Empirical research on exchange rate expectations: macro and micro perspectives

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Abstract:

Throughout academic and professional circles concerned with finance or financial market research exchange rates are regarded as being mainly driven by expectations. In conjunction with the efficiency assumption of the foreign exchange market, this led engraving the asset approach accordingly. However, due to Meese and Rogoff's influential paper in 1983, in which they showed that existing efficient market models at that time fail empirically to explain exchange rates, the pillars of fundamental exchange rate research had been cut to the quick. Emerging research then turned on a broad scale its attention away from market efficiency towards market imperfections due to suboptimal behavior of investors, e.g. inattentiveness, biasedness or inefficiency. Altogether, these approaches each implement some particular kind of irrationality in order to design models more realistic, with which eventually the decoupling of exchange rates from related fundamentals should be explained.

The aim of this work is to shed some light on the imposed irrational elements of investors' behavior nowadays many exchange rate models are built upon. Hereunto we put particular emphasis on the examination of real world medium-term expectations of financial variables from different macroeconomic and microeconomic perspectives. By this means we can trace back existing imperfections due to investors' attitudes and behavior. Throughout this work, three key issues hover above the discussion: investor heterogeneity, biasedness and rationality. In sum, underlying research reveals following findings: fundamentals are relevant on the foreign exchange market; investors' forecasting bias depends partly on their particular style of analysis, investor sentiment as well as dispersion are time variant, but compatible with rational reasons and finally, the ability of exchange rate forecasting differs in accordance with the individual attributes of the investors.

We reveal different forms of investor heterogeneity as well as biases in exchange rate forecasting; however, these finding are compatible with rationality and so deliver further evidence for the efficiency of the foreign exchange market. In addition, medium-term exchange rate expectations appear to stabilize the market, since professional forecasters rely to a great extent on fundamentals.

Keywords: Exchange rates, expectations, heterogeneity, biasedness and rationality.

Kurzfassung:

Dass Wechselkurse vornehmlich von Erwartungen bestimmt werden, wird heute sowohl von akademischen Fachkreisen wie auch professionellen Finanzmarktakteuren fast einstimmig vertreten. Gleichwohl gerieten die Festen fundamentaler Wechselkursforschung bereits im Jahre 1983 durch eine Arbeit von Meese und Rogoff stark ins Wanken, welche aufdeckte, dass die zu jener Zeit existenten Effizienzmarktmodelle nicht vermögen Wechselkursbewegungen adäquat zu prognostizieren. Dieser Erkenntnis war es geschuldet, dass die Wissenschaft ihren Fokus teilweise neu ausrichtete, weg von Markteffizienz hin zu Marktimperfektionen verursacht durch suboptimales Investorenverhalten, z.B. unregelmäßige Informationsverarbeitung (‚inattentiveness'), verzerrte Analyseausrichtung (‚biasedness') oder ineffiziente Informationsnutzung (‚inefficiency'). Mittels der Implementierung verschiedener Formen von Irrationalität sollen die Modelle wirklichkeitsnäher konzipiert werden, um so die Entkoppelung von Wechselkursen und Fundamentals zu erklären.

Ziel dieser Arbeit ist die empirische Erforschung irrationaler Verhaltensweisen der Finanzmarktakteure, die heute vielfach in Wechselkursmodellen a priori zugrunde gelegt sind. Der Fokus liegt hierbei auf reale Finanzmarkterwartungen der mittleren Frist, welche aus verschiedenen makro- und mikroökonomischen Perspektiven untersucht werden, um so bestehenden Unvollkommenheiten seitens der Investoren auf den Grund zu gehen. Drei Schlüsselthemen durchziehen sich durch die Arbeit: Heterogenität, Verzerrtheit sowie Rationalität. Insgesamt offenbaren die zugrunde liegenden Forschungsarbeiten folgende Erkenntnisse: Fundamentales sind für den Devisenmarkt überaus bedeutend, Verzerrtheit der Wechselkursprognosen hängt partiell vom Analysestil ab, Marktstimmungen sowie Prognoseuneinigkeit erweisen sich zeitvariable, sind jedoch mit rationalen Gründen vereinbar und die Prognosefähigkeit der Investoren hängt von individuellen Analyseeigenschaften ab.

In dieser Arbeit werden verschiedene Formen von Heterogenität sowie Verzerrungen in realen Wechselkurserwartungen aufgedeckt. Diese Erkenntnisse sind jedoch mit rationalen Erklärungen vereinbar und liefern somit Hinweise zur Effizienz des Devisenmarktes. Ferner scheinen mittelfristige Wechselkurserwartungen stabilisierend auf den Markt zu wirken, da professionelle Marktteilnehmer en Gros auf fundamentale Erklärungsvariablen zurückgreifen.

Schlüsselwörter: Wechselkurse, Erwartungen, Heterogenität, Verzerrtheit and Rationalität.

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0 Foreword

Since the end of the 1970s exchange rates are regarded as being mainly driven by expectations. Since exchange rates are primarily determined by expectations, for instance stocks and bonds, this led to the asset approach on the foreign exchange market. Moreover, technical tools to analyze financial prices of asset markets have been adopted over the years on the foreign exchange market. The belief that exchange rates underlie a stable relationship with fundamentals, i.e. economic variables which determine exchange rates like inflation, growth and interest rates, led to efficient market models. However, the monetary model turned out most recognized; its basic argument states that the nominal exchange rate is determined by the conditions of respective money markets and thus is the relative price of one money in terms of another (see e.g. Frankel's later hybrid version, 1979). Next the Dornbusch model appeared which stresses the stickiness of the good markets (see Dornbusch, 1976). On account of this, PPP only holds in the long run while exchange rates overshoot in shorter horizons. Finally, the portfolio balance model emerged, which focuses the differences between domestic and foreign assets and corresponding relative supplies (see e.g. Dooley and Isard, 1982). So equilibrium is derived upon utility maximization by means of optimal portfolio diversification. Taken together efficient market models dominated at that time the way of thinking about exchange rate determination.

Then in 1983 Meese and Rogoff showed that all these models fail empirically to explain exchange rate movements. This finding shocked the foundations of fundamental exchange rate economics, because fundamental research on the foreign exchange market appeared henceforth useless. Nevertheless new hope arose with the analyses of macroeconomic news. Derived from the asset approach, only unexpected changes in the fundamentals could trigger exchange rate movements whereas all expected fundamental changes are anticipated and thus already incorporated into prices (see Frankel and Rose, 1995, p. 1699). It does not surprise that event studies appeared most promising at that point in time in order to reconfirm the relevance of fundamentals for exchange rate determination and hence related economic theories as well.

In the following Chapter 1 we present a review of event studies on the foreign exchange market. Event studies offer a particular methodology in order to measure news effects in financial market prices like stocks, bonds or exchange rates. In particular, news comprises the surprises in announcements of fundamentals, i.e. the differences between realizations of respective variables and prior expectations. Hence, based upon semi-strong market efficiency, fundamental announcements' influence on financial prices ought to be restricted to related news (see Fama, 1991). The essential findings from more than 30 years of event studies on the foreign exchange market sum up as follows: first, exchange rates respond on fundamental news, thus indicating the relevance of fundamentals for the exchange rate dynamics. Second, news-effects on exchange rates work through two separate channels. While the direct news-channel carries the public news into exchange rates instantaneously without any trade taking place, the indirect news-channel, which lasts for some time, absorbs private news-effects via order flow. Third, next to scheduled macroeconomic news a bulk of further news such as central bank interventions and technical market signals prove to be relevant for exchange rate movements as well. Fourth, whereas a few news sources show alternating influence on exchange rate movements over time (e.g. trade balance and inflation) the majority of relationships are stable over time. Nevertheless, fifth, exchange rate reactions on macroeconomic news underlie some asymmetric patterns, i.e. the timing of specific announcements as well as the discrimination between good and bad news matter.

What efficient market models as well as event studies have in common is that they are built on the assumption of rational expectations. However, this has been questioned already since some time and a bunch of papers have studied actual expectations taken from surveys.[1] It has become a stylized fact that exchange rate expectations are on average biased, i.e. the mean of the related forecast error is significantly unequal zero, and inefficient, i.e. respective forecasters do not use the entire public information set, which clearly contradicts to the assumption of rationality (see surveys by Takagi, 1991, and MacDonald, 2000). However, little is known about the possible sources of irrationality.

In Chapter 2 earlier studies on the formation of exchange rate expectations are extended by using a survey dataset of US-dollar expectations, which includes information about forecasters' reliance on fundamental analysis. The findings are the following: First, we show that related biases in exchange rate expectations are systematically related to belief in PPP. Second, when we group respondents on their reliance to fundamental analysis, we find that fundamentalists' biases of mean-reversion prove to be even stronger, whereas technical analysts tend to expect too much trend extrapolation. Third, the further the exchange rate moves from the (fair) PPP rate, the stronger the biases in expectations. Fourth, while the

[1] The use of survey expectations is widely spread in the economic literature (see Pesaran and Weale, 2006), amongst others Consensus Economics (London), Money Market Services (International) and the Financial Market Survey of the Centre for European Economic Research (Mannheim, Germany).

group-specific expectations prove to be inaccurate, they all show directional forecasting ability.

However, the empirical failure of market efficiency models to explain exchange rate movements, led to a bunch of empirical studies revealing several empirical puzzles concerning the behavior of exchange rates. The foremost empirical puzzle in international economics has been called the "exchange rate disconnect puzzle". According to Obstfeld and Rogoff (2001), the "exchange rate disconnect puzzle" includes the "exchange rate determination puzzle", i.e. more often than not, exchange rates prove to be disconnected from their underlying fundamentals (see in a renewed work Cheung, Chinn and Garcia Pascual, 2005).[2]

In spite of exchange rates' disconnection from economic variables, the foundations of efficient market models remained popular and with the availableness of more sophisticated techniques and newer considerable datasets, the validity of these exchange rate models has been reviewed. One strand of empirical literature uses long spans of data in order to increase the low power of accordant testing procedures (see e.g. Lothian and Taylor, 1996, and Rapach and Wohar, 2002). Second, a number of studies employ panel techniques from the post-Bretton Woods float, again in order to increase the power of respective tests (see e.g. Papell, 1997, and Taylor and Sarno, 1998). The third strand has emerged using nonlinear techniques to capture more complex relationships among the respective variables (see e.g. Kilian and Taylor, 2003, and Taylor, Peel and Sarno, 2001). Indeed, all these developments refreshed the exchange rate literature, but still some related puzzles remain. One such caveat deals with the joined observation that exchange rates are apparently connected to fundamentals in the long run, whereas professionals form consistently irrational exchange rate expectations (see also Chapter 2). In fact, professionals' exchange rate expectations have never been reconciled with accordant long-term movements towards exchange rate equilibriums. Instead, evidence shows that professionals' exchange rate expectations underlie considerable "expectational errors" (see Frankel and Froot, 1987, p.150).

We tackle this question in Chapter 3 from a different perspective, by analyzing the effective time horizon of investor sentiment in exchange rates and further, by distinguishing between its short- and long-run determinants. We reveal following findings in investor

[2] Other well known puzzles in the exchange rate literature include the lack of feedback from the exchange rate to the macro economy (see Engel, 1996), the excess volatility of the exchange rate in respect to fundamentals (see Baxter and Stockman, 1989) and the forward premium puzzle (see Fama, 1984).

sentiment in the US-dollar: sentiment is longer-term oriented than accordant predefined forecast horizons indicate. Second, sentiment is connected to well-known exchange rate fundamentals; third, the fundamental long-term relation between investor sentiment and exchange rate fundamentals becomes stronger, the larger the misalignment of the actual exchange rate from the long-run PPP rate.

However, in contrast to confirm the market efficiency models, a different strand of the literature developed new exchange rate models. In fact, three different modeling approaches have established. First, the Obstfeld-Rogoff framework, which is based upon dynamic utility optimization of a representative agent (see Obstfeld and Rogoff, 1996), second, the microstructure of the foreign exchange market (see Lyons, 2001), which led in particular to new insights of how information is aggregated into prices and third, the chartist-fundamentalist approach, initiated by Frankel and Froot (1987). The latter literature rejects the validity of the use of a representative agent and proposes heterogeneous agents, holding different beliefs about the dynamics of the exchange rates. There is now plentiful evidence that market participants have fairly heterogeneous beliefs in the sources of exchange rate determination and thus on future exchange rates (see e.g. Gourinchas and Tornell, 2004, Bacchetta and van Wincoop, 2006, and De Grauwe and Grimaldi, 2006). Further, it appears rather difficult to explain the huge trading volumes on the foreign exchange market, which turns out to be a multiple of the trade volume in goods and services. Even though investor heterogeneity is key to understanding exchange rate dynamics, empirical studies on expectation heterogeneity have mainly studied cross-sectional differences, i.e. differences between some certain individuals.

Tying up the findings of Chapter 2, where we already revealed differences between fundamentalists and chartists, in Chapter 4 we deepen the analyses of heterogeneity in the foreign exchange market by investigating dispersion in exchange rate expectations. We confirm the importance of the chartist-fundamentalist approach such that misalignments of the exchange rate as well as exchange rate momentum explain heterogeneity. Moreover, the risk premium influences heterogeneity as well, but neither macroeconomic variables nor exchange rate's volatility further influences heterogeneity.

Finally, regarding the stylized fact of inaccurate exchange rate expectations, Bacchetta and van Wincoop (2007) have recently reconfirmed the existence of expectation errors in consensus forecasts. However, this questions the rationality of market participants and so the efficiency of the foreign exchange market, since other professional market participants could take profit on these bad forecasts by opening market positions against them. Moreover, since tremendous funds of currencies are dealt on the foreign exchange market, the finding that professional market participants consistently form bad forecasts appears questionable.

Hence, in Chapter 5 we shed new light on this apparent puzzle by investigating individuals' trend forecasts of exchange rates. It should be stressed that trend forecasts seem to replicate real forecasts much better, because market participants in fact do not form point forecasts. Furthermore, we link individuals' forecasting performances to related personal information and their expertise in fundamental analyses. In sum, the following main findings result: fist, professionals' forecasting performances differ systematically. Second, knowledge of future interest rates trends influences individual's forecasting ability in exchange rates. In addition to that exchange rate forecasting performance depends on individual's experience (positively) and personnel job responsibilities (negatively).

Throughout this work three key issues determine the overall discussion: investors' heterogeneity, biasedness and rationality. Surveying news-effects in Chapter 1, we confirm the relevance of fundamentals for exchange rates. Moreover, the fact that order flow processes different expectations and opinions into market prices indicates the importance of heterogeneity. Actually, in Chapter 2 we reveal overall investor heterogeneity, which we can trace back to the presence of fundamentalists and technicians. Since investors hold too much on their specific beliefs, they underlie respective forecasting biases which points to irrationality. Further, analyzing in Chapter 3 the forecasting bias of investor sentiment over time, we confirm its connection to fundamentals. Bearing in mind that investors are aware of the difficulties of forecasting shorter-term exchange rates and the fact that longer-term exchange rates depend on fundamentals, it appears rational to fall back on fundamental concepts when analyzing exchange rates. Additionally, we uncover heterogeneity over time in Chapter 4 and link it to rational causes: the relevance of fundamental misalignments, higher market momentum and market uncertainty for investor heterogeneity can be traced back to the validity of fundamentals, technical analysis and a risk premium for exchange rates. In addition, we find in Chapter 5 cross-sectional heterogeneity by looking at investors' forecasting performance. The composition of forecasters' accuracy appears in accordance with market efficiency and the individual causes explaining respective performance differences (e.g. experience and competence in fundamentals) harmonize with rationality.

In sum, examining heterogeneity from the macroeconomic and the microeconomic perspective, we reveal different forecasting biases. However, linking them to comprehensible causes, we see them in accordance with rationality. Beyond, as investors rely on (long-term) fundamental concepts, exchange rate expectations appear to stabilize the market.

