 ***	0.7509 ***	0.0394
		3.611	-0.0496	0.0174	-0.2451 *	0.3213	0.0439

> Monthly data, sample period: 89:1-94:12

> Dependent variables are expressed as 100xln(.) and main regressor (overnight money market rate differential) is expressed in percentage points, so results can be interpreted in terms of percentage devaluations in response to percentage point changes in policy variable.

> Regressions also include current exchange rate as well as a constant term (not reported; see equations (7a)-(7g) and (8a)-(8d) in text).

> *, ** and *** stand for significance at the 10%, 5% and 1% level, respectively (based on heteroskedasticity-consistent standard errors).

TABLE 5
Term Structure Regressions IRELAND

Estimated Coefficients

Dependent Variable	**Horizon** 2-3 months a	2-3 months b	4-5 months a	4-5 months b	6-11 months a	6-11 months b	12+ months a	12+ months b	Nonlinearity Null: all b=0
$S^{j,k}$	-0.0902	-0.0054	0.0230	-0.0029	-0.0727	0.0055	0.3346	0.0029	-
$di^{j,k}$	-0.1897 ***	0.0113 ***	-0.1450 ***	0.0042 ***	-0.5150 ***	0.0226 ***			di: ***
									all: ***
$P^{k,j}$	0.0994	-0.0166	0.1680 **	-0.0071 **	0.4423 **	-0.0171 -			P: **
Equality across di, P	a: **	b: *	a: ***	b: ***	a: ***	b: **			Overall di, P Equality: ***
	a, b: -		a, b: ***		a, b: ***				

Economic Impact on Exchange Rate Expectations

(increase in dependent variable implied by increase in policy interest rate, divided by size of increase)

Dependent Variable	**Mean Interest Rate**	**Changed Interest Rate**	**Horizon** 2-3 months	4-5 months	6-11 months	12+ months	**1 month**
$di^{j,k}$	1.741	2.741	-0.1391 ***	-0.1263 ***	-0.4135 ***		-0.6790 ***
		10.111	-0.0560 ***	-0.0956 ***	-0.2466 ***		-0.3982 ***
		18.481	0.0384	-0.0607 ***	-0.0571 ***		-0.0794
$P^{k,j}$	1.741	2.741	0.0249	0.1364 ***	0.3656 **		0.5269 ***
		10.111	-0.0978	0.0844 ***	0.2395 ***		0.2261 **
		18.481	-0.2371	0.0254 ***	0.0962 ***		-0.1154
$S^{j,k}$	1.741	2.741	-0.1143 *	0.0101	-0.0479	0.3478 **	0.1957
		10.111	-0.1538 ***	-0.0112	-0.0072	0.3695 ***	0.1974 **
		18.481	-0.1986 *	-0.0353 **	0.0391 **	0.3942 ***	0.1994 **

> Monthly data, sample period: 91:6-94:12
> Dependent variables are expressed as 100xln(.) and main regressor (overnight money market rate differential) is expressed in percentage points, so results can be interpreted in terms of percentage devaluations in response to percentage point changes in policy variable.
> Regressions also include current exchange rate as well as a constant term (not reported; see equations (7a)-(7g) and (8a)-(8d) in text).
> *, ** and *** stand for significance at the 10%, 5% and 1% level, respectively (based on heteroskedasticity-consistent standard errors).

TABLE 6

Term Structure Regressions ITALY

Estimated Coefficients

Dependent Variable	Horizon 2-3 months a	b	4-5 months a	b	6-11 months a	b	12+ months a	b		Nonlinearity Null: all b=0
$S^{j,k}$	0.1669	-0.0407	-0.3037	0.0318	-1.523 **	0.1639 **	1.921 *	-0.1853		-
$di^{j,k}$	0.0040	-0.0151 ***	0.2190 *	-0.0462 ***	0.5436 **	-0.0954 ***			di:	***
									all:	***
$P^{k,j}$	0.1629	-0.0256	-0.5227 ***	0.0779 ***	-2.066 ***	0.2593 ***			P:	***
Equality across di, P	a: -	b: -	a: ***	b: ***	a: ***	b: ***			Overall di, P Equality:	***
	a, b: -		a, b: ***		a, b: ***					

Economic Impact on Exchange Rate Expectations

(increase in dependent variable implied by increase in policy interest rate, divided by size of increase)

