Scandinavian forward discount bias risk premia

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Abstract

In this article, we investigate expectations concerning Scandinavian exchange rates with the aid of a survey dataset containing market participants’ forecasts of the exchange rates. Our findings indicate that formal tests of forward discount bias do not always result in statistically significant rejections. This contrasts with most of the results reported in the literature, which typically demonstrate sound rejections of unbiasedness. Our tests of rational expectations demonstrate significant irrationality in many, but not all, cases. Alternative explanations of the rejections focus on peso problems and learning about policy changes. Tests of perfect substitutability indicate the significant presence of time-varying risk premia for all pairs of currencies studied, and almost all horizons. © 2001 Elsevier Science B.V. All rights reserved.

Keywords: Exchange rates; Expectations; Risk premia; Survey data

JEL classification: F31

1. Introduction

The debate regarding the empirical finding that the forward discount is a biased predictor of the future change in the exchange rate continues to be an issue of central concern in the international financial economics literature – see the surveys on the efficiency of the forward foreign exchange markets by Hodrick (1987) and Engel (1996), for instance. The early empirical evidence suggests that future exchange rate changes and current interest differentials (i.e. the forward discount) are negatively correlated. That is, relatively high domestic nominal interest rates predict appreciation of the domestic currency. The rejection of forward market efficiency may be attributable to the irrationality of market participants, to the existence of time-varying risk premia, ‘peso problems’,

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learning about a policy change or to some combination of these phenomena. See, e.g. Frankel and Froot (1987a); Froot and Frankel (1989); Cavaglia et al. (1993a,b, 1994) and Lewis (1995).

In the current article we aim to provide statistical evidence on the nature of the forward discount bias for Scandinavian forward exchange markets, using survey expectations of the Norwegian krona/US dollar, the Swedish krona/US dollar and the Swedish krona/German mark exchange rates. By gathering independent measures of expectations it is possible to decompose the forward discount bias into separate components attributable to risk premia and to expectational errors. The study complements previous work that has largely focused on analyzing survey data for the five most actively traded currencies vis-a-vis the US dollar, and on EMS currencies.

This article, presented in four sections, extends the findings of Frankel and Froot (1987a,b); Froot and Frankel (1989) and Cavaglia et al. (1993a,b, 1994, 1998) by considering a new survey dataset that covers the Scandinavian exchange rates over the January 1986–May 1992 period. After this period the survey, unfortunately, was discontinued. In Section 1, the construction of the exchange rate survey is outlined. In Sections 2 and 3 we address the principal question of whether rejection of forward market efficiency is attributable to the existence of time-varying risk premia or irrational behavior on the part of economic agents. Finally, in Section 4, the empirical results of this investigation on Scandinavian exchange rate expectations are summarized and discussed.

2. The survey data

Since 1985, Business International Corporation has conducted a monthly survey of exchange rate expectations covering, among others, the Norwegian and Swedish kronas relative to the US dollar and the Swedish krona relative to the German mark, which are published in its *Cross Rate Bulletin*. For publication purposes, survey participants were asked a few days prior to month’s end to fax 3-, 6-, and 12-month-ahead expectations of the currency, with projections being made from the beginning of the following month. Thus, for instance, the 3-, 6-, and 12-month-ahead expected Norwegian Krona/US dollar rate recorded on December 27, 1989 represent the expected spot rate on April 1st, 1990, June 1st, 1990, and January 2nd, 1991, respectively\(^1\). The dates when the surveys were conducted were recorded as well as the spot rate on that particular day.

The thirty-odd participants of the survey are treasurers of multinationals and private banks residing in four of the world’s continents. Although not all participants will provide their views regarding a particular currency, the response rate is at worst 60%. The Cross Rates Bulletin reports the geometric mean forecast of the response received, thus minimizing the effect of extreme forecasts.

The use of survey data allows the direct measurement of a risk premium: conditional on market efficiency and rational expectations, the forward exchange rate is equal to the expected future spot rate plus a risk premium. Thus, the forward discount can be decomposed into two components – the expected rate of depreciation and the risk premium:

\[
F_{t+k} - S_t = (E_tS_{t+k} - S_t) + P_t
\]