1 Review of event studies on the foreign exchange market

1.1 Introduction

"Changes in exchange rates will come to provoke no more comment than changes in the real price of an airline ticket!", these are the presidential words of Fischer Black (1985, p. 530) addressing the outlook on the future of the foreign exchange market in his paper "Noise" (published in the Journal of Finance). Certainly, Black's statement is very provoking since he implicitly relates exchange rate movements largely or even solely to occurring noise. Nonetheless, economic science is confronted with the mission to link these asset price changes to fundamental causes which would otherwise remain in public's perception "noise", even if exchange rates would be in fact connected with macroeconomic conditions. One appropriate technique to accomplish this task proves the application of event study approach.[3]

Surveying the literature of empirical exchange rate research Frankel and Rose (1995, p. 1699) state that the primarily reason for exchange rate movements is connected to unexpected news and so presume the relevance of fundamentals in the foreign exchange market. Event studies in turn provide a specific methodology to measure news effects in financial market prices like stocks, bonds and exchange rates. However, news comprises only the surprises in announcements of fundamentals, i.e. the differences between realizations of variables and respective prior expectations–the unexpected parts of variable changes.[4] Assuming the validity of semi-strong market efficiency, fundamental announcements' influences on financial prices ought to be restricted to respective news, which traces back to the following idea: surprises in announcements of macroeconomic variables influence investors' mindsets and in turn change expected future fundamental outcomes wherefore asset prices change instantaneously (see Fama, 1991, and Frankel and Rose, 1995).[5]

The event study approach can look back on a long history. MacKinlay (1997) constitutes its origin to the thirties of the last century, when Dolley (1933) published an

[3] Ironically, if Black's statement (1985) does not hold he in turn "blame(s) it on noise" (p. 530).

[4] Fundamentals are macroeconomic variables, which are seen relevant for the specific variable of interest.

[5] Though fully anticipated announcements should not lead to asset price changes, otherwise the assumption of semi-strong market efficiency is violated (given that future developments and are not anticipated to change). However, the traditional thinking suggests that exchange rates should completely and instantaneously reflect movements in underlying fundamentals, which implicitly rules out the occurrence of news.

analysis of equity splits and their effects on subsequent stock prices. However, this methodology established in stock market research only in the seventies with a series of many more studies analyzing stock price reactions on fundamental news. But then again, one had to wait until the eighties before event studies were taken over in foreign exchange market research. Mussa (1976) observes that exchange rate movements are mainly unexpected and traces them back to new information (see also Dornbusch, 1980, p. 159). Edwards (1983) confirms this presumption and finds that exchange rates are strongly influenced by arising macroeconomic news. Nevertheless, this coincided with Meese and Rogoff's (1983) influential paper, which shows that out-of-sample exchange rate forecasts produced by structural models based on exchange rate fundamentals are worse than those obtained by using the random walk (naive) model. This finding shocked the pillars of exchange rate economics especially at this particular time and fundamental research appeared useless. For this reason, new hope arose to revitalize fundamental exchange rate research by analyzing macroeconomic news in-depth.[6] The asset approach became widely accepted on the foreign exchange market, hence ever since exchange rates have been primarily regarded as driven by expectations (see Hakkio and Pearce, 1985, p. 621, and Frankel and Rose, 1995).

New developed models have alternated during time to arising finer techniques in econometrics, which have been accompanied closely by the disclosure of larger datasets. Whilst in the beginning (rough) news-models had dominated the scene, accordant critics regarding the low-frequency of related data series quickly prevailed, leading to announcement studies. These are more alike the preceded stock market event studies since they focus on only those days following respective fundamental announcements. The opening of tick-by-tick data then provided an enormous amount of data and led to high-frequency models. The inclusion of order flow was then reflected in the hybrid approach, which is basically based on two different news-channels. In recent times, several studies examine different asset price changes like stocks, bonds and exchange rates simultaneously in order to reveal mutually news reactions.

Until today the event study literature of the foreign exchange market can look back on nearly 30 years of research. Since various meaningful insights have been revealed, it is about time to survey comprehensively the developments and findings of this strand of literature and this is what this article aims for.

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[6] Further news-applications are devoted to the efficiency of the foreign exchange market (see Fama, 1991) or the quantification of the risk premium in exchange rates (see Froot and Frankel, 1989, Koedijk and Wolff, 1996, and Bams, Walkowiak and Wolff, 2004).

1.2 The news-model

The first event studies on the foreign exchange market are based on monthly or quarterly data and are known in the literature as news-models (see Dornbusch, 1980, Frenkel, 1981, Edwards, 1983, and Bomhoff and Korteweg, 1983).

1.2.1 The baseline model

The news-model is formulated as follows:

$$s_t - E_{t-1}[s_t] = \alpha + \sum_k \beta^k \cdot N_t^k + \varepsilon_t \qquad (1.1)$$

$$\text{with } N_t^k = f_t^k - E_{t-1}[f_t^k],$$

$$\text{and} \quad k = 1,...,K .$$

The expectation error in the exchange rate, $s_t - E_{t-1}[s_t]$, is regressed on the related errors in the fundamentals, $f^k_t - E_{t-1}[f^k_t]$, as well as the disturbance variable, ε_t, which is assumed iid. Assuming that market participants are rational, the expectations are based on all relevant public information up to time t-1 (see MacKinlay, 1997, p.13).[7] Since exchange rates show asset-like behavior, they are supposed to react first, only on unexpected news, i.e. surprises in fundamentals, and second, instantaneously without any related trading in the foreign exchange market (see Frenkel, 1981, p. 686).

However, three issues prove being essential for this model setting: first, the choice of the considered fundamentals, i.e. the macroeconomic variable set which enters into equation (1.1) in order to explain exchange rate surprises; second, the way how expectations of fundamentals are actually obtained and third, how to generate exchange rate surprises at all.

So regarding the first issue, structural macroeconomic models based on conventional fundamentals deliver respective variables. An alternative approach relies on the rather ad-hoc choice of popular variables, which are seen as important at the time.

Regarding the way of modeling fundamental expectations, two possibilities are at hand: first, generating statistical innovations via univariate time series analysis (see e.g.

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[7] This implies a relationship between the exchange rate and its fundamentals, $s_t = \sum_k \beta^k \cdot f^k + \varepsilon_t$, known to the investors and hence, their expectations add up to $E_{t-1}[s_t] = \sum_k \beta^k \cdot E_{t-1}[f_t^k]$.

Frenkel, 1981, Copeland, 1984 and 1984a, and MacDonald, 1985) or via multivariate analysis (e.g. Edwards, 1983). Alternatively, again one could rely on accordant macroeconomic models in order to produce corresponding fundamental surprises (e.g. Edwards, 1982, MacDonald, 1983, MacDonald and Taylor, 1992).

Turning now to the third issue, several authors use the forward rate to proxy exchange rate expectations (e.g. Frenkel, 1981, Edwards, 1982a, and MacDonald, 1985). Obviously, its indisputable advantage turns out to be the easiness of getting corresponding data. However, by using the forward rate one assumes implicitly that the exchange rate risk premium either does not exist or is constant over time, since otherwise the risk premium would be instable which in turn would bias severely upcoming estimation results (see Frankel and Rose, 1995).[8] Alternatively, by modeling the exchange rate process arising residuals could be pulled up to proxy the unexpected exchange rate movements, since those increments cannot be explained by the respective underlying exchange rate model. In this manner Copeland (1984, 1984a) runs an ARIMA-process and uses corresponding residuals as exchange rate surprises. In a second attempt, he pulls up exchange rate returns in order to proxy respective news, by attributing implicitly all exchange rate movements to fundamental news. Considering the concept of uncovered interest parity, Dornbusch (1980) uses exchange rate excess return, i.e. subtracting corresponding interest differences from exchange rate returns (see also Rose, 1984). However, what speaks in turn against these alternatives is that they depend on the validity of the underlying model, which proves a priori unknown. However, if the true data generating process is different from the one assumed, the specification is incorrect and the estimated parameters severely biased.

1.2.2 Empirical evidence

A bulk of papers applying the news-model arose, but from today's perspective several serious shortcomings distort the results. Even though corresponding R-squares prove to be very high, the parameters of many popular fundamentals are insignificant (see Dornbusch, 1980, Frenkel, 1981, and Edwards, 1982). Comparing the results of related studies to one another, parameter estimates and corresponding significances vary extremely and apparently depend on the data period, the specific exchange rate and the data frequency as well.

[8] A constant forward premium would be captured by the constant α in equation (1.1) and so would not bias the estimated parameters. Needless to say, that the results would be unbiased too, if a risk premium would not exist.

Thus, several authors analyze for delayed news-effects. Assuming rationality, such occurrences should not exist since "past innovations are not news any more" (see Edwards, 1982, p. 219). Nonetheless, if news is announced with delays, corresponding lag-structures in news-effects appear consistent with rationality. Indeed MacDonald (1983) finds significant lags in money-news on exchange rates. However, a clear structure is missing and so he leaves it open to what sources they are linked. Bomhoff and Korteweg (1983) in fact find lagged news-effects, but too long to be connected either with delayed publications or with related revisions. However, they attribute central bank interventions to causing these belated effects. In fact, announcements are published with large delays and beyond underlie serious revisions, which even occur several months later. Market participants do not hold final macroeconomic announcements on which most of the news-models are based and so Hoffman and Schlagenhauf (1985) focus on the announcement values, which actually have been available to investors at the time. They cannot make any meaningful improvements; nevertheless, they declare that the validity of the results depend on dataset's frequency. By analyzing monthly and quarterly data respectively, they reveal more stable results upon the former data. Finally, from today's perspective disregarding for cointegration among the variables most certainly helps to explain somewhat the generated high R-squares in news-models.[9]

In sum, news-models prove to be very instable, due to questionable expectation modeling, too low data frequency and perhaps the dependence on time-invariant relationships between exchange rates and fundamentals–the latter argument is owed again to the low data frequency (see Frankel and Rose, 1995, p. 1701).

1.3 Announcement studies

Thus, considering all these critics it is not surprising that late in the eighties the news-model was replaced by a more accurate technique, i.e. announcement studies. These studies use daily data and thus are able to focus on only these days, when economic announcements actually take place.

By comparing the news-model with announcement studies, the latter's event window is considerable smaller, i.e. it decreases from a month (or a quarter respectively) in news-models to a day in announcement studies. By this means, exchange rate reactions on news can be much better separated from other influences as before in news-models such as applied in

[9] In fact studies relying on quarterly data generate even higher R-squares than accordant studies on monthly data.

Dornbusch (1980), Frenkel (1981) and Edwards (1982) (see this statement in Ito and Roley, 1987, p.256). Picking up the hesitations connected to final released fundamental announcement data, announcement studies overcome this issue by using original release data in order to replicate occurring news-effects at that time. Even though fundamental announcements underlie several revisions afterwards, this does not bother upcoming results, because more importantly the focus rests only on measuring how markets actually react on news.[10] Since for most industrialized countries the dates of fundamental announcements are known beforehand, news-effects can now be revealed much easier than via the rough news-model (see Frankel and Rose, 1995). So regressing exchange rate changes on respective news, Hardouvelis (1988, p. 23) finds the application of announcement studies "a different, more direct strategy".

Another innovation connected to announcement studies is the implementation of survey forecasts in order to replace artificially generated fundamental expectations in news-models.[11] In the likely case that latter sub-models turn out being misspecified, this source of inaccuracy is not anymore present. However, accordant surveys deliver forecasts typically from financial markets professionals, whose day-by-day business depend partly on their forecasts' appropriateness. Thus, this kind of data proves to be promising–see for more details of the use of survey data Takagi, 1991, MacDonald, 2000, and further Pesaran and Weale, 2006). Therefore, most announcement studies fall back on surveys' consensus data in order to cover fundamental expectations, since this is seen most suitably to cover market opinions (see Hakkio and Pearce, 1985, p. 627).[12]

1.3.1 The baseline model

Concerning the description of an announcement study we refer to MacKinlay (1997) who describes the implementation of an event study in several different steps. Above all, the success of an event study depends on the exact identification of the times, when events actually take place. Once again, we see the asset-like character of exchange rates since the

[10] In this spirit Faust, Rogers and Wright (2003) investigate the forecasting performance of original release data of standard exchange rate fundamentals, i.e. in a real-time forecasting framework and argue its major relevance.

[11] It is interesting to note that Dornbusch (1980) is first who uses expectation data in an event study on the foreign exchange market. Running a news-model he relies on OECD-forecasts to proxy current account and economic growth expectations.

[12] Specific surveys are e.g. Consensus Economics (London, Great Britain), Financial Market Survey (Mannheim, Germany) and Money Market Services International.

foreign exchange market generates continuously market prices, which proves to be very useful for an event study (see Hardouvelis, 1988, p. 23). Thus the announcement study presents as follows:

$$\Delta s_t^k = \sum_k \sum_j \beta_j^k \cdot N_{t-j}^k + \varepsilon_t^k \tag{1.2}$$

$$\Delta s_t^k = \alpha + \sum_k \sum_j \beta_j^{k1} \cdot N_{t-j}^k + \sum_k \sum_j \beta_j^{k2} \cdot E_{t-1-j}[f^k] + \varepsilon_t^k \tag{1.3}$$

with $N_{t-j}^k = f_{t-j}^k - E_{t-1-j}[f^k]$,

with $k = 1,...,K$ and $j = -J,...,-1,0,1,...,J$.

In spirit of market efficiency, the exchange rate change, $\Delta s_{t,i}$, is regressed in equation (1.2) on surprises in fundamentals and an iid disturbance variable as well. Thus the exchange rate change replaces the forward premium of the news-model. However, since announcement studies are typically based on only those days, when actually at least one announcement took place, corresponding exchange rate changes are interpreted as rational surprises on the foreign exchange market–this is why every fundamental together with its parameter can be assigned to an individual regression. In this manner, expectations in exchange rates prove to be irrelevant and hence are not part of the analysis anymore.[13] The surprises in fundamentals, N^k, consist of the differences between consensus expectations and corresponding originally released announcements. Next to current news-effects, respective leads and lags are captured by index j.

Equation (1.3) tests additionally for market efficiency. So if the foreign exchange market proves to be efficient in fact, the parameters α and β^k have to be insignificant different from zero–equation (1.2) implicitly assumes efficiency (see Cornell, 1983). Further, both equations allow for lagged news-effects. Since the event-window is much smaller than the one in the news-model, it appears self-evident to examine additionally for delayed news-effects that reach beyond the specific announcement day (see Hakkio and Pearce, 1985).[14]

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[13] Mussa (1976) claims that approximately 90 percent of exchange rate movements are unanticipated. So taking the return in exchange rates as a proxy of unexpected exchange rate changes appears logically.

[14] Moreover, anticipated news-effects could also be on hand and are therefore considered in equation (1.2) and (1.3) via lead-effects – a few studies actually found some news anticipation (see e.g. Hakkio and Pearce, 1985).

1.3.2 Empirical evidence

Thus, Engel and Frankel (1984) analyze news in monetary policy and show that exchange rates appreciate after positive money surprises (i.e. money being larger than previously expected). Cornel (1983) questions this finding, since he does not find such a relationship before October 1979. After this date the relationship becomes significant; however, it is contradicted by the finding that bond rates react positively on money news too, since the latter relationship indicates long-term inflation expectation. Hardouvelis (1984) confirms Cornell's findings and additionally reveals a positive relationship between long-term exchange rate expectations and money news. In his opinion, the Fed regained credibility in financial markets after its policy change in October 1979, but some related uncertainty remained, which shows up in an inflation premium. Hakkio and Pearce (1985), who use three exchange rates per day, show a structural break in the relationship between the exchange rate and money news in October 1979, when the Fed changed its policy orientation from the Fed Funds rate to money (for further accordant studies see Roley, 1986, Tandon and Ulrich, 1987, and Hardouvelis, 1988).

Irwin (1989) states a positive relationship between the exchange rate and current account deficit, but only after June 1984. At this time the deficit hit a critical high, which alarmed financial market participants and switched market attention to current account announcements. Ever so often, market participants anticipated central bank interventions when surprisingly negative current account numbers have been published. Klein, Mizrach and Murphy (1991) analyze the effect of the Plaza agreement in September 1985 on the influence of US-current account news on exchange rates. Surprisingly, they find a structural break first in March 1986, several months later. In their understanding, market participants had been skeptical in the beginning concerning the credibility of the policy change but believed in it later. Aggrarwal and Schirm (1992) consider in addition to that the Louvre Accord in 1987. They state that next to central banks' strategies, particularly international agreements matter for the influence of current account-news on exchange rates. However, if particular policy acts prove to be creditable, financial markets react very strong on them. Karfakis and Kim (1995) examine Australian current account news for two periods, one before 1989 and one thereafter. Regarding the first time, they find the exchange rate appreciating significantly after higher current account deficit news, which they connect to anticipated central bank interventions. In contrast to that, the relationship turns out to be insignificant thereafter. They attribute this to a change in 1989 of Australian central bank's monetary strategy from restrictive to more relaxing, wherefore market participants did not anticipate interventions on the foreign exchange market anymore, following negative Australian current account news. Taking together, actual policy orientations and accordant strategies determine the way how particular fundamental news influences exchange rates. But next to institution's orientation and connected actions, the power of enforcement and the will to act accordingly, determine if and how news is incorporated into exchange rates.