Dependent Variable	Mean Interest Rate	Changed Interest Rate	Horizon 2-3 months	4-5 months	6-11 months	12+ months	1 month
$di^{j,k}$	3.365	4.365	-0.1126 ***	-0.1380 ***	-0.1942 ***		-0.4448 ***
		4.973	-0.1218 ***	-0.1661 ***	-0.2522 ***		-0.5401 ***
		6.581	-0.1461 ***	-0.2404 ***	-0.4057 ***		-0.7921 ***
$P^{k,j}$	3.365	4.365	-0.0347	0.0798 *	-0.0616		-0.0165
		4.973	-0.0502	0.1272 ***	0.0961		0.1730
		6.581	-0.0913	0.2525 ***	0.5131 ***		0.6741 ***
$S^{j,k}$	3.365	4.365	-0.1473 **	-0.0582	-0.2558	0.4880 **	0.0267
		4.973	-0.1720 **	-0.0389	-0.1562	0.3754 *	0.0083
		6.581	-0.2374 **	0.0122	0.1074	0.0773	-0.0405

> Monthly data, sample period: 90:5-92:8

> Dependent variables are expressed as 100xln(.) and main regressor (overnight money market rate differential) is expressed in percentage points, so results can be interpreted in terms of percentage devaluations in response to percentage point changes in policy variable.

> Regressions also include current exchange rate as well as a constant term (not reported; see equations (7a)-(7g) and (8a)-(8d) in text).

> *, ** and *** stand for significance at the 10%, 5% and 1% level, respectively (based on heteroskedasticity-consistent standard errors).

TABLE 7

Term Structure Regressions NORWAY

Estimated Coefficients

Dependent Variable	Horizon 2-3 months a	2-3 months b	4-5 months a	4-5 months b	6-11 months a	6-11 months b	12+ months a	12+ months b		Nonlinearity Null: all b=0
$S^{j,k}$	-0.0786	0.0388	0.2742	0.0692	0.5372 **	0.1382 ***	-1.230 ***	-0.3366 ***		***
$di^{j,k}$	-0.1927 ***	-0.0120 **	-0.3143 ***	-0.0295 **	-0.7314 ***	-0.0910 **			di: all:	*** ***
$P^{k,j}$	0.1141	0.0509	0.5885	0.0987	1.269 ***	0.2291 ***			P:	***
Equality across di, P	a: - a, b: -	b: -	a: ** a, b: -	b: *	a: *** a, b: **	b: ***			Overall di, P Equality:	***

Economic Impact on Exchange Rate Expectations

(increase in dependent variable implied by increase in policy interest rate, divided by size of increase)

Dependent Variable	Mean Interest Rate	Changed Interest Rate	Horizon 2-3 months	4-5 months	6-11 months	12+ months	1 month
$di^{j,k}$	-1.934	-0.934	-0.1582 ***	-0.2298 ***	-0.4706 ***		-0.8585 ***
		-0.370	-0.1650 ***	-0.2464 ***	-0.5218 ***		-0.9332 ***
		-1.193	-0.1838 ***	-0.2925 ***	-0.6641 ***		-1.140 ***
$P^{k,j}$	-1.934	-0.934	-0.0319	0.3055	0.6114 ***		0.8851 **
		-0.370	-0.0032	0.3612	0.7406 ***		1.099 **
		-1.193	0.0764	0.5154	1.099 ***		1.691 ***
$S^{j,k}$	-1.934	-0.934	-0.1900	0.0758	0.1409	-0.2643	-0.2377
		-0.370	-0.1681	0.1148	0.2188	-0.4541	-0.2886
		-1.193	-0.1074	0.2230	0.4349 **	-0.9805 **	-0.4300 *

> Monthly data, sample period: 89:1-92:10

> Dependent variables are expressed as 100xln(.) and main regressor (overnight money market rate differential) is expressed in percentage points, so results can be interpreted in terms of percentage devaluations in response to percentage point changes in policy variable.

> Regressions also include current exchange rate as well as a constant term (not reported; see equations (7a)-(7g) and (8a)-(8d) in text).

> *, ** and *** stand for significance at the 10%, 5% and 1% level, respectively (based on heteroskedasticity-consistent standard errors).

TABLE 8

Term Structure Regressions SPAIN

Estimated Coefficients

Dependent Variable	**Horizon** 2-3 months a	2-3 months b	4-5 months a	4-5 months b	6-11 months a	6-11 months b	12+ months a	12+ months b		Nonlinearity Null: all b=0
$S^{j,k}$	-0.4656	0.0375	-1.111 ***	0.1108 ***	-0.0971	0.0082	1.960 ***	-0.1873 ***		***
$di^{j,k}$	-0.0542	-0.0081	0.0134	-0.0204 ***	-0.1940	-0.0185			di:	***
									all:	***
$P^{k,j}$	-0.4114	0.0456	-1.125 ***	0.1312 ***	0.0969	0.0266			P:	***
Equality across di, P	a: -	b: -	a: ***	b: ***	a: -	b: -	Overall di, P Equality:			***
	a, b: ***		a, b: ***		a, b: ***					