\(^1\)Although the notation used in Sections 2 and 3 will be presented as if the survey was constructed on December 31st (in the example at hand), care has been exercised throughout the empirical analysis to ensure that conditional expectations are computed on the proper information set.
Here $S_t$ is defined as the natural logarithm of the spot exchange rate at time $t$, $E_t S_{t+k}$ is defined as the expected logarithm of the spot exchange rate at time $t+k$, formed at time $t$, $F_{t+k}$ is defined as the natural logarithm of the forward rate at time $t$ for delivery at time $t+k$ and $P_t$ is the associated risk premium. Because the survey expectations are direct estimates we do not need to assume any particular model of expected depreciation or of the risk premium. To give Eq. (1) economic content, a model of international asset pricing that describes the determination of $P_t$ is required.\(^2\)

3. Tests of forward discount bias

Forward market efficiency has generally been tested by regressing the observed change in the spot exchange rate on the forward discount. Thus, the null hypothesis of unbiasedness implies that it is possible to decompose $S_{t+k} - S_t$ as

$$S_{t+k} - S_t = \alpha + \beta (F_{t+k} - S_t) + e_{t+k}$$

where $\alpha = 0$, $\beta = 1$, and $e_{t+k}$ has mean zero and is uncorrelated with $F_{t+k} - S_t$. Eq. (2) was estimated by ordinary least squares (OLS) for each forecast horizon ($k = 3, 6$ and $12$ months). Realized spot exchange rates were obtained from Datastream\(^3\). Hansen and Hodrick (1980) demonstrated that, when the forecast horizon is longer than the observational frequency, the forecast error $e_{t+k}$ will be serially correlated. While OLS point estimates of $\beta$ remain consistent in spite of the serially correlated residuals, the OLS standard errors for the regression coefficient are biased. This can be corrected via the Newey and West (1987) estimation procedure. Therefore, the $k$-month-ahead forecast equations in this section are estimated with the Newey–West estimator, assuming a moving average process of order $k-1$ for the monthly $k$-month-ahead forecast errors\(^4\).

As is well known, the results of many previous studies suggest rejection of the null hypothesis across the spectrum of forward rates. Oftentimes the estimate of $\beta$ is reliably less than one. In fact, $\beta$ is frequently estimated to be less than zero, evidenced by an average coefficient of $-0.88$ across some 75 published estimates – see Froot and Thaler (1990).

Table 1 reports the results of fitting Eq. (2) for each forecast horizon via OLS, with Newey–West standard errors. Overall, the results indicate a less robust rejection of the null hypothesis that the forward discount of the Scandinavian exchange rates is an unbiased predictor of the future change in the corresponding spot exchange rates. Almost all $\beta$-estimates are less than one, but not statistically significantly so. Cavaglia et al. (1994) find positive $\beta$-coefficients for EMS currencies relative to the Deutschmark. In addition, Bossaerts and Hillion (1991) find positive estimates of $\beta$ for most currencies against the French franc, whereas Flood and Rose (1996) find higher $\beta$-coefficients for

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\(^2\)Equilibrium models of international asset pricing that provide us with such descriptions are presented, for instance, in Adler and Dumas (1983), Hodrick (1981), Hodrick and Srivastava (1984), Roll and Solnik (1977), and Stulz (1981).

\(^3\)The spot exchange rates at time $t+k$, $S_{t+k}$, used to compute the change in the spot rate are obtained from Datastream on days corresponding to the survey forecast dates. If the forecast date falls on a holiday or weekend, the next business day is chosen.

\(^4\)See Cavaglia et al. (1993a) for a more detailed description. Note that the $k$-month-ahead forecast is in reality a $k$-month plus a few days ahead forecast.
Table 1
Test of forward discount unbiasedness: $S_{t+k} - S_t = \alpha + \beta(F_{t+k} - S_t) + \epsilon_{t+k}$. From January 1, 1986, through May 1, 1992

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<tr>
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<th>3 months</th>
<th>6 months</th>
<th>12 months</th>
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<tbody>
<tr>
<td></td>
<td>$\beta$</td>
<td>$\chi^2$</td>
<td>$\beta$</td>
</tr>
<tr>
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<td>(0.2805)</td>
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<tr>
<td>SK/US</td>
<td>0.9829</td>
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<td>SK/DM</td>
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<td>2.28</td>
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<tr>
<td></td>
<td>(0.1069)</td>
<td>(0.318)</td>
<td>(0.2178)</td>
</tr>
</tbody>
</table>

Note: The standard errors of the coefficients are given in parentheses; *, **, *** denote rejection at the 10, 5, and 1% levels for the hypotheses that $\alpha = 0$, $\alpha_t = 0$, $\alpha_z = 0$, $\beta_1 = 0$, $\beta_t = 0$, and $\beta_z = 1$, respectively. The $\chi^2$ pertains to the joint hypothesis that $\alpha = 0$ and $\beta = 1$, $\alpha_t = 0$ and $\beta_t = 0$, and $\alpha_z = 0$ and $\beta_z = 1$, respectively (P values are given in parenthesis).