Further specific news-issues have been analyzed, e.g. lagged and anticipated news-effects, which contradict market efficiency at first glance. Hakkio and Pearce (1985) show the existence of lagged effects in CPI and money announcements and attribute them to central bank interventions of the Bank of Canada. MacDonald and Torrance (1988) however, cannot reveal any lagged news-effects in British-money. Further Goodhart (1988) expects under- and overshooting to news, attributed to vague effects arising from interactions between short-term orientated speculators, sluggish fundamentalists and central bankers following political targets. However, Goodhart cannot show such a lag-structure and presumes that daily-data proves inappropriately to reveal such interrelations, if it is a matter of an intra-daily phenomenon.

Beck (1993) shows anticipated news-effects of two to three days in US-public deficits. He presumes the existence of heterogeneous information the way that a few market participants hold some private information, wherefore he claims that asymmetric reactions on news can be inline with efficiency of the foreign exchange market. Karfakis and Kim (1995) separate their data in good and bad current account news and show that negative news is followed by significant exchange rate appreciations, i.e. the current account deficit is lower than expected. They connect this finding with anticipated interventions of the central bank, which obviously would not arise if current account news turns out to be positive.[15]

Summing up, a lot of announcement studies have been applied on the foreign exchange market focusing in contrast to news-model analyses additionally on some specific issues such as lagged effects and heterogeneous reactions. Several advantages of announcement studies are at hand: first, the use of survey expectations renders artificially generated fundamental expectations obsolete; second, the event-window decreases dramatically that is why news-effects can now be better separated from other influences than before; third, exchange rate expectations prove irrelevant and so another potential source of misspecification vanishes. However, even though this model proves clearly superior, some

[15] They admit that the insignificant effects arising from positive news could be connected with anticipated future data revisions – at this time good news has turned to bad news via later data revisions quite often.

shortcomings still remain. Above all, the main critic concerns the event-window, which may remain still too wide to capture certain news-effects properly.[16] Further, despite many significant fundamental news and much more consistent results between the different announcement-studies, R-squares turn out very low. Frankel and Rose (1995) confess "that (news) effects typically diffuse rapidly in a stream of other information that the researcher is not able to observe, so that statistical significance disappears when exchange rate changes are measured a day or two late" (p. 1701).

1.3.3 Recent studies

As a matter of fact, two announcement studies have been published recently which brought some further insights into the news-literature of the foreign exchange market. Since these studies do not belong conceptually to later approaches, we present them hereunder in a separate subchapter.

Ehrmann and Fratzscher (2005) analyze daily changes of the US-dollar/euro (until 1999 -/D-mark respectively) by using real-time news of macroeconomic announcements during the period 1993-2003. They confirm that US news have larger influence on exchange rates than respective news from the euro area (or Germany). Further, by pooling respective news for the US and the euro area in a composite variable, they analyze for the existence of several asymmetries in news-effects. In particular they find that news-effects depend on certain market conditions. News tends to have more impact if previous exchange rate volatility is higher, news is large or bad. So in accordance to the Veronesi-effect more uncertainty leads to larger news-effects (see Veronesi, 1999).[17]

Another interesting issue arises with the use of proxies for the macroeconomic variables, which are considered as exchange rate fundamentals. Since the latter's data underlie some severe problems, i.e. low frequency, obsolete data, some difficulty of generating related expectations and so accordant errors, the use of appropriate proxies seems promising to

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[16] Hakkio and Pearce (1985) already point at this issue, wherefore they use three exchange rates per day and indeed generate relative to Cornell (1982) and Hardouvelis (1984) more consistent results.

[17] Manzan and Westerhoff's (2005) show in a behavioral news model that investors' perception of fundamental shocks on exchange rates vary, depending on latter's volatility. When volatility is low, they tend to underreact on fundamental news, whereas overreaction takes place when volatility is high. Even though Ehrmann and Fratzscher do not investigate this issue explicitly, their finding of higher news-effects arising from larger news-surprises could be consistent with under- and overreactions in the foreign exchange market on fundamental news.

perform more accurate event studies.[18] In this notion, Fatum and Scholnick (2006) analyze whether US monetary policy matters for D-mark/-, GB-pound/- and JP-yen/US-dollar rates on a daily basis. Hence, they use daily changes in the 2-month ahead Federal Funds future rate to extract market expectations of future US monetary policy without relying on too infrequent survey outcomes or questionable model specifications. Next to actual exchange rate responses on infrequent actual policy changes, they show that monetary policy also matters for daily exchange rate determination. In accordance with the efficiency of the foreign exchange market, they show that exchange rates react without delays on day-to-day changes in monetary policy expectations and further, only on the unexpected elements of actual monetary policy changes.[19]

1.4 High-frequency studies and the hybrid approach

In the late eighties studies turned up using tick-by-tick data, minimizing the event-window radically and thus this high-frequency model ever since then has dominated the event study literature. However, this development appeared to be only a matter of time, due to the immense data-mass the foreign exchange market produces–highly-liquid currency pairs deliver several thousand quotes per day. Whereas first such attempts were restricted to announcement data only (see e.g. Goodhart and Figliuoli, 1991, and Goodhart, Hall, Henry and Pesaran, 1993), later studies use related expectations again in order to generate the surprise elements.

1.4.1 The baseline model

Since the event-window ranges from just a minute or so to a maximal of a few hours, de-facto single regressions result, which are separated by the specific fundamental news items. The high-frequency model arises as follows:

[18] Solnik (1987) follows a news-model-like approach using monthly (and quarterly) data for the period July 1973 to December 1983 in order to explain real exchange rate changes. In contrast to the classical news-model he uses financial market prices to proxy macroeconomic variables since corresponding news are real-time and more directly measured. So he proxies changes in economic activity by real stock returns and monetary shocks by interest rates respectively.[18] In sum, his results are fairly weak, which he explains partly by the use of poor proxies. However, he emphasizes that using financial prices in lieu of traditional macroeconomic time series proves to be a promising field of further research.

[19] In fact, Faust et al. (2007) also use Federal Funds future prices in order to generate corresponding surprises.

$$\Delta s^k_{t,t+s} = \sum_k \sum_s \sum_j \beta^k_{j,s} \cdot N^k_{t-j} + \varepsilon^k_{t,t+s} \tag{1.4}$$

$$\text{with } N^k_{t-j} = f^k_{t-j} - E[f^k_{t-j}],$$

$$\text{with } k = 1,\ldots,K, \quad s = 1,\ldots,S \quad \text{and } j = -J,\ldots,-1,0,1\ldots,J.$$

In equation (1.4), the exchange rate change, $\Delta s_{t,t+s}$, is regressed on the news items, N^k, and an iid disturbance variable. By using several event-windows with different lengths s (measured in e.g. 5-minute units), the durations of the individual news-effects can be analyzed; though index j includes all sorts of respective lead and lag effects. However, if asymmetric news-effects exist, corresponding parameters would be instable. So dependent on the validity of the current economic state, equation (1.5) provides the relevant news parameters (for illustrative purposes the focus rests on one period without leads and lags):

$$\Delta s^k_{t,t+1} = \alpha^k_r + \beta^k_r \cdot N^k_t + \varepsilon_{t,t+1} \tag{1.5}$$

$$\text{with } \beta^k_r = \alpha^k_1 + \beta^k_1 \cdot N^k_t \quad \text{if state 1,}$$

$$\text{and } \beta^k_r = \alpha^k_2 + \beta^k_2 \cdot N^k_t \quad \text{if state 2.}$$

1.4.2 Empirical evidence

Goodhart and Figliuoli (1991) analyze exchange rate reactions on news-effects upon minute-by-minute data for two trading days. Even though they allow for lag effects, they cannot reveal significant relationships. However, the study of the full 3-month dataset could indeed reveal several meaningful price jumps following news (see Goodhart, 1989). Nevertheless, both studies lack the implementation of corresponding fundamental expectations, which questions the results as such. Goodhart, Hall, Henry and Pesaran (1993) follow the issue, whether news-effects on exchange rates are permanent or temporary. Hereunto they analyze the US-dollar/GB-pound during April and July in 1989 regarding the US trade balance and a particular rise of the UK prime rate. They find that both the mean and the variance of the exchange rate react significantly on this news, but only temporarily, because during the following trading week such effects are reversed. However, one should keep in mind that Goodhart et al. (1993) only examine two individual events. Analyzing 5-

minute intervals of the D-mark/US-dollar from January 1992 until December 1994, Almeida, Goodhart and Payne (1998) wonder how much time it takes until news-effects are fully processed into exchange rates. In fact, using MMS expectations in order to generate the surprising elements in announcements, they show that in general the news-effects are significant until a two hour-horizon after release except for the Payroll and consumer confidence figures. The latter continue to be significant until twelve hours after respective releases and therefore confirm "that the very short-term reaction to news is drowned very rapidly in subsequent noise" (p. 392). Furthermore, they reveal that US news reaches its maximum impact after 15 minutes, but German news only after approximately three hours; however, both significant levels are maximal at the 15-minute horizon. Almeida, Goodhart and Payne (1998) attribute this to the fact that the dates of US announcements are known in advance, whereas German announcements are most often unscheduled and thus market participants need some extra time to process the latter news. Andersen and Bollerslev's (1998) study intraday volatility of the D-mark/US-dollar using tick-by-tick data from October 1992 to September 1993. They show that macroeconomic announcements induce the largest intraday movements; however, taken together the typical intraday volatility patterns clearly continue to dominate overall.[20] Anderson, Bollerslev, Diebold and Vega (2003) analyze five-minute intervals for five exchange rates from 1992 to 1998 on 41 German and US announcements.[21] Moreover they use MMS-expectations to generate corresponding surprises. Indeed, much US news is significant, e.g. economic cycle variables let the US-dollar to appreciate. In contrast, German news is seldom relevant, which they explain in accordance to Almeida, Goodhart and Payne (1998). While US news often explain 30 percent and more of exchange rate's variance (trade balance news achieves almost 60 percent), German news contributes rarely more than 15 percent. Further, Almeida, Goodhart and Payne show that the timing of news matter. Grouping the news-variables in different groups, e.g. real-activity, consumption and prices, and arranging them chronologically on the announcement date and the respective time, they are able to calculate if news' impacts differ accordingly. As presumed, first announcements of each group reveal the highest impact on subsequent exchange rate changes. The authors explain this finding with the fact that later news often only confirm the former and therefore are not really news anymore. Finally, separating good

[20] In particular US announcements related to the real economy appear most significant, while in Germany monetary announcements dominate – they link this to different perceived central bank policies.

[21] Andersen et al. (2003) find that prices adjust fully to news within five minutes while volatilities adjust gradually with complete adjustment within about an hour.

from bad news, the authors look for a specific source of parameter instability in respect to news-effects by using equation (1.5). In fact, they find asymmetrical exchange rate reactions on news, particularly on the trade balance and payroll announcements. Furthermore, the authors follow the idea that bad news should have an unusually large impact in "good times" and consult the standard deviation of exchange rate expectations as a proxy for market uncertainty. Focusing on bad news, payroll employment, durable goods orders and trade balance increase market uncertainty after bad news of about 30, six and twelve percent.[22]

In sum, the major critic who has rested on event studies could be met. Thus, by using tick-by-tick data, the event-window shrinks to only a few minutes, wherefore potential disturbances, which could dilute the respective news-effects, are most likely removed. On the other hand, high-frequency studies focus on only the instantaneous exchange rate changes after news. So it should not surprise that R-squares of up to 60% arise, since the major part of exchange rate movements is masked out. Furthermore, high-frequency studies allow to analyze the required duration needed to incorporate news into market prices. However, pulling up the first tow statistical moments of the exchange rates, it figures out that news-effects last only temporary. Moreover, earlier preliminarily findings in announcement studies showing asymmetric reactions arising from good and bad news can be confirmed (see e.g. Karfakis and Kim, 1995, and Andersen et al., 2003). However, one major critic remains: high-frequency studies focus on only these short-term exchange rate changes, which follow macroeconomic news. Hence, considering on only a small part of exchange rate movements by construction, high-frequency studies leaves the major part of the variance unconsidered.[23]

1.5 The hybrid approach

Thus, short-run exchange rate movements do not correlate well with macroeconomic variables, why various announcements do not appear significant in explaining exchange rate changes. Today broad agreement exists in the exchange rate literature regarding investor heterogeneity arising from differing information bases, market uncertainty or diverse opinions (see e.g. Bacchetta and van Wincoop, 2006, Flood and Rose, 1996, and De Grauwe and Grimaldi, 2006). Moreover, microstructure models, which rely inter alia on the heterogeneous

[22] Good news in bad times is not considered since good news dominates over the whole period of the dataset.

[23] Dominguez and Panthaki (2006) estimate that high-frequency models, which do not include order flow as an additional regressor, can only explain less than one percent of the total of exchange rate movements.

expectations assumption, are seen to be relative successful in explaining exchange rate movements in the short run, e.g. via order flow.

Haven said that the bulk of the exchange rate variance still remains unexplained; news may affect exchange rates additionally via another channel. Andersen et al. (2003, p. 59) note that the consideration of order flow appears promising and the microstructure variable order flow found its way in high-frequency studies.[24]

1.5.1 News, exchange rates and order flow

In fact, we already introduced the direct news-channel in Section 2 without mentioning this explicitly, since at that stage we did not consider trading as a vehicle to process fundamental news into market prices. Hence, the direct channel is restricted to news on which market participants fully agree and thus is based upon public information, which consequently is called common knowledge (CK) information. So CK information is transported directly and instantaneously into market prices and has to be distinguished from non-common knowledge (NCK) information, which arises due to divergent expectations about future fundamentals' paths and their respective impacts on exchange rates (see Evans, 2002). The latter reflects heterogeneity in information among market participants, which in turn causes speculative trades and though can be observed in order flow.[25] Hence, NCK information, i.e. private information, is processed into market prices via order flow and constitutes the indirect news-channel, which in contrast to the direct channel requires trading.

Cai et al. (2001) reveal a strong influence arising from customer order flow on the volatility of the JP-yen/US-dollar during 1998, even after taking into account US and Japanese macroeconomic announcements. Actually, Evans and Lyons (2002) find a significant relationship between exchange rates and related interdealer order flow (IOF) from May until August 1996. Using daily data, they explain 63% of the variance in the US-dollar/D-mark and 40% in the US-dollar/JP-yen. Considering the disappointing results of empirical exchange rate modeling (see Meese and Rogoff, 1983, and in a later study Cheung, Chinn and Garcia Pascual, 2005), Evans and Lyons' results appear striking.

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[24] The market microstructure classifies order flow as private information, e.g. heterogeneous expectations, interpretations and information. Hence, order flow is declared as an elementary medium to process disagreement among market participants into prices. However, in contrast to that, the traditional macroeconomic theory claims market homogeneity and hence no such influences arsing from order flow on market prices.

[25] The sum of these trades flows in order flow, whereas the latter is defined as the overall difference between the volume of buyer-initiated and seller-initiated trades.

In addition to that, Evans und Lyons (2007a) show in their intraday analyses that order flow following macroeconomic news contributes more to US-dollar/D-mark movements than at other times. Trade intensity rises significantly after announcements, accompanied by higher order flow. It stands to reason that market participants do not share common opinions in respect to the meaning of certain news and thus, form different expectations which finally lead to corresponding order flow. Hence, it does not surprise that when following news, order flow's influence on exchange rates rises, since arising uncertainty due to heterogeneous news' interpretations have to be processed into market prices (see Evans and Lyons, 2002).[26] A further interesting aspect of Evans and Lyons's (2007a) intraday analyses reveals that trade intensity in exchange rates following scheduled news proves to be higher compared to unscheduled news. Since order flow's impact on exchange rates increases with more trades, order flow proves at least as important in subsequent price reactions following scheduled news as non-scheduled news. This observation surprises since the former news are standardized and thus more transparent than unscheduled news.