Economic Impact on Exchange Rate Expectations

(increase in dependent variable implied by increase in policy interest rate, divided by size of increase)

Dependent Variable	**Mean Interest Rate**	**Changed Interest Rate**	**Horizon** 2-3 months	4-5 months	6-11 months	12+ months	**1 month**
$di^{j,k}$	4.954	5.954	-0.1422 ***	-0.2088 ***	-0.3957 ***		-0.7467 ***
		6.781	-0.1489 ***	-0.2256 ***	-0.4110 ***		-0.7855 ***
		8.608	-0.1636 ***	-0.2628 ***	-0.4447 ***		-0.8712 ***
$P^{k,j}$	4.954	5.954	0.0860	0.3061 ***	0.3875 ***		0.7797 ***
		6.781	0.1237 **	0.4145 ***	0.4096 ***		0.9478 ***
		8.608	0.2070 *	0.6541 ***	0.4582 ***		1.319 ***
$S^{j,k}$	4.954	5.954	-0.0562	0.0973	-0.0082	-0.0831	-0.0501
		6.781	-0.0252	0.1889 **	-0.0014	-0.2379 *	-0.0756 *
		8.608	0.0434	0.3913 ***	0.0135	-0.5800 **	-0.1319 **

> Monthly data, sample period: 89:1-94:12

> Dependent variables are expressed as 100xln(.) and main regressor (overnight money market rate differential) is expressed in percentage points, so results can be interpreted in terms of percentage devaluations in response to percentage point changes in policy variable.

> Regressions also include current exchange rate as well as a constant term (not reported; see equations (7a)-(7g) and (8a)-(8d) in text).

> *, ** and *** stand for significance at the 10%, 5% and 1% level, respectively (based on heteroskedasticity-consistent standard errors).

TABLE 9

Term Structure Regressions SWEDEN

Estimated Coefficients

Dependent Variable	Horizon: 2-3 months a		2-3 months b		4-5 months a		4-5 months b		6-11 months a		6-11 months b		12+ months a		12+ months b			Nonlinearity Null: all b=0
$S^{j,k}$	-0.1247	*	0.0050	**	-0.0438		0.0011		-0.1276		0.0054	*	0.2699	*	-0.0095	**		*
$di^{j,k}$	-0.1421	***	0.0046	***	-0.1843	***	0.0048	***	-0.4119	***	0.0120	***					di:	***
																	all:	***
$P^{k,j}$	0.0174		0.0004		0.1405	***	-0.0037	***	0.2843	***	-0.0066	***					P:	***
Equality across di, P	a:	**	b:	**	a:	***	b:	***	a:	***	b:	***					Overall di, P Equality:	***
	a, b:	***			a, b:	***			a, b:	***								

Economic Impact on Exchange Rate Expectations

(increase in dependent variable implied by increase in policy interest rate, divided by size of increase)

Dependent Variable	Mean Interest Rate	Changed Interest Rate	Horizon: 2-3 months	4-5 months	6-11 months	12+ months	1 month
$di^{j,k}$	4.600	5.600	-0.0952 ***	-0.1358 ***	-0.2898 ***		-0.5208 ***
		17.207	-0.0419 ***	-0.0806 ***	-0.1509 ***		-0.2734 ***
		29.813	0.0161 ***	-0.0207 ***	0.0002		-0.0046
$P^{k,j}$	4.600	5.600	0.0219	0.1027 ***	0.2171 ***		0.3417 ***
		17.207	0.0270	0.0598 ***	0.1406 ***		0.2273 ***
		29.813	0.0326 ***	0.0131 ***	0.0575 ***		0.1031 ***
$S^{j,k}$	4.600	5.600	-0.0733	-0.0331	-0.0727	0.1728	-0.0064
		17.207	-0.0148	-0.0209 *	-0.0103	0.0622	0.0162
		29.813	0.0487 ***	-0.0076 *	0.0575 ***	-0.0579 ***	0.0406 ***

> Monthly data, sample period: 89:4-92:10

> Dependent variables are expressed as 100xln(.) and main regressor (overnight money market rate differential) is expressed in percentage points, so results can be interpreted in terms of percentage devaluations in response to percentage point changes in policy variable.

> Regressions also include current exchange rate as well as a constant term (not reported; see equations (7a)-(7g) and (8a)-(8d) in text).

> *, ** and *** stand for significance at the 10%, 5% and 1% level, respectively (based on heteroskedasticity-consistent standard errors).