The $\chi^2$-statistics, that test the joint hypothesis $\alpha = 0$ and $\beta = 1$, are not always significantly different from zero, is in contrast to most of the results in the literature for other currencies.

Rejection of forward market efficiency has often been attributed to either the failure of rational expectations or the existence of time-varying risk premia. In this context Frankel and Froot (1987a), Froot and Frankel (1989), and Taylor (1989) demonstrated how survey expectations data can be exploited to ascertain the economic importance of these competing explanations. In Eq. (2) the probability limit of the estimate of the $\beta$-coefficient is

$$\beta = \frac{\text{cov}(F_{t+k} - S_t, S_{t+k} - S_t)}{\text{var}(F_{t+k} - S_t)}.$$  
(3)

Defining $u_{t+k}$ to be the $k$-month-ahead expectations forecast error, $S_{t+k} - E_tS_{t+k}$, and using the decomposition of the forward discount in Eq. (1), it follows that

$$\beta = \beta_1 + \beta_2$$  
(4)

where

$$\beta_1 = \frac{\text{cov}(F_{t+k} - S_t, S_{t+k} - E_tS_{t+k})}{\text{var}(F_{t+k} - S_t)}$$  
(5)

and

$$\beta_2 = 1 - \frac{\text{cov}(F_{t+k} - S_t, P^k)}{\text{var}(F_{t+k} - S_t)}.$$  
(6)

Under the hypothesis of rational expectations, $\beta_1$ will equal zero since the forecast error, $u_{t+k}$, will be orthogonal to any variable in the set of information known to agents at the time they formed their expectations within the EMS versus the Deutschmark than for economies versus the US dollar. The $\chi^2$-statistics, that test the joint hypothesis $\alpha = 0$ and $\beta = 1$, are not always significantly different from zero, is in contrast to most of the results in the literature for other currencies.

Bansal and Dahlquist (1999) present evidence from emerging and the lower-income countries that is consistent with economic intuition – a positive domestic interest rate differential predicts a depreciation of the domestic currency.
expectations. Under the hypothesis that the correlation of the risk premium with the forward discount is zero (no time-varying risk premium), $\beta_2$ will equal one. In the next section we consider formal tests along these lines. Also, we will consider alternative explanations that were suggested in the literature.

4. Decomposition of the bias: irrationality, exchange risk premia, peso problems, or other factors?

Survey data will be exploited in this section to decompose the forward discount bias into portions attributable to irrational behavior of economic agents or to the existence of time-varying risk premia. Here it is worth mentioning that the irrationality hypothesis is actually not the only explanation for a possible rejection of rationality of expectations. Other prominent explanations involve ‘peso problems’, on which see Krasker (1980), and learning about government policies, see Lewis (1995).

To test for the rationality of the survey exchange rate expectations, we consider a fairly standard test (see Peseran, 1987) – the orthogonality test. The orthogonality test aims to assess whether economic agents use information that is available to them efficiently to forecast future exchange rates. The null hypothesis of rational expectations (orthogonality) implies that $\alpha_1 = 0$ and $\beta_1 = 0$ in regressions of the following form:

$$ S_{t+k} - ES_{t+k} = \alpha_1 + \beta_1 (F_{t+k} - S_t) + \nu_{t+k}, \tag{8} $$

where the left-hand-side variable is the survey forecast error. Under the null hypothesis of rational expectations and under the assumption that any measurement error in the survey is orthogonal to the forward discount, the $\beta_1$-coefficient is precisely equal to $\beta_1$ in Eq. (6). Eq. (8) was fitted via OLS for each forecast horizon; standard errors are corrected to allow for a $k - 1$ order moving average as in the estimation of Eq. (2).

Table 2 reports regressions of the forecast error on the 3-, 6-, and 12-month-ahead forward discount. Interestingly, the null hypothesis of rational expectations is rejected in many cases, sometimes also when forward discount unbiasedness could not be rejected in Table 1.