Known as the hybrid approach in the literature, news influences exchange rates via two dimensions (see Lyons, 2001, p. 16).

1.5.2 Empirical evidence

Analyzing simultaneously daily US-dollar/D-mark rates, order flow and a broad pool of different fundamental announcements, Evans and Lyons (2007a) explain approximately 36% of the exchange rate movements via the hybrid model. Furthermore, they show that the indirect news-channel is twice as important as the direct channel in order to process corresponding news. Nevertheless, regarding both news-channels German news explains more than double the amount of US-American news. However, due to the fact that German news occurs four times as often as US-American news in the dataset, one news item of the latter has a slightly larger effect on prices. Love and Payne (2007) analyze high-frequency-data comprising exchange rates of the euro, US-dollar and GB-pound. They confirm that the indirect news-channel is more relevant than the direct channel (the former contributes 2/3 to the explained variance). Moreover, by increasing the event-window up to 20 minutes they show that the relevance of the indirect channel increases following announcements. Further,

[26] Following fundamental news, traders are confronted with uncertainty concerning subsequent price setting. However, with arising order flow traders learn how to interpret news which in turn reduces uncertainty.

in respect to the question how news effects spread out, this depends on news's geographical origin; news that do not stem from one of the two countries of the regarded currency-pair is processed exclusively via order flow. Thus, analyzing news-effects in the foreign exchange market, Love and Payne propose a multi-country approach.

So combining these results with the finding in Evans and Lyons (2002, 2007a), where order flow explains 60% of the US-dollar/D-mark, Evans and Lyons confess that approximately 1/3 of the explained exchange rate variance is related to indirect macroeconomic news-effects, whereas the remaining share is not related to news. Furthermore, 15% of the unexplained exchange rate variance by order flow stems from direct news-effects, leaving only 25% of further unknown sources altogether (see Evans and Lyons, 2007a). All in all, the authors claim that currency traders primarily use order flow to interpret new macroeconomic information correctly, in order to process them accurately into market prices afterwards. This agrees to Frömmel, Mende and Menkhoff (2007), who analyze different trading groups of the foreign exchange market and show that only order flow from banks and financial customers is positively related to exchange rate volatility. Their interpretation that this result is a consequence of information aggregation in the market is confirmed since some order flow, i.e. from commercial customers, is not related to volatility.

Thus, order flow establishes as an important element in order to incorporate macroeconomic news into financial prices. However the question arises, how much time this process requires from being complete? Love and Payne (2007) show that indirect news-effects arising from order flow following macroeconomic announcements are processed within two minutes only, thus the foreign exchange market appears efficient. In contrast to that, Evans and Lyons (2007a) find that order flow is autocorrelated up to 90 minutes after corresponding announcements, and so they disagree with Love and Payne's view. Using tick-by-tick transaction data of the D-mark/US-dollar rate, Carlson and Lo (2006) focus on a particular interest rate raise by the Deutsche Bundesbank on October 9, 1997. This unforeseen event triggers an interesting intra day pattern in order to study the reactions of currency dealer to news in detail. However, even though Carlson and Lo reveal some instantaneous speculation following news triggered by these people, they show that those destabilizing actions die out soon after; trading volume and volatility settle down to normal conditions after two hours. Further evidence for an even longer-lasting information process is indicated in Evans and Lyons (2007), who show highly persistent expectation errors in respect to exchange rate fundamentals. In fact, autocorrelation proves to be still significant after three months of the corresponding announcements.[27]

Finally, pulling up again the exemplary 25% unexplained variance of exchange rates from news and order flow (see Evans and Lyons, 2002 and 2007a), it is possible that further relevant but so far unconsidered news sources are still unconsidered. Thus, the news-pool has to be extended and to some extent reshaped. Scheduled macroeconomic news only comprises past information of very low frequency, i.e. monthly or quarterly; so their information content appears somewhat outdated (see also Fatum and Scholnick, 2006). Consequently, the extension of the considered information basis about unscheduled macroeconomic news (e.g. new economic laws and central bank interventions) and non-fundamental information (e.g. technical trade-signals and market sentiment) stand to reason to meet the critique of too low (fundamental) news frequency.[28] Dominguez and Panthaki (2006) analyze high-frequency data using 20-minute intervals to explain US-dollar/euro- and US-dollar/GB-pound-returns via both news-channels.[29] Considering an extensive set of additional variables, many novel news items prove to be significant, even though R-squares rise just marginally (about 1% and 4% concerning the US-dollar/euro and -/GB-pound respectively).[30] However, if Dominguez and Panthaki split the datasets in two separated regimes, dependent on respective exchange rate volatility, R-squares rise from 15% to 32% in respect of the US-dollar/euro and from 6% to 21% regarding the euro/GB-pound. So the authors confirm that news-effects spread out primarily via order flow and state that the indirect news-channel dominates in the foreign exchange market.[31] Further, it shows that next to (common) scheduled macroeconomic news, unscheduled macroeconomic news and non-fundamental news prove to be relevant as well to

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[27] Evans and Lyons (2007) examine US-American and German money and economic growth as well as inflation rates and show that order flow forecasts future fundamentals better than accordant exchange rates do.

[28] Conducting a questionnaire among currency traders, Gehrig and Menkhoff (2004) show an increasing popularity of non-fundamental analysis. In fact, these professionals assign technical analysis more relevance than fundamental analysis.

[29] In fact Melvin and Yin (2000) first examine the role of (broad) public information arrival on the D-mark/US-dollar and the JP-yen/US-dollar. They show its relevance on related volatilities and quote frequencies as well.

[30] We have to confess that Evans and Lyons (2007a) already consider a broad spectrum of news. However, they restrict the analyses to macroeconomic announcements since they see other news as being negligible.

[31] Regime 1 holds, when current exchange rate volatility exceeds two times the standard deviation of its average volatility, whereas regime 2 holds otherwise. When splitting the sample dependent on the amount of arising news, results prove to be very similar.

explain exchange rate movements. Nevertheless among those news sources it figures out that scheduled macroeconomic news influences exchange rates in first place.

1.6 The multi-asset approach

In this section we put together the findings regarding cross-market linkages and dynamic responses to news of joint analyses of different financial variables such as stocks, bonds and exchange rates. Particularly the later works aim to reveal further findings concerning mutually news reactions from financial markets en bloc and accordingly, corresponding interdependencies.

First of all, by surveying the prior literature related to this approach, Hardouvelis (1988) examines daily exchange rate and interest rate reactions to news in macroeconomic announcements from October 1979 to August 1984. He shows that markets react primarily on monetary news, but also on trade balance, inflation and real economy news. In accordance with models stressing price rigidity and absence of strong form of purchasing power parity, he finds for all news items that positive interest rate responses are accompanied by US-dollar appreciations and vice versa. Ederington and Lee (1993) analyze several different assets following scheduled macroeconomic announcements in order to disclosure the duration of news-procession in market prices. Analyzing 5-minute intervals for the Treasury bond, Eurodollar and US-dollar/D-mark, they find that most of the price adjustments occur within one minute, whereas volatility remains considerably higher than normal circumstances for another fifteen minutes. Ederington and Lee (1995) stick on the analysis by analyzing even finer intervals of only ten seconds and reveal some overreaction within the first 40 seconds following the release, which is then corrected in the following one or two minutes. However, the latter two studies have in common, that they do not relate the bond and exchange rate findings to one another.

Edison (1997) examines daily news-reactions of the D-mark/US-dollar and the JP-yen/US-dollar as well as the responses of US, German and Japanese interest rates. Using survey data, she extracts the news items of several US macroeconomic announcements and finds that the exchange rates react systematically to real economy news, but not to inflation. Regarding the interest rates, only US rates respond more or less to all country-specific news (Japanese interest rates respond less strong and German rates not at all). Again, respective results are not related between the different assets.

Fair (2003) focuses on direct news-effects on future prices of the S&P 500, Treasury bond, US-dollar/D-mark (-/euro beginning 1999), -/JP-yen and -/GB-pound respectively. He uses accordant tick-by-tick transaction data from April 1982 to March 2000 in order to study the intraday reactions of these variables following announcements (he does not only consider macroeconomic news). It should be noted that his proceeding is different to others such that he fist localizes significant intra-daily price jumps after the announcements in at least one of the considered assets; those incidents he then calls news.[32] Once a news item is localized, the relationships among the asset prices can be analyzed in order to reveal systematic interdependencies. Amongst others he shows that many of the news can indeed be attributed to US macroeconomic announcements. Further, exchange rates are relative to bond rates less affected by price news, than by monetary and real news. However, even though Fair relates the different influences arising from news to one another, the overall picture remains unclear.

Faust, Rogers, Wang and Wright (2007) analyze joint movements of exchange rates as well as US and foreign term structures following US macroeconomic announcements (the foreign countries are Great Britain, euro area and Germany until 1999 respectively). Using high-frequency data for a considerable long period which spans 1987-2002, they are able to investigate time-variation in the direct news-effects. Moreover, they use survey data in order to extract the net news elements. In contrast to Ehrmann and Fratzscher's (2005) findings, responses on real and nominal announcements show a very consistent pattern over time, thus instable relationships between the considered asset prices and respective news prove of little evidence.[33] In sum, they show that positive surprises regarding real activity in the US lead the US-dollar to appreciate and raise short-term as well as long-term interest rates particularly in the US. However, consulting the uncovered interest parity relationship supplemented by the risk premium they show that a positive surprise in US real activity which is accompanied by a stronger US-dollar implies either an expected weaker US-dollar in the future, a lower risk premium for holding foreign currency assets or a combination of these. Furthermore, positive US surprises in inflation leave the US-dollar nearly unchanged, but implies either an increase in the premium required for holding US-dollar assets, an expected US-dollar depreciation or again a combination of these.

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[32] An event is considered being news, if at least one of the analyzed assets shows a one- to five-minute price change greater than 0.75% in absolute value. Doing so, he reveals 221 such news.

[33] Exceptions are surprises in PPI, CPI, nonfarm payrolls and the trade balance, whose responses tend to fall in magnitude and significance over time.

Andersen, Bollerslev, Diebold and Vega (2006) examine the simultaneous response of US, German and British stocks, bonds and exchange rates to real-time US macroeconomic news. They use accordant price data from July 1998 to December 2002 and in addition to that survey data in order to extract the news-elements. Following a multi-market analysis, Andersen et al. allow for dynamic news responses and cross-market as well as cross-country linkages in the periods surrounding US macroeconomic announcements. They show that all examined markets are linked to fundamental news in a high-frequency horizon, while bond rates respond most strongly to news. Equity market reactions actually depend on the current condition of the real economy thus considering that, stocks and exchange rates react almost equally strong to macroeconomic news. Further, whereas news about inflation does not affect exchange rates in a systematic way, positive shocks related to the real economy lead to exchange rate appreciations. In sum, stocks, bonds and exchange rates show significant contemporaneous cross-market and cross-country intraday linkages, even after controlling for news-effects. Focusing on the exchange rates, negative bond returns (higher bond rates) and positive stock returns–indicating a stronger real economy–induce corresponding exchange rate appreciations.

1.7 Resume

The appearance of event studies on the foreign exchange market is driven ab initio from the hope to revitalize fundamental exchange rate research, since Meese and Rogoff showed in 1983 that macroeconomic models fail to forecast exchange rates more accurately than the random walk. Since then, event studies underwent several methodological refinements, flanked by larger and finer datasets which led to date on one side to the hybrid-approach, separating a direct and an indirect news-channel and on the other side to the multi-asset approach, examining news-effects on different asset prices simultaneously.

The essential findings sum up as follows: first, news-effects on exchange rates work through two separated channels. While the direct news-channel incorporates CK information in exchange rates instantaneously, NCK information is processed into prices via order flow. Second, next to scheduled macroeconomic news, unscheduled macroeconomic news and non-fundamental news prove to be relevant for exchange rate movements as well. However, as Dominguez and Panthaki (2006) state, the latter two groups are of minor importance. Third, questioning how quick prices adjust to news, on the one hand direct news-effects can be considered to be processed instantaneously, whereas on the other hand no consensus establishes so far in respect to the speed of indirect news-procession via order flow (see e.g. Love and Payne, 2007, and Evans and Lyons, 2007a). Fourth, closely related to the former issue the question arises how the pattern of the instantaneously news reactions appear. Carlson and Lo (2006) show exemplarily that after excessive trading among traders in the interdealer market, normal market conditions regarding trading volume and volatility of the exchange rate are reestablished about two hours following the macroeconomic surprise. Fifth, the timing of macroeconomic announcements matter. Regarding news items attributed to one specific macroeconomic group, first released announcements impact exchange rates presumably higher, whereas later news tend to confirm the former with accordingly lower impacts (see Andersen et al., 2003). Sixth, asymmetrical exchange rate reactions on news partly exist, most likely dependent on whether the news is good or bad; especially bad news have an unusually large impact in good times and vice versa, which can be traced to market uncertainty on hand. Seventh, except for inflation, nonfarm payrolls and the trade balance, exchange rate reactions on macroeconomic news do not vary basically over time; however, this is different for stock-reactions, depending on related economic conditions (see Andersen et al., 2006). Eights, comparing the magnitudes of news-reactions between stocks, bonds and exchange rates, bonds respond strongest to macroeconomic announcements. Further, if we consider the asymmetric reaction pattern of stocks (conditional on real activity), stocks and exchange rates react equally strong. Ninths, in principal news indicating a stronger real economy leads the related currency to appreciate, though expected related future pathways depend on market participants’ mindsets, which are eventually unobservable (see e.g. UIP considerations in Faust et al., 2007).

Overall, by looking back on 30 years of event studies on the foreign exchange market, it appears justified to conclude that exchange rates react on macroeconomic news, which in turn confirms that exchange rates are in fact related to fundamentals. Nonetheless, reviewing the insights gained from the hybrid approach, it follows that the success of event studies depends highly on the (accurate) integration of expectations; as Mussa (1976, p. 236) points out, the relationship between fundamentals and exchange rates depend on the influence of news on accordant expectations. Since the latter map the general perception pattern, it is part of individual’s experience. So, more comprehensive datasets and finer techniques may help in future to model market’s expectations more precise that would in turn emerge in a better understanding of the relationship between the exchange rate and its fundamentals.

2 Do dollar forecasters believe too much in PPP?[34]

2.1 Introduction

Since about 20 years we know that exchange rate forecasts of professionals show some degree of "irrationality" (Dominguez, 1986, p.281). It has become a stylized fact that these forecasts do not hold predictive power and that forecasters do not even use the entire information available (surveys by Takagi, 1991, Sarno and Taylor, 2002). Too little is known about possible sources of this pattern. Our research contributes towards a better understanding of this seemingly "irrational" behavior by using a new database. This enables us to analyze monthly US-dollar/euro and US-dollar/D-mark forecasts for more than 12 years, i.e. significantly longer than earlier studies. Additionally and for the first time on this literature, the forecasts of professionals are examined in groups defined by their relative reliance on fundamental analysis. We determine that forecasters in general rely too much on mean reversion on exchange rates, mean represented by purchasing power parity (PPP). The revealing fact is that fundamentalists show even more biased forecasts–this is consistent to the opinion that Dollar forecasters believe too much in PPP.

Right from its beginning the thorough analysis of exchange rate expectations have been motivated under the issue of market efficiency. The Frankel and Froot (1987) "finding of systematic expectational errors" (p. 150) set the ball to roll and was confirmed by numerous authors and various samples (see MacDonald, 2000). The many repetitions of the early results might have been responsible for the fact that a caveat has been readily neglected so far: Frankel and Froot (1987) reveal systematical errors but they also report that the sign of the error may depend on the sample period. This puts into question, whether deeper forces at work appear that may play a responsible part upon the changing sign. An analysis of this issue requires longer time series exceeding the often used two to four years.

Another important issue already addressed by Frankel and Froot (1990a) is the forecast heterogeneity. Earlier studies, such as Dominguez (1986) or Frankel and Froot (1987, 1987a), are based on consensus forecasts. More recent studies though analyze individual expectation data to reveal indeed different pattern in forecasts (e.g. Bénassy-Quéré et al.,

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[34] Co-authors: Lukas Menkhoff, Leibniz Universität Hannover, Germany and Michael Schröder, Centre for European Economic Research (ZEW), Germany, forthcoming in Applied Economics, see also article in press: http://www.informaworld.com, copyright Taylor & Francis.

2003). This line of work describes and examines heterogeneity but does not allow inferences on possible sources of heterogeneity. For the latter purpose one would need additional, exogenous information (see, Moosa and Shamsuddin, 2004, p. 1606). A rare example is shown in the analysis of the exchange rate forecasts of commercial services (Goodman, 1979), where technically-oriented services perform better than economics-oriented services. However, the data spans less than three years and considers only 13 forecasting services. Another example is the examination of a relatively short Japanese sample which allows classification of six groups, such as exporters etc. This data indicates that expectations can be affected by private information (Wakita, 1989) but is also influenced by wishful thinking (Ito, 1990). It is again Frankel and Froot (1990a) who suggest another cut in the data that might be warranted: they speculate that there may be forecasters "who think long-term" and consequently form regressive expectations then again others "who think short-term" form rather static expectations. We know that professionals picture expectations differently, though we need a rationale for this behavior–such as the one suggested by Frankel and Froot–provided that we want to reach beyond description and build an economic understanding instead.

We read the suggestion of long-term motivated regressive exchange rate expectations as a hint towards the possible importance of PPP. PPP is a core part in many exchange rate models; it is an intuitively plausible benchmark for thinking about exchange rates and–most important–it has received credit as an empirically valid concept as surveyed by Rogoff (1996) or Taylor and Taylor (2004). To pinpoint it further: as there is no single exchange rate theory that holds empirically (Frankel and Rose, 1995, Sarno and Taylor, 2002), which economic concept forecasters ought to be used if not PPP?

An examination of this issue would therefore profit from data that fulfills two conditions: the time series should be long and there should be information indicating that the economic concept of PPP drives expectations. The long period is needed in order to cover exchange rate movements to and from PPP. Additional information towards motivation of forecasters is useful to derive directly the importance of PPP. To the best of our knowledge, there is no data set in the literature that would fulfill these two conditions except for the data used here.

We show that professionals from Germany, covering more than the past 12 years, behave very conventionally: our first result shows that according to standard surveys their expectations are not purely rational and they seem to apply different kinds of expectation formation. As this is in unison to the literature, we declare it as indication that other results derived from our data can be generalized too. Second, biases in expectations are identified in the consensus forecasts, as professionals significantly belief too much in mean reversion, mean being represented by PPP. Third, according to their reliance on fundamental analysis and as soon as the sample is divided into three groups, the forecasters who rely most strongly on fundamentals analysis–"fundamentalists"–reveal an even stronger bias. The group who relies the least on fundamentals–prefer technical analysis instead: "technicians"–shows a much smaller bias. So, stronger belief in fundamentals and thus PPP is revealed as a source of bad forecasting performance. Fourth, though, the technicians' "advantage" in this respect is compensated by another bias not unexpected for technicians, showing too much expectation of trend extrapolation. Fifth, we illustrate, that forecasting biases of fundamentalists and technicians will get stronger when the exchange rate is further away from PPP. Finally, ‘point forecasts' performance of both groups is of similar poor quality. Interestingly, all groups distinguished show some directional forecasting ability.

The remainder is structured as follows. Subchapter 2.2 describes data, whereas results are presented in Subchapter 2.3 Subchapter 2.4 concludes.

2.2 Data

Our expectation data is based upon the ZEW Financial Market Survey. The Centre for European Economic Research (ZEW) of Mannheim (Germany) collects every month numerous economic and financial 6-month horizon forecasts. The ZEW survey is a qualitative questionnaire, which has been driven since December 1991 and soon grew up to a stable panel with more than 300 participants in Germany. Around 75 per cent of the participants work in the banking sector (as analysts, fund managers etc.) and 25 per cent work either in the insurance or in the industrial sector.[35] In comparison to other surveys the amount of participants is relative large and its composition according to their profession is similar to others (Consensus forecasts, London, contain 75 per cent participants from financial institutions). The forecasts collected are standardized by fax and are usually processed on the last Friday of each month.

Our dataset contains the individual six months exchange rate forecasts of the US-dollar/euro (respectively the US-dollar/D-mark) from December 1991 to April 2004 and sums

[35] The ZEW publishes out of the ZEW Financial Market Survey regularly amongst others the ZEW Indicator of Economic Sentiment, which is a leading indicator for the German economy and of similar prominence like the ifo Index.

up to a total of 149 surveys. To our knowledge no other study uses a panel of monthly exchange rate expectations with a dataset as long as ours.[36] Additionally we use daily US-dollar/euro and US-dollar/D-mark rates from the Deutsche Bundesbank, six month Libor rates from EcoWin and price index data from the International Financial Statistics (IFS) of the International Monetary Fund (IMF).

We are aware about criticism regarding the use of survey data for modeling expectations in general and for financial forecasts in particular. Nevertheless, incentives for participants not to reveal their true beliefs are very limited as the ZEW publishes the aggregated forecasts (consensus forecasts) only. Moreover manipulating the data with extreme forecasts is practically impossible, due to around 300 participants and the qualitative responses given. Additionally the incentive to participate at the survey in order to get an extensive summary of the consensus data with additional background information from the ZEW directly seems to be quite strong as this data is well covered by the financial media.

To get a first impression of the exchange rate forecasts, some descriptive statistics are presented in Table 2.1 For comparison we include the corresponding six month forward rates and the realized exchange rates at the same time. With respect to the level statistics one recognizes that consensus forecasts as well as forward rates behave similar to realized exchange rates though forward rates resemble exchange rates even better. If one looks at the change statistics, consensus forecasts still behave similar to realized exchange rates, in contrary to forward rates which differ especially on their variability measures. Finally the consensus expects a slightly stronger US-dollar on average towards the euro whereas the US-dollar actually weakens on average.

Additionally in a specific survey ZEW participants were asked on which information they actually base their exchange rate forecasts (see ZEW Financial Market Report, 2004).[37] This enables us to categorize the participants according to their use of analytical instruments. We base our classification on the use of fundamental analysis and organize the survey participants in fundamentalists, technicians and intermediates. We could not find any significant difference between people who use primarily technical analysis or flow analysis due to the fact, that flow analysis is used to a much smaller degree than other instruments of

[36] Recently Audretsch and Stadtmann (2005) uses the Wall Street Journal survey which covers a longer time period (1989 – 2003), but at the cost of semi yearly data only, which generates just 30 data points.

[37] Participants were asked to distribute 100 points amongst the categories fundamental, technical and flow analysis according to the way how they do their exchange rate analysis.

analysis (the average share of flow analysis in the forecasting process sums up to 10 per cent, whereas technical analysis adds up to 30 per cent and fundamental analysis to 60 per cent).[38] The respective outcome of this questionnaire is summarized in Table 2.2. One can see that the group of fundamentalists is about as big as the group of technicians, due to the threshold values being chosen. The average numbers of these two groups representing more than 35 seem big enough for our analysis.[39]

2.3 Results

In the following analysis we use OLS estimators corrected for Newey-West standard-errors (see, Newey and West, 1987). We choose five lags as a result of the overlapping problem attributed to monthly forecasts with a six month forecast horizon, which imparts a fifth order moving average error process (see, for example Hansen and Hodrick, 1980). In addition and owing to the qualitative nature of the expectation data we use the quantification technique from Carlson and Parkin (1975) to generate point forecasts.[40] Due to non-stationarity characteristics of the time series, we use change forecasts rather than point forecasts. Detailed descriptions of the calculations and analyzed variables are given in each of the attached tables.

2.3.1 Rationality of expectations

In order to check characteristics of our survey participants with well established results in the literature, we perform conventional tests of forecast rationality. Since Dominguez (1986) and for this purpose primarily it is common to check the degree of unbiasedness as well as efficiency.

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[38] This could be connected to the panel composition, i.e. analysts being more represented than traders. We know that traders rely significantly more than others on flow analysis (see Gehrig and Menkhoff, 2004). The high representation of technical analysis seems very plausible, however, as it is known that fund managers – which are represented here too – heavily rely on technical investment strategies, such as momentum trading (Menkhoff and Schmidt, 2005).

[39] This average number of responses reflects the fact that we include only those observations in the sample where the person responding to the "use of information-question" does not change during time. Therefore, it seems almost unavoidable that the sample becomes smaller the more we go back into history.

[40] Taylor (1989), among others, also uses this method to quantify categorical responses.

Test of unbiasedness: $$\Delta s_{t+6} = \alpha + \beta \cdot \Delta s^{e}_{t+6} \quad (2.1)$$

Test of efficiency: $$\Delta s^{e}_{t+6} - \Delta s_{t+6} = \alpha + \beta \cdot FD_{t+6} \quad (2.2)$$

The unbiasedness test is modeled in equation (2.1), where the change of the exchange rate (Δs_{t+6}) is regressed on the corresponding expectation change (Δs^{e}_{t+6}). To satisfy the postulate of rationality, the estimated value of β has to be one, whereas α needs to be zero. Additionally in equation (2.2) the difference of the expected exchange rate change and the actual change is regressed on the six months forward rate premium (FD_{t+6}). To confirm efficiency and rationality of the expectations, it is required that β as well as α are both zero.

Table 2.3 presents results on the test of unbiasedness which reject the hypothesis of rational expectations, because β is significantly below unity. Furthermore the test of efficiency shows evidence of irrationality too, since β is significantly above null which implies that even data easily available such as the forward premium is not completely processed in exchange rate forecasts.[41] Taken together, the unbiased expectations hypothesis (and therefore the assumption of rationality) on consensus forecasts has to be rejected, being well in-line with the literature (e.g. Kim, 1997, MacDonald, 2000).

2.3.2 Bias of expectations

However, our primary interest lies on the sources for the irrationality of FX-forecasts. To reveal the kind of forecast pattern we estimate a hybrid model. Since the work by Frankel and Froot (1987) a lot of analyses have been carried out to estimate the expectation formation for exchange rates, i.e. extrapolative, adaptive, regressive expectations and some sort of mixed models on former (see e.g. Cavaglia et al., 1993, Ito, 1994, Bénassy-Quéré et al., 2003). In sum, it figures out that depending on the forecast horizon, short-term forecasts exhibit evidence of destabilizing behavior whereas long-term forecasts show stabilizing evidence.

Here we use a mixed model to regress the exchange rate forecasts on an extrapolative and a regressive term, since the former term covers well technical orientated forecaster behavior, whereas a regressive term should display the way how fundamentalists form their expectations. Furthermore, this procedure fits well into the relevant literature for comparative purposes (e.g. Moosa and Shamsuddin, 2004).

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[41] Not surprisingly, running the unbiasedness test for the forward rate reveals strongly biased results as well.

Expectations formation: $\Delta s^{e}_{t+6} = \alpha + \gamma \cdot (s_t - s_{t-1}) + \upsilon \cdot (\bar{s}_t - s_t)$ (2.3)

Systematic bias: $\Delta s^{e}_{t+6} - \Delta s_{t+6} = \alpha + \gamma \cdot (s_t - s_{t-1}) + \upsilon \cdot (\bar{s}_t - s_t)$ (2.4)

Equation (2.3) shows the expectation mechanism. The expected change of the exchange rate is regressed on an extrapolative term ($s_t - s_{t-1}$), which contains the previous one month change of the exchange rate. The second term on the right side of the equation displays the regressive formation ($\bar{s}_t - s_t$). The latter one is based upon the difference between a fundamental equilibrium and the current exchange rate. To generate the fundamental variable we have chosen the well known relative PPP model and calculated corresponding rates upon PPI differences. In addition to that we would like to find out, whether the consensus relies too much on these expectations concepts on average. Doing so, we use again the expectation errors (see notes to equation 2.2) and follow the approach of Frankel and Froot (1987a, pp. 147-150) in equation (2.4), regressing them on the expectations mechanisms.

The results in Table 2.4 show that the consensus is based upon a mixture of extrapolative and regressive expectation, so both mechanisms seem to matter. More interestingly the results for equation (2.4) show that forecasters rely too much on regressive expectations on average, whereas the same doesn't hold in respect to the extrapolation of current trends. We can summarize that the participants of the ZEW panel rely too heavily on the concept of PPP when forming US-dollar/euro forecasts in some way.

2.3.3 Expectations of fundamentalists and technicians

In this Subchapter we run the same regressions for the separated groups as in Subchapter 2.3.2. We would like to know, whether there are any differences in the way that groups form exchange rate expectations (indicator i separates the different groups).

Expectations formation: $\Delta s^{e,i}_{t+6} = \alpha^i + \gamma^i \cdot (s_t - s_{t-1}) + \upsilon^i \cdot (\bar{s}_t - s_t)$ (2.5)

Systematic bias: $\Delta s^{e,i}_{t+6} - \Delta s_{t+6} = \alpha^i + \gamma^i \cdot (s_t - s_{t-1}) + \upsilon^i \cdot (\bar{s}_t - s_t)$ (2.6)

Table 2.5 shows that the γ^i coefficient of equation (2.5) differs between the different groups. Technicians seem to rely most heavily on the extrapolative term and fundamentalists least, whereas intermediates take a position in between. On the other hand forming regressive expectations seems to be most important for fundamentalists, followed by intermediates and least important for technicians. Not surprisingly when we compare the biased coefficients in equation (2.6) fundamentalists rely significantly too much on the regressive term but not on the extrapolative term. Contrary, technicians orientate on a smaller degree too much on the regressive term, but additionally, they seem to follow too much on trend extrapolation (here the statistical significance is less obvious). Again intermediates find themselves between the other two groups with biased forecasts towards the regressive term.[42]

2.3.4 A threshold analysis of expectations

Following our last results we use a switching regression model with different regimes in order to get deeper insights into the structures of US-dollar/euro forecast biases. We determine the absolute value of the regressive term as the transition variable ($c_t = |\bar{s}_t - s_t|$), set the number of regimes to two (r = 2) and choose the threshold level (κ^i) via a grid search method (see e.g. Franses and Dijk, 2000, p. 84). Function ($I_i\,[c_t]$) indicates the valid regime in time t. The expectations model ($f_{r,i}[\bullet]$) shows different parameters, depending on the regime and the group. We follow this approach to see, whether the group specific forecast biases differ between periods, where the US-dollar/euro shows large deviations from PPP and periods, where exchange rates are in line with the fundamental concept. Earlier research by Taylor et al. (2001) has in fact indicated that adjustment speed in real exchange rates towards PPP may change faster in periods of large deviations from PPP.

Expectations formation: $$\Delta s_{t+6}^{e,i} = f_{1,i}[\bullet]\cdot I_i[c_t] + f_{2,i}[\bullet]\cdot(1 - I_i[c_t]) \qquad (2.7)$$

Systematic bias: $$\Delta s_{t+6}^{e,i} - \Delta s_{t+6} = f_{1,i}[\bullet]\cdot I_i[c_t] + f_{2,i}[\bullet]\cdot(1 - I_i[c_t]) \qquad (2.8)$$

with $f_{r,i}[\bullet] = \alpha_r^i + \gamma_r^i\cdot(s_t - s_{t-1}) + \upsilon_r^i\cdot(\bar{s}_t - s_t)$ and $r = 1,2$,

with $c_t = |\bar{s}_t - s_t|$ and $I_i(c_t)\begin{cases} = 1 \;, if\ |\bar{s}_t - s_t| \geq \kappa^i \\ = 0 \;, if\ |\bar{s}_t - s_t| < \kappa^i \end{cases}$.

[42] To test whether expectation coefficients are statistically different between groups, t-tests are performed. Between fundamentalists and other groups all coefficients are significantly different, whereas this applies between technicians and intermediates only for the regressive term in equation (2.5).

Table 2.6 represents the corresponding results and explains our procedure in detail. Summarizing and focusing on the estimation results of equation (2.7), the group of fundamentalists forms regressive expectations in both regimes, whereas the extent in regime 1 is greater (periods of major exchange rate deviations from PPP). This could contribute to stabilization in exchange rates and the utility of PPP. Additionally fundamentalists rely on trend extrapolation, but only in regime 2 (periods of minor exchange rate deviations from PPP). Contrary, technicians show a mix of regressive and extrapolative formation in both regimes. Further and looking at the parameter estimations of equation (2.8), all groups show a regressive bias in regime 1 but not in regime 2.[43] Finally we reveal also an extrapolative bias in the expectation formation of technicians but only for regime 1, while fundamentalists still do not show any adherence on an extrapolative bias. These results on forecasting bias may cause some worries: they indicate that expectations about mean reversion in exchange rates towards PPP might appear too optimistic; moreover, some professionals–the technicians–seem to form even extrapolative expectations to an unjustified degree and might consequently destabilize the market.