In order to test whether the existence of time-varying risk premia is an important reason for rejection of forward market efficiency, we fitted the following equation:

$$ ES_{t+k} - S_t = \alpha_2 + \beta_2 (F_{t+k} - S_t) + z_t. \tag{9} $$

The null hypothesis of perfect substitutability implies that $\alpha_2 = 0$ and $\beta_2 = 1$. Under the hypothesis that the correlation of the risk premium with the forward discount is zero (no time-varying risk premium), $\beta_2$ will equal one. By inspection, the $\beta_2$ coefficient is precisely equal to $\beta_2$ in Eq. (7),

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1 In particular, Krasker (1980) demonstrated that in the presence of a small and positive probability of a devaluation, an efficient exchange rate market will imply that the expected value of the future spot rate will reflect the probability of that event. However, as long as the devaluation does not take place within the sample period examined, the expectation of the future spot rate will consistently overestimate the realized future spot rate.

2 When the expected depreciation is on the left-hand side of the regressions, forecast horizons longer than the observational frequency do not themselves imply that the error term is serially correlated, since expectations are formed using only contemporaneous and past information. Therefore, Eq. (9) was estimated using the standard OLS procedure.
Table 2
Test of rational expectations: $S_{t+k} - E S_{t+k} = \alpha_t + \beta_t (F_{t+k} - S_t) + \epsilon_{t+k}$, from January 1, 1986, through May 1, 1992

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<th>3 months</th>
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<th>6 months</th>
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<th>12 months</th>
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<td></td>
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<td>$\chi^2$</td>
<td>$\beta$</td>
<td>$\chi^2$</td>
<td>$\beta$</td>
<td>$\chi^2$</td>
</tr>
<tr>
<td>NK/US</td>
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<td>2.20</td>
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<td>2.39</td>
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<td>(0.2341)</td>
<td>(0.050)</td>
<td>(0.2907)</td>
<td>(0.332)</td>
<td>(0.4754)</td>
<td>(0.302)</td>
</tr>
</tbody>
</table>

Note: The standard errors of the coefficients are given in parentheses; *,**,***, denote rejection at the 10, 5, and 1% levels for the hypotheses that $\alpha = 0$, $\alpha_1 = 0$, $\alpha_2 = 0$, $\beta_1 = 0$, and $\beta_2 = 1$, respectively. The $\chi^2$ pertains to the joint hypothesis that $\alpha = 0$ and $\beta_1 = 1$, $\alpha = 0$ and $\beta_2 = 0$, and $\alpha = 0$ and $\beta_2 = 1$, respectively ($P$ values are given in parenthesis).

reflecting a deviation from forward discount unbiasedness due to the existence of time-varying risk premia. Similarly, the hypothesis of a zero mean risk premium can be tested by examining whether the $\alpha_2$ coefficient is significantly different from zero.

The results of fitting Eq. (9) for each forecast horizon are reported in Table 3. The results indicate quite strongly that there is a time-varying risk premium for almost all currencies and horizons. The existence of time-varying risk premia corroborates some of the results of Cavaglia et al. (1994) for bilateral exchange rates relative to the US dollar and relative to the German mark spanning the same time period. By contrast, Froot and Frankel (1989) found estimates of $\beta_2$ that were insignificantly different from one for survey-based tests using four of the major currencies relative to the US dollar.

Table 3
Test of perfect substitutability: $E S_{t+k} - S_t = \alpha_2 + \beta_2 (F_{t+k} - S_t) + \epsilon_{t+k}$, from January 1, 1986, through May 1, 1992

<table>
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<th>3 months</th>
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<th>6 months</th>
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<td>$\chi^2$</td>
<td>$\beta$</td>
<td>$\chi^2$</td>
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<td>(0.1485)</td>
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Note: The standard errors of the coefficients are given in parentheses; *,**,***, denote rejection at the 10, 5, and 1% levels for the hypotheses that $\alpha = 0$, $\alpha_1 = 0$, $\alpha_2 = 0$, $\beta_1 = 0$, and $\beta_2 = 1$, respectively. The $\chi^2$ pertains to the joint hypothesis that $\alpha = 0$ and $\beta_1 = 1$, $\alpha = 0$ and $\beta_2 = 0$, and $\alpha = 0$ and $\beta_2 = 1$, respectively ($P$ values are given in parenthesis).
5. Conclusions

In this article, we have investigated expectations concerning some Scandinavian exchange rates, with the aid of a survey dataset containing market participants’ forecasts of the exchange rates. Our findings indicate that formal tests of forward discount bias do not always result in statistically significant rejections. This contrasts with most of the results reported in the literature, which typically demonstrate sound rejections of unbiasedness. Our tests of rational expectations demonstrate significant irrationality in many, but not all, cases. Alternative explanations of the rejections focus on peso problems and learning about policy changes. Tests of perfect substitutability indicate the significant presence of time-varying risk premia for all pairs of currencies studied, and almost all horizons.

References