2.3.5 Performance of expectations

Our last analyses examine the forecast ability of the separated groups. Additionally we deal with related forward rates and random walk forecasts. The results are shown in Table 2.7 and include four accuracy tests applied to corresponding point forecasts and a hit rate (share of right direction forecasts) applied to underlying trend forecasts.

To cut a story short, one can not detect significant differences in the performance between fundamentalists, intermediates and technicians. However, if we concentrate on the analysis for point forecasts such as MAE (mean absolute error) and RMSE (root mean square error), the random walk beats all groups of forecaster as well as the forward rate, even though the latter one performs also better than the forecaster groups. On the other hand if we consider the hit rate, which is calculated upon underlying trend forecasts, that all groups perform significantly better than the random walk, whereas forecasts based on the forward rate are

[43] The different behavior of the bias depending on the currently valid regime approves, that in conventional regressions the bias varies over time (see, Frankel and Froot, 1987a, p. 150).

significantly worse than the random walk.[44] In addition to that, corresponding differences between the forecaster groups and the forward rate are highly significant.[45]

Taken together, both groups, fundamentalists and technicians, perform upon point forecast measures significantly worse than the random walk, as well as the forward rate. On the other hand, if we consider just the implicit trend forecasts, than these forecaster groups outperform the other forecast series. It definitely shows that participants of the ZEW survey have forecasting abilities despite all kinds of biases revealed (see also Wakita, 1989). If they would be able to avoid systematical distortions there would be an even better chance to forecast. This result stands in line with Elliott and Ito (1999, p. 455), "that more is going on in the models of the respondents than static expectations with random noise".

2.4 Conclusions

Our study on exchange rate expectations intends to bring fresh evidence into an established field. Thus, we first reproduce the stylized fact of non-rational expectation formation and conclude that our participants do not differ in this respect from those of earlier survey studies. We also notice–largely in line with the literature–that forecasts are biased, in particular that the sign of the bias does change over time. Our objective is, however, not just to perform the conventional tests for another survey at another time. We rather aim for adding a completely different and most interesting kind of information to the field to understand biased forecasts better: our survey is the first to combine a large data set of forecasts with information on the forecasters' preferred analytical instrument, e.g. their reliance on fundamentals.

We reveal that the preference of fundamental analysis is useful information to understand the way how exchange rate expectations are formed. Moreover, we detect that the preference of fundamental analysis helps to understand specific biases: fundamentalists believe too much in mean reversion of the US-dollar/euro, more than others. So, this misguided belief is consistent with poor forecasting performance. However, any claim of superior performance due to reliance on technical analysis is premature. Although the technicians' expectations are less distorted by too much reliance on PPP, they also show a misguided belief: they extrapolate short-term trends as one would assume, yet, they

[44] Note that the origin of the individual forecasts is of qualitative nature. Derived point forecasts are only used for comparative purposes.

[45] Performance statistics separated by PPP regimes show, that the groups perform better in regime 2. Moreover, if we pull up the hit rate, their out performance to the forward rate will get even bigger.

extrapolate too much. Consequently, this additional expectation distortion hinders them to form appropriate forecasts.

Overall, we argue that our data provide new evidence on possible sources of systematic forecasting biases. In addition to Ito's (1990) discovery of wishful thinking we reveal too much belief in mean reversion which can be interpreted usefully as too much belief in PPP. One ought to speculate whether Ito's and our detections may be connected to behavioral distortion in decision making: in this sense, our participants possibly overestimate the precision of their knowledge of exchange rate changes relying too much on their interpretation of PPP. However, there is also a competing explanation for fully rational forecasters, who show proper understanding of fundamentals: as we are covering professionals with somewhat long-term orientation, markets might act inconsistent to them. Then, foreign exchange markets are possibly dominated by short-term considerations which are less consistent with the directions that fundamentals advise.

Tables 2

TABLE 2.1

Statistics of consensus forecasts, forward rates and exchange rates

	consensus forecasts		**forward rates**		**exchange rates**	
	S^e_{t+6}	Δs^e_{t+6}	S^f_{t+6}	Δs^f_{t+6}	S_{t+6}	Δs_{t+6}
mean	1.1169	-0.0141	1.1297	0.0006	1.1294	0.0033
variance	0.0120	0.0037	0.0224	0.0006	0.0221	0.0052
std. dev.	0.1094	0.0604	0.1497	0.0249	0.1487	0.0709
min.	0.8808	-0.1470	0.8464	-0.0604	0.8510	-0.1304
max.	1.3282	0.1312	1.4358	0.0292	1.4120	0.1828

Notes: Using the method of Carlson and Parkin (1975) to derive aggregate point expectations requires two assumptions. First, each individual forecast is based upon a subjective probability distribution concerning the outcome of this forecast. However, applying the logistic distribution did not yield the results in any qualitatively different way. Second, the corresponding means of the individual probability distributions follow-up a normal distribution, which can be justified with the Central Limit Theorem. Furthermore we have to set a scaling factor, which displays the threshold, of which the forecasters perceive noticeable changes in the exchange rate. We choose a symmetric scaling factor of three percent. In a special survey the participants of the ZEW Financial Market Survey were asked to reveal their individual thresholds in correspondence to their different forecasts. The average median for the US-dollar/D-mark was a symmetric threshold of roughly three percent. Nevertheless, choosing other thresholds around three percent, didn't show any qualitatively different results. Taylor (1989) also uses the normal distribution and sets his scaling factor on 2.5 per cent. Other methods like choosing the threshold that the mean expected change is equal to the mean actual change or that squared prediction errors are minimized seem inappropriate because of overwhelming evidence towards irrational and inaccurate exchange rate expectations. Finally, in order to rescue some data points, in cases where the probability of a category is zero, we used neighboring estimated volatilities to compute the forecast (Carlson and Parkin, 1975, p. 130-131).

S^e is defined as the (consensus) forecast of the US-dollar/euro, whereas Δs^e represents the percentage change forecast of the US-dollar/euro.

S^f is defined as the implicit forecast of the US-dollar/euro based upon the 6 month libor rate difference and Δs^f represents the corresponding change forecast in percentage.

S is defined as the US-dollar/euro and Δs^t_{t+6} represents the percentage change of the US-dollar/euro from t to t+6.

TABLE 2.2

Statistics of the numbers of participants divided by groups

	fundamentalists	**intermediates**	**technicians**
group criteria: Fundamental analysis ≡ X	X ≥ 80	80 < X > 40	X ≤ 40
mean	35	80	38
min.	12	9	8
max.	57	122	58

Notes: All measurements are based upon a quantity of people. The statistics are calculated on the ZEW surveys from 12.1991 to 04.2004. Accordingly the number 35 that corresponds to the combination "mean" and "fundamentalists" represents the average number of people amongst all surveys, who use fundamental analysis to a degree of 80 or more per cent. Furthermore the combination "max." and "technicians" shows 58 and implies the maximum number of technicians in one survey. Concerning the participants in the survey, whom we categorized as technicians, their mean of technical analysis adds up to 52 per cent (considering the mean of the whole survey is 30 per cent) whereas they use 17 per cent on flow analysis on average (the corresponding overall mean is 10 per cent). In fact we are dealing with 237 individuals as not all participants of the ZEW survey responded to our questionnaire.

TABLE 2.3

Testing rational expectations: Unbiasedness and efficiency tests

$$\Delta s_{t+6} = \alpha + \beta \cdot \Delta s^{e}_{t+6}$$
$$\Delta s^{e}_{t+6} - \Delta s_{t+6} = \alpha + \beta \cdot FD_{t+6}$$

	β	[t-value]	α	[t-value]	DF	adj. R^2	F-test (α=0, β=1)
Δs_{t+6}	0.00	[0.02]	0.00	[-0.07]	147	-0.01	19.86***
$\Delta s^{e}_{t+6} - \Delta s_{t+6}$	1.79***	[3.73]	0.02	[1.35]	147	0.23	-

Notes: Here, as in the following tables of this chapter (except for Table 2.7), all variables are calculated in natural logarithmic form so that their differences represent corresponding changes:

Δs_{t+6} is defined as the difference between the current euro/US-dollar rate (D-mark/US-dollar-) and their prior six month rate.

Δs^e is defined as the difference between the expected euro/US-dollar consensus rate (D-mark/US-dollar-) and their subsequent actual realization.

FD is defined as the forward discount of the euro/US-dollar (D-mark/US-dollar), calculated upon the difference of 6 month libor rates.

All regressions are estimated with Newey-West standard-errors (see, Newey and West, 1987). Asterisks refer to the level of significance: *: ten per cent, **: five per cent, ***: one per cent.

TABLE 2.4

Hybrid model for consensus expectations

$$\Delta s^{e}_{t+6} = \alpha + \gamma \cdot (s_t - s_{t-1}) + \upsilon \cdot (\bar{s}_t - s_t)$$

$$\Delta s^{e}_{t+6} - \Delta s_{t+6} = \alpha + \gamma \cdot (s_t - s_{t-1}) + \upsilon \cdot (\bar{s}_t - s_t)$$

	γ	[t-value]	υ	[t-value]	α	[t-value]	adj. R^2
Δs^{e}_{t+6}	0.38***	[3.81]	0.35***	[10.25]	0.00	[0.72]	0.68
$\Delta s^{e}_{t+6} - \Delta s_{t+6}$	0.34	[1.26]	0.26***	[2.96]	0.01	[0.56]	0.16

Notes: The extrapolative term represents the previous one month change of the euro/US-dollar rate. Longer periods e.g. 3 months or 6 months changes show less significant results therefore we use the one month changes. The equilibrium rate of the foreign exchange rate is based upon the relative PPP concept. Corresponding rates are calculated upon PPI differences between the euro area and the USA. The use of CPI data could not reveal qualitatively different results. In addition to that robustness checkups show that the parameters indeed vary over time. Specifically we separated by equal time periods, up and down periods of the exchange rate as well as over- and undervaluation periods upon the PPP concept. However, in the majority of cases their signs remain equal.

TABLE 2.5

Hybrid model for group expectations

$$\Delta s^{e,i}_{t+6} = \alpha + \gamma^i \cdot (s_t - s_{t-1}) + \upsilon^i \cdot (\bar{s}_t - s_t)$$

$$\Delta s^{e,i}_{t+6} - \Delta s_{t+6} = \alpha + \gamma^i \cdot (s_t - s_{t-1}) + \upsilon^i \cdot (\bar{s}_t - s_t)$$

		γ^i	[t-value]	υ^i	[t-value]	α^i	[t-value]	adj. R^2
funda-mentalists	$\Delta s^{e,1}_{t+6}$	0.14	[0.58]	0.46***	[6.18]	0.00	[-0.54]	0.59
	$s^{e,i}_{t+6} - s_{t+6}$	0.12	[0.35]	0.37***	[3.31]	0.00	[-0.02]	0.23
inter-mediates	$\Delta s^{e,2}_{t+6}$	0.63**	[2.33]	0.42***	[5.13]	0.01	[1.26]	0.40
	$s^{e,2}_{t+6} - s_{t+6}$	0.58	[1.54]	0.33***	[3.14]	0.02	[1.00]	0.17
technicians	$\Delta s^{e,3}_{t+6}$	0.64***	[3.32]	0.40***	[6.73]	0.02**	[2.16]	0.45
	$s^{e,3}_{t+6} - s_{t+6}$	0.59*	[1.79]	0.31***	[3.06]	0.02	[1.38]	0.16

Notes: The extrapolative term as well as the regressive one is calculated in the same way as showed in Subchapter 2.3.2 As well as in above calculations we carried out robustness checks. Eventually the results appeared qualitatively very much alike. It is worth pointing out, that above all the differences between fundamentalists and technicians approved according to corresponding conclusions in this chapter.

TABLE 2.6

Hybrid model for group expectations with thresholds

$$\Delta s^{e,i}_{t+6} = f_{1,i}(\bullet)\cdot I[c^i_t] + f_{2,i}(\bullet)\cdot(1 - I[c^i_t])$$

$$\Delta s^{e,i}_{t+6} - \Delta s_{t+6} = f_{1,i}(\bullet)\cdot I[c^i_t] + f_{2,i}(\bullet)\cdot(1 - I[c^i_t])$$

$$\text{with } f_r(\bullet) = \alpha^i_r + \gamma^i_r \cdot (s_t - s_{t-1}) + \upsilon^i_r \cdot (\bar{s}_t - s_t) \quad \text{and } r = 1,2,$$

$$\text{with } c^i_t = |\bar{s}_t - s_t| \qquad \text{and } I(c^i_t)\begin{cases} = 1 & ,if\ |\bar{s}_t - s_t| \geq \kappa^i \\ = 0 & ,if\ |\bar{s}_t - s_t| < \kappa^i \end{cases}.$$

		r	γ^i_r	[t-value]	υ^i_r	[t-value]	α^i_r	[t-value]	adj. R^2
funda-mentalists	$\Delta s^{e,1}_{t+6}$	1	0.06	[0.16]	0.46***	[5.95]	0.00	[-0.15]	0.60
		2	0.29**	[2.22]	0.37**	[2.45]	-0.01	[-1.12]	0.32
	$s^{e,1}_{t+6} - s_{t+6}$	1	0.30	[0.73]	0.39***	[3.42]	0.00	[-0.16]	0.30
		2	-0.15	[-0.48]	0.20	[0.47]	0.00	[0.21]	-0.02
inter-mediates	$\Delta s^{e,2}_{t+6}$	1	0.70*	[1.75]	0.40***	[5.01]	0.03*	[1.91]	0.39
		2	0.51**	[2.48]	0.47**	[2.29]	-0.01	[-0.72]	0.31
	$s^{e,2}_{t+6} - s_{t+6}$	1	0.92**	[2.03]	0.33***	[3.24]	0.03	[1.20]	0.21
		2	0.06	[0.16]	0.24	[0.53]	0.00	[0.19]	-0.01
tech-nicians	$\Delta s^{e,3}_{t+6}$	1	0.67**	[2.48]	0.38***	[6.41]	0.03**	[2.58]	0.43
		2	0.60***	[3.62]	0.41***	[2.71]	0.00	[-0.01]	0.40
	$s^{e,3}_{t+6} - s_{t+6}$	1	0.87**	[2.25]	0.31***	[3.12]	0.03	[1.34]	0.19
		2	0.17	[0.52]	0.23	[0.55]	0.01	[0.64]	-0.01

Notes: Regime one represents the periods, when the euro/US-dollar deviates ten percent or more from his fundamentally fair value based upon the relative PPP theory. Regime two therefore represents the periods, when the realized exchange rates deviate less than ten percent from PPP exchange rates. The indicator function $I(c_t)$ shows in which regime exchange rates are currently located. Concerning the grid search method, we restrict the search for the threshold in a range of 2.5 – 25.0 per cent (with intervals of 2.5 per cent in between). Additionally we require that the number of observations in each of the regimes contains 30 per cent at minimum. Finally, the threshold is selected, if the overall residual sum of squares is minimized. Alternatively, setting wider threshold ranges results in slightly different thresholds between the separated groups; however, the outcomes do not show any qualitative changes.

TABLE 2.7

Tests of accuracy and quality of performance

	ME	MAE	RMSE	Theil's U	hit rate
fundamentalists	-0.0157	0.0964	0.1226	1.5367	0.6154***
intermediates	-0.0319	0.0974	0.1246	1.5613	0.5946**
technicians	-0.0392*	0.0956	0.1247	1.5681	0.5959**
forward rate	-0.0006	0.0746	0.0912	1.1455	0.3289***
random walk	-0.0010	0.0656	0.0796	-	-

Notes: Random walk forecasts are calculated on current exchange rates, respectively no change forecast.

ME represents the mean error based on euro/US-dollar forecasts and realized exchange rates.

MAE represents corresponding absolute mean error.

RMSE represents corresponding root mean square error. Differences between groups and other forecast series were examined upon

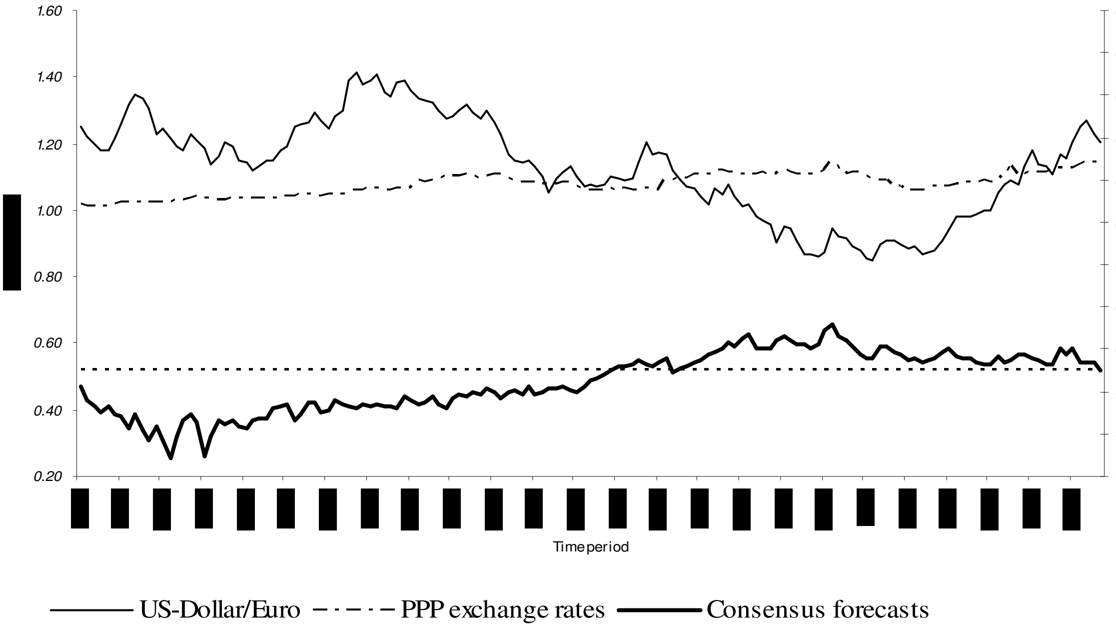
Theil's U represents the relation between the group specific RMSE and the RMSE of the random walk.

hit rate represents the share of right direction forecasts. In brackets you find the p-values of the chi-square test statistic in correspondence to the hypothesis of no directional forecast ability (Diebold and Lopez, 1996, pp. 256-258). Differences between the forecast series were tested upon contingency tables in connection with χ^2-tests.

Figures 2

FIGURE 2.1

US-dollar/euro rates, PPP exchange rates and consensus forecasts



Notes: This figure shows actual realizations of the US-dollar/euro and US-dollar/D-mark exchange rates, where the latter are transformed on the official exchange rate between the D-mark/euro of 1.95583 (left scaled). In addition to that it shows PPP exchange rates, which are calculated upon the PPP concept (left scaled) and consensus change predictions (right scaled). The consensus data were generated with the quantification method introduced by Carlson and Parkin, 1975 (for further details see note in Table 2.1). To calculate the fundamental exchange rates we used the PPP concept (further explanations are given in chapter regressive expectations). Whereas the US-dollar/euro as well as the PPP exchange rates are presented in their levels (corresponding left axis), the consensus data are shown in their changes (corresponding right axis). It can be seen, that the swap of the consensus forecasts from an appreciation of the US-dollar/euro to a depreciation occurred around the same time, when the US-dollar/euro crossed the line of the PPP exchange rates. Furthermore the amplitudes show a similar pattern, at least in their peaks.

3 Investor sentiment in the US-dollar: longer-term, nonlinear orientation on PPP[46]

3.1 Introduction

Foreign exchange markets, such as the US-dollar/euro market, seem to be characterized by a separation along the time horizon (see Frankel and Rose, 1995, p.1718). At shorter horizons, i.e. up to one or two years, there reigns the "exchange rate disconnect puzzle" (see Obstfeld and Rogoff, 2000). At longer horizons, however, exchange rates appear linked with economic fundamentals (see e.g. Sarno and Taylor, 2002). Unfortunately, this longer-term tendency of exchange rates towards equilibrium values—revealed in empirical exchange rate research—has never been reconciled with actual professionals' expectations. On the contrary, evidence shows that professionals' exchange rate expectations are consistently irrational.[47] This leaves us with a puzzle: why are exchange rates in the long run in line with fundamentals, whereas professional forecasts underlie considerable "expectational errors" (Frankel and Froot, 1987, p.150)? This chapter contributes to this question from a different perspective, first by analyzing the effective time horizon, to what investor sentiment is connected with subsequent exchange rate returns, and further, by distinguishing between sentiment's short- and long-run determinants. In sum, we find investor sentiment in exchange rates to be longer-term oriented than the predefined forecast horizon states, to be aligned with exchange rate fundamentals and to depend nonlinear on the actual exchange rate deviation from long-run purchasing power parity (PPP).

Researchers have always been unsatisfied with the consistent finding of "poor" exchange rate expectations of professionals. We argue that this result underlies a joint hypothesis problem, i.e. next to irrational expectations, drawing on an inappropriate time horizon could be on hand as well.[48] According to the empirical exchange rate literature, we propose three hypotheses concerning investor sentiment, which we test in this study (see e.g.

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[46] Co-author: Lukas Menkhoff, Leibniz Universität Hannover, Germany, forthcoming in Journal of Empirical Finance, copyright Elsevier.

[47] In fact, MacDonald (2000) surveys the related literature and states that professionals' exchange rate expectations violate throughout the criteria of unbiasedness and orthogonality. Thus, it seems "hard to avoid the conclusion that [this finding] implies some irrationality among market participants" (p. 94).

[48] There may be other reasons as well, such as Peso problems or learning processes (see e.g. MacDonald, 2000).

Sarno, 2005): first, sentiment derived from qualitative 6-month exchange rate expectations is longer-term oriented than the predefined forecast horizon states, which second, is attributed to its alignment with economic fundamentals. Third, higher deviations of current exchange rates from PPP cause stronger dependence of investor sentiment on fundamentals.

One robust finding in the empirical literature states that exchange rate models fail to outperform naïve (random walk) forecasts over shorter-term horizons (see Cheung, Chinn and Garcia Pascual, 2005). However, there exists a lot of evidence, which shows that exchange rates are linked to fundamentals in the long run (see early contributions e.g., MacDonald and Taylor, 1994, Mark, 1995).[49] Recent contributions confirming the latter finding include Abhyankar, Sarno and Valente (2005), who reveal the economic value of out-of-sample exchange rate forecasts using a monetary model as well as Rapach and Wohar (2002) or Sarno, Valente and Wohar (2004), who show cointegration between monetary fundamentals and exchange rates using long spans of data. Taken together, it appears to us, that professional forecasters cannot seriously expect to predict exchange rates in shorter-term horizons successfully, but are possibly aware about the long-term relation between exchange rates and fundamentals, which motivates our first hypothesis: because exchange rate expectations are aligned with fundamentals, they may well be biased towards longer-term horizons.[50]

Concerning the actual fundamentals, which probably influence investor sentiment, we refer particularly to the prominence of long-run PPP as a main building block of the monetary model. Its economic motivation is well understood and calculating equilibrium values is simple. Furthermore, the debate on the validity of PPP has experienced a complete reversal in the literature during the 1990s, since its absolute rejection has been later replaced by gradual acceptance (see Taylor and Taylor, 2004). In the beginning, PPP was seen as a very long-run phenomenon at best. However, calculated half-lives for deviations of exchange rates from PPP have remarkably decreased in empirical analyses, due to the application of more sophisticated methods. Estimated half-lives have decreased from five to six years (see Rogoff,

[49] The fact that some contributions show the long run linkage between exchange rates and fundamentals as early as in the 1990s, supports our argument, since professional forecasters could have known about this finding at the time the ZEW survey began.

[50] There is indeed early evidence of regressive expectations, e.g. in Frankel and Froot (1987). However, even 12-month expectations prove to be poor, when compared to related exchange rates.

1996) to approximately one to two years only (see Coakley and Fuertes, 2000, Imbs et al., 2005).[51] Thus, the concept of PPP has probably gained importance for investor sentiment.

With respect to our third hypothesis, empirical exchange rate research shows the existence of nonlinear adjustment processes towards fundamental concepts. Particularly it is found that the speed of exchange rates' mean reversion depends on the deviation of the current exchange rate from its equilibrium level. If exchange rates are close to fundamental equilibrium values, adjustments turn out being slow, if existent at all. However, if exchange rates deviate from fundamentals substantially adjustments towards related equilibriums are significantly stronger. Various studies confirm this finding, e.g. Taylor, Peel and Sarno (2001) or Kilian and Taylor (2003), both use an ESTAR model, different from Canjels, Prakash-Canjels and Taylor (2004) who run a TAR model, and Sarno and Valente (2006) who apply a Markov switching model. It follows that investor sentiment's relation to exchange rate fundamentals may be nonlinear, i.e. depending positively on the distance of the current exchange rate from its fundamental equilibrium.[52]

In the following subchapters we test whether these three hypotheses—i.e. longer-term orientation, alignment with fundamentals and nonlinear dependence on the PPP deviation—are reflected in investor sentiment in the US-dollar/euro. Our analysis is based on professionals' expectations, arisen from a monthly survey of the Center for European Economic Research at Mannheim (ZEW). This survey, which started in December 1991 and queries on average about 300 financial market professionals, has established as a standard source for financial market analyses and is featured inter alia by Bloomberg and Reuters.

We pursue the first hypothesis by applying long-horizon regressions, which allow us to investigate investor sentiment's orientation over various time horizons. In doing so, we follow Brown and Cliff's (2005) simulation technique, which is used to analyze investor sentiment's impact on US stock markets. Furthermore, since we are dealing with qualitative expectations, we condense the latter into a conventional sentiment indicator by calculating the relative share of upwards minus downwards expectations (i.e. known as "bull-bear spread"). It turns out that investor sentiment is not connected with subsequent exchange rate returns over

[51] Flôres et al. (1999) show that half-lives are about two years for various European countries, but considerable longer for Japan and Canada. Coakley et al. (2005) show further evidence in favor of relative PPP.

[52] Coakley and Fuertes (2006) reveal analogous stock dynamics concerning their related adjustment speeds.

shorter horizons, but becomes relevant to a significant degree in time horizons of more than two years.[53]

This finding encourages us to analyze investor sentiment's determinants. We examine a range of potential determinants, derived from common exchange rate models, e.g., interest rates, moneys and growth rates (see Sarno and Taylor, 2002). Since investor sentiment shows very persistent behavior, we apply Johansen's vector error-correction approach (see Johansen, 1995), which in addition enables us to separate sentiment's short-term and long-term elements. In fact, we reveal one cointegration relation to which sentiment error-corrects and which in turn confirms hypothesis two, i.e. investor sentiment is aligned with fundamentals.

Finally, in order to test for nonlinear effects underlying investor sentiment, we apply a threshold vector error-correction model, attributed to Hansen and Seo (2002). There are two reasons for following the threshold approach. First, threshold models, such as Canjels, Prakash-Canjels and Taylor (2004), have been applied successfully in the empirical exchange rate literature and, second, it seems economically plausible that sentiment changes somewhat abruptly, depending on accordant changes in professionals' mindsets. Studies arguing along this line include Shiller (1990), referring to financial markets in general, and Bacchetta and van Wincoop (2004) referring to the foreign exchange market. In so far, the "coordination channel", regarding the usefulness of official exchange rate intervention (see Sarno and Taylor, 2001, Reitz and Taylor, 2006) provides a plausible economic explanation. In this connection, central bank interventions act as a coordinating device to bring about the combined engagement of fundamentally oriented, stabilizing speculators at the same time. Accordingly, this linkage motivates to follow a threshold approach in order to test hypothesis three, i.e. the nonlinear dependence on the PPP deviation.[54]

Reassuringly, we reveal nonlinearity concerning investor sentiment's error-correction. Thus, once we consider the existence of different regimes, depending on the exchange rate's deviation from long-run PPP, mean reversion is weak inside a specific range around the PPP value. However, if actual exchange rates are outside this range, mean reversion becomes significantly stronger.

A misunderstanding could possibly arise by relating our findings to sentiment research on stock markets: most such studies find that investor sentiment reflects short-term

[53] Recently Ang, Bekeart and Wei (2006) find that surveys forecast better future US inflation than several other models, e.g., ARIMA processes or term structure models.

[54] We are aware that threshold as well as smooth transition models are approximations of the true but unknown nonlinear process. Both approaches have been successfully applied in many earlier studies.

exuberance, caused by irrational market forces, which disconnects stock prices from related fundamentals.[55] One plausible explanation of these findings states that investor sentiment comprises noise trader risk, which is introduced by less informed investors, such as private investors. In fact, separating market participants into informed institutionals (professionals) and uninformed individuals (private investors) reveals the latter being the driving force of stock price misalignments.[56] However, we cannot reveal such a phenomenon in our long-horizon regressions, possibly because there are hardly any individual investors in the foreign exchange market.

Nevertheless, also exchange rates may well be influenced at shorter-horizons by sentiment even though this does not show up in our long-horizon regressions. One way of considering this alternative, which is consistent with findings in stock market research, is thinking of sentiment as the sum of two unobserved components: a longer-term (stabilizing) component, described as a non-stationary process, and a shorter-term (destabilizing) component, constituting the stationary process. A plausible reason why we only find the longer-term component in investor sentiment may be due to the survey's composition, which consists mainly of analysts, strategists and portfolio managers. These groups tend to hold longer-term views on exchange rates, whereas short-term oriented foreign exchange traders amount only a minor fraction in the dataset (see e.g. Gehrig and Menkhoff, 2006).

In sum, we conclude that investor sentiment in exchange rates reflects three characteristic features: longer-term orientation, alignment with fundamentals and nonlinear dependence on exchange rate's deviation from PPP. We emphasize that we do not argue investor sentiment causing exchange rate dynamics in longer-term horizons. In lieu thereof, it reflects anticipation of apparent longer-term mean reversion in exchange rates towards PPP– acknowledged in several studies e.g., Kilian and Taylor (2003), Coakley et al. (2005), and, Sarno and Valente (2006). However, we emphasize that our findings contribute to put the apparent puzzle of contemporaneous exchange rate's long-run move towards fundamentals and professionals' seemingly irrational beliefs in perspective: given that investor sentiment in exchange rates is strongly aligned with fundamentals, it proves biased towards longer-term horizons.

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[55] See e.g. Baker and Wurgler (2006), Brown and Cliff (2004, 2005), Coakley and Fuertes (2006), and Fung and Lam (2004).

[56] The finding, that institutional investors often behave more sophisticated than individuals, has been shown in several studies (see e.g. Locke and Mann, 2005, Schmeling, 2006).

The chapter is structured as follows: Subchapter 3.2 presents a description of the data used for the empirical analyses. Subchapter 3.3 examines investor sentiment's orientation on future exchange rate returns. In Subchapter 3.4, sentiment's determinants are revealed, whereas we allow in Subchapter 3.5 for nonlinearity in the corresponding relations. Subchapter 3.6 summarizes the main findings.

3.2 Data

Our analysis is based on the well-established monthly financial market survey of the Centre for European Economic Research (ZEW) in Mannheim, Germany. Compared to other surveys of financial market professionals, the ZEW's survey structure is conventional (e.g., similar to Consensus Forecasts, London), but participation is large with about 300 responses.

The ZEW collects every month numerous economic and financial expectations, which are based on a time horizon of six months. For this purpose, the ZEW conducts a standardized questionnaire via fax, where responses are usually processed on the last Friday of each month. About 75 percent of participants work in the financial sector. Among these financial professionals, analysts represent the main fraction; however, traders, portfolio managers and senior bankers are included in the sample as well. Participants outside the financial sector work in finance or accounting departments and thus are likewise familiar with financial markets. The ZEW survey asks participants to reveal their qualitative expectations, i.e. "up", "down" or "no change". This sort of data fits absolutely to generate a bull-bear spread, which is a common measure in the financial community (see Brown and Cliff, 2004):

$$\text{SENTIMENT} = \text{UP} - \text{DOWN} \tag{3.1}$$

Investor sentiment is analyzed for the major foreign exchange market, i.e. the US-dollar/euro market, which links the two largest economic areas in the world (we convert the D-mark/US-dollar into euro/US-dollar until December 1998 respectively). In order to ensure continuity we take the reciprocal value of the euro's conventional notation, i.e. from January 1999 we use the euro/US-dollar exchange rate. Accordingly, "up" contains the relative amount of participants who forecast a stronger US-dollar vis-à-vis the euro and vice versa with respect to "down". Both numbers are measured in relation to all participants; thus, sentiment yields zero when the numbers of upwards and downwards expectations are equal.[57]

We cover the period from December 1991, i.e. the survey's introduction, to August 2005, which sums up to 165 observations. In addition to the sentiment series, further data is necessary for the analysis. Thus, we use euro/- and D-mark/US-dollar end of month rates from the Deutsche Bundesbank in order to generate the required exchange rate series. Both time series, i.e. sentiment and exchange rate, are shown in Figure 3.1 over the investigation period. Moreover, we consider various fundamental variables, which are used in standard exchange rate models. Taking the monetary model as the reference model, these variables are the following: differences of changes in money and income as well as of interest rates between the euro zone (Germany until December 1998 respectively) and the US. In detail, we use a broader definition of money, i.e. M3, and a narrower one, M2. In order to proxy income growth on a monthly basis, we rely on industrial production; additionally quarterly GDP is interpolated to generate a monthly frequency. With respect to interest rates, we use six months Libor rates. Furthermore, in order to consider Frankel's real interest differential model (1979) we incorporate 10-year government bond yields. Finally, and somewhat pragmatic, we control for the following variables in addition to this reference model. First, inflation is often seen to be a better proxy to capture price trends than money aggregates. Second, the trade balance is often assessed as a further exchange rate determinant (see e.g. Obstfeld and Rogoff, 1995) and, third, capital flows reach out money market instruments why we consider stock index returns too (see Hau and Rey, 2006).[58] Before we run the analyses, the time series properties of the underlying data have to be examined. Hence, we consult standard unit-root tests (Augmented Dickey-Fuller, Philips-Perron as well as KPSS).

Overall, these tests provide somewhat mixed results, depending on the particular procedure as well as the exact investigation period (see Table 3.1). Hence, the level series of the considered variables show at least very persistent behavior.[59]

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[57] Unless all participants expect either "up" or "down", investor sentiment outcomes range below one and above minus one. However, in this study investor sentiment never hits one of these borders.

[58] 6-month Libor rates and stock indices are taken from EcoWin. M2, M3, industrial productions, GDP, CPI inflation and trade balances stem from IMF's International Financial Statistics. German government bond yields are taken from the Deutsche Bundesbank and equivalent US yields from the Federal Reserve.

[59] However, the differences of the time series are stationary, so we can exclude dealing with I(2)-ness in the data.

3.3 Investor sentiment's horizon

By investigating professional's expectations formation, respective studies have taken formal forecast horizons literally—the related horizon of our data spans six months. However, we allow for various time horizons and find that investor sentiment in exchange rates is connected to longer-term returns. Nevertheless, the validity of aggregated exchange rate expectations based upon their predefined time horizons have been consistently irrational (see MacDonald, 2000). The same result applies to our data, as shown in Appendix 3A.[60]

Initiating our somewhat different approach; we draw on long-horizon regressions in order to test investor sentiment's orientation on future exchange rates by considering a bulk of different time horizons—ranging from one month to 60 months. In doing so, we follow Brown and Cliff's bootstrap technique (2005) with which they investigate investor sentiment in the US stock market.

$$r_t^k = \alpha^k + \boldsymbol{\Theta}^{k\prime} \cdot \boldsymbol{z}_t + \beta^k \cdot S_t + \varepsilon_t^k \qquad (3.2)$$

We regress k-period future average returns of the euro/US-dollar, r_t^k, on a vector of control variables, z_t, and on investor sentiment, S_t. The variables in the control vector are all those exchange rate determinants, which we already discussed in Subchapter 3.1 Thus, we follow the question, to which exact time horizon investor sentiment is related. The methodological difficulty of this approach is twofold. First, we deal with overlapping observations. Calculating average returns of sequential periods, one generates a moving average process in the error term, ε_t^k, of order k-1. Using Newey-West standard errors would be a way out, but due to our relatively small sample size, this correction has small power and so turns out being inappropriate (see Hodrick, 1992). Second, the persistent behavior of some of the regressors as well as the regressand has to be considered. The regressors appear as stochastic processes, possibly influenced by innovations, which are correlated with the disturbance term, ε_t^k. Accordingly, corresponding estimations would be biased, even though the regressors are predetermined, and hence, spurious regressions are the outcome (see Stambaugh, 1999). Therefore, significance levels of estimates of long-horizon regressions could increase even though an actual relation does not exist, because the overlapping of

[60] Here we analyze the accuracy of expectations: the test results are very much alike as that in other studies, which are based on different surveys (see Menkhoff et al., 2006, analyzing a somewhat shorter sample).

sample fractions alters the stochastic orders of the variables, which in turn generates persistence (see Valkanov, 2003).[61] Following Brown and Cliff (2005), we deal with this issue by applying a bootstrap simulation technique. Hence, we run 10,000 repetitions in order to derive simulated distributions of the estimates, which in turn allow us to calculate accurate test statistics.

Results presented in Table 3.2 reveal an interesting pattern. In the short run, investor sentiment does not correlate with future exchange rate returns at time horizons up to twelve months. However, by increasing the time horizon, corresponding beta coefficients rise and probability values decline, indicating that longer horizons matter. From month 32 upwards, investor sentiment's corrected coefficients turn out being statistically significant at the five percent level.

Thus, we receive our first finding: investor sentiment does not correlate in the short run with subsequent exchange rates but in longer horizons, which supports hypothesis one that investor sentiment is longer-term connected with exchange rates than the predefined forecast horizon states.[62]

3.4 Determinants of investor sentiment

Since we showed that investor sentiment is connected to longer-term exchange rates, one may wonder to which sources this finding is attributed. Therefore, we search in this subchapter for investor sentiment's economic determinants. In fact, we find that sentiment depends on several exchange rate fundamentals, i.e. the difference in inflation and in bond yields as well as the current exchange rate. Altogether, investor sentiment seems to align with long term PPP, which backs up hypothesis two that professionals are influenced by the insights from long-run exchange rate modeling. Due to the strong persistence of our data, we use a vector error-correction model (VEC model) in order to explain investor sentiment. Treating investor sentiment as integrated of order one, we can separate between its shorter-term and longer-term elements. Bearing in mind that investor sentiment is longer-term aligned we expect to reveal a long-term relation between fundamentals and investor sentiment. If

[61] Ferson et al. (2003) show that even if the regressand is not highly persistent, spurious regressions could result.

[62] We do not judge sentiment being of value in forecasting longer-term exchange rate returns. Although our dataset covers almost 14 years, it constitutes one entire up- and down-cycle of the Euro/US-dollar (see Figure 3.1).

investor sentiment also consists of destabilizing elements, we expect them being captured in sentiment's stationary component and thus showing up in the short-term relation.

In the following, the VEC model is formulated in differences, in which we restrict the constants into the cointegration space:[63]

$$\Delta x_t = \mathbf{\Pi} \cdot x_{t-1} + \mathbf{\Gamma}_1 \cdot \Delta x_{t-1} + \varepsilon_t \tag{3.3}$$

with $\mathbf{\Pi} = \alpha \cdot \beta'$,

with $\varepsilon_t \sim N_p(0, \mathbf{\Sigma})$ and $t = 1, \ldots, T$.

Vector X_t contains the essential variables forming the system, in which we have considered all variables mentioned in Subchapter 3.2, inter alia interest rates, growth etc. Our objective is to find a dataset, which delivers best model-fit and specification properties in order to explain sentiment. By checking the model specification, we run residual tests and present respective results in Table 3.3. Multivariate maximum-likelihood-tests do not reveal autocorrelation, but autoregressive heteroskedasticity of order three and five. Furthermore, residuals do not seem to be normally distributed; however, asymptotic test results are robust to heteroskedasticity and non-normality (see Johansen, 1995 and 2006). Identifying the rank of the VEC model, we run Johansen's Trace tests, which show that our model underlies one long-run relation (see results in Table 3.4). Assuming the chance that one variable of X_t generates a unit-root in this multivariate system we consult related LR-tests. Results in Table 3.5 show clearly that the revealed long-run relation does not constitute one of the variables being a unit-root.[64]

Table 3.6 presents the estimation results of the VEC model.[65] Regarding the long-run relation, it turns out that all variables of X_t are significant. Putting investor sentiment on the left, both the inflation and the bond yield difference affect sentiment positively. We associate the influence from bond yields on sentiment with longer-term inflation expectations. Moreover, the exchange rate correlates negatively with investor sentiment, which points to anticipated mean reversion in the euro/US-dollar. Turning to the short-run dynamics, next to investor sentiment only the bond yield difference significantly error-corrects to the

[63] For robustness, we consider other specifications without restrictions on the constants. Respective results do not change qualitatively the outcome. By testing for seasonal effects, no meaningful changes in the results show up.

[64] By selecting the lag-length of the VEC model via LR-tests, the lag of one proves being sufficient.

[65] Other attempts, using different variable sets, turn out being less fruitful than our final set up.

cointegration relation. Nevertheless, the magnitudes of the corresponding alpha-coefficients seem rather small, which consequently puts the economic significance into question. Furthermore, regarding the short-run coefficients arising from lagged differences of investor sentiment, we notify that investor sentiment does not influence any other variable in the short run. Looking at the significant determinants of investor sentiment's short-run equation, investor sentiment is affected negatively by the bond yield difference and positively by the euro/US-dollar. Whereas we attribute the short-term impact from the nominal exchange rate to common extrapolative behavior in financial markets, the negative short-run affect arising from the bond term is in line with the importance of real interest rates in foreign exchange markets (see Frankel, 1979).

Summarized, investor sentiment shows some destabilizing elements in the short run, caused by exchange rate momentum and changes in bond yields. In contrast, its nonstationary component is driven by stabilizing elements, which are associated with anticipated mean reversion in the exchange rate and expected future inflation. Regarding sentiment's error-correction parameter value, the long-run relation is lacking economic significance, which may indicate that some further sort of nonlinearity underlying investor sentiment has not been taken into account yet.

3.5 Threshold effects in investor sentiment

Following the idea of different speeds of investor sentiment's reaction on exchange rate misalignments, we analyze whether sentiment error-corrects differently by using a regime-switching model. Hereunto, we set up a threshold vector error-correction model (threshold VEC model), in which investor sentiment depends on exchange rate deviations from long term PPP.

Picking up our third hypothesis, i.e. investor sentiment's alignment with fundamentals depends on the exchange rate's deviation from PPP; we refer to Kilian and Taylor (2003). They assume that in a market with heterogeneous beliefs, consensus' anticipation of exchange rate mean reversion grows, the larger the misalignment from PPP (see also Taylor and Taylor, 2004, p.148). Relying on our previous results, we assume one cointegration relation, to which investor sentiment error-corrects.[66] Next to sentiment and the bond term, the long-run relation contains the inflation difference and the actual exchange rate (see Table 3.6). However, we

[66] In fact, the linear VEC analyses in Subchapter 3.4 do not indicate another existing long-run relation (see Table 3.4).

incorporate the latter two variables into a regressive term, which comprises the difference between the actual exchange rate and the corresponding PPP value.[67] Our procedure is motivated by Frankel's (1979) real interest differential model, in which next to the regressive term, the bond yield difference determines exchange rate expectations. By considering the latter variable, Frankel extends Dornbusch's sticky-price monetary exchange rate model by longer-term inflation expectations (proxied by bond yields).[68] In spirit of Kilian and Taylor (2003), investor sentiment should error-correct stronger to the cointegration relation, the higher the current exchange rate deviates from PPP. Hence, we draw on Hansen and Seo's model (2002), which combines cointegration and regime-switching and incorporates an exogenous threshold variable (see Appendix 3B).[69] Since recent studies in nonlinear exchange rate modeling show symmetric behavior of exchange rates, irrespective of being above or below their fair values (see e.g. Taylor, Peel and Sarno, 2001, Kilian and Taylor, 2003), we use symmetric thresholds as well by measuring the threshold variable in absolute values. Hence, we handle a two–regime model; in regime 1, the exchange rate is close to its PPP value, whereas in regime 2, exchange rate deviations from PPP are comparatively huge. Our model shows up as follows:

$$\Delta x_t = \begin{cases} \Pi \cdot x_{t-1} + \Gamma_1^{(1)} \cdot \Delta x_{t-1} + \varepsilon_t & \text{if} \quad z \leq \gamma \\ \Pi \cdot x_{t-1} + \Gamma_1^{(2)} \cdot \Delta x_{t-1} + \varepsilon_t & \text{if} \quad z > \gamma \end{cases} \tag{3.4}$$

$$\text{with } \Pi = \alpha \cdot \beta',$$

$$\text{with } \varepsilon_t \sim N_p(0, \Sigma) \qquad \text{and} \quad t = 1,\ldots,T.$$

Vector X_t comprises sentiment, the regressive term and the bond yield difference. Since we follow the idea that investor sentiment is subject to nonlinear (symmetric) error-correction, depending on exchange rate's misalignment from PPP, we regard the regressive term measured in absolute values as being the threshold variable, z. Hence, the current value of the latter identifies in connection with the endogenously generated threshold, γ, the

[67] Indeed, we estimated also the accordant linear VEC model and obtained very similar results to that in Table 3.6.

[68] MacDonald and Marsh (1997) consider balance of payment equilibriums, that's why they integrate the interest rate differential in an augmented PPP model. So in their setting, exchange rate expectations show up as being determined by a PPP term and the interest rate differential.

[69] Seo (2003) tests the expectations hypothesis of the term structure and shows significant nonlinear mean reversion in the term structure. He puts this down to threshold effects existing in the error-correction process.

effective regime, whereas all short-term coefficients are considered to vary between the two regimes.

Results are shown in Table 3.7, denoting a threshold value of 0.1597. Accordingly, regime 1 applies, if the exchange rate's misalignment is small, i.e. in a range of up to approximately 16 percent around the PPP value, whereas regime 2 holds, if the exchange rate is respectively outside this range. Overall, 64% of the observations take place in regime 1 and so the remaining 36% belong to regime 2. As expected, error-correction of investor sentiment to the cointegration relation increases significantly from 0.06 to 0.25, when switching over from regime 1 to regime 2. Looking at investor sentiment's short-run relation, the bond term influences sentiment negatively in regime 1, whereas no such relation shows up in regime 2. Moreover, influence from the regressive term on investor sentiment only takes place in regime 2.

Although we do not claim to take the estimated 16% threshold value too literally, we provide some intuitive interpretation regarding its usefulness. Looking at Figure 3.2 that shows the PPP-rate for the full post-Bretton Woods period it seems interesting to note that the frequency of regime 2 turns out almost equal to the corresponding frequency in our dataset. The last occurrence of regime 2 happened between February 2000 and October 2002, i.e. a period of considerable US-dollar strength and euro weakness, respectively. A look at investor sentiment given in Figure 3.1 shows that, indeed, sentiment turned strongly negative during this episode, indicating a fundamental undervaluation of the euro from the viewpoint of survey participants. Obviously, investor sentiment runs ahead of the later euro appreciation, whereas in the second half of 2000 actual interventions almost precisely mark the point when the euro weakness stopped.[70]

Overall, we find that sentiment's error-correction depends on the degree of the exchange rate misalignment from long-run PPP. In a 16 percent-range around the corresponding PPP value, investor sentiment does not show economically significant error-correction. However, outside this range, error-correction becomes definitely significant.

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[70] Fratzscher (2006) reveals around the years 1999 and 2000 heavy oral interventions by the European Central Bank with the purpose of supporting the Euro; however, these coincide with higher sentiment in the euro strength.

3.6 Conclusions

This chapter analyzes investor sentiment in the euro/US-dollar–based on professionals' qualitative expectations. In sum, investor sentiment is longer-term connected with exchange rates than the predefined forecast horizon states. Adapted from our analysis, we attribute this to investor sentiment's alignment with fundamentals, which in turn depends positively on exchange rate's deviation from long-run PPP.

By applying long-horizon regressions, we investigate investor sentiment's alignment over various time horizons, independent from its predefined forecast horizon. In fact, it turns out that sentiment is connected with future exchange rate returns over horizons of more than two years. In order to distinguish between investor sentiment's short- and long-run determinants, we set up a VEC model and reveal one statistically significant cointegration relation to which sentiment error-corrects. The long-run relation comprises variables, which closely mirror the concept of long-run PPP. By contrast, as the short-term relation of investor sentiment shows some extrapolative behavior, exchange rate sentiment seems to be influenced by destabilizing forces as well. However, since recent empirical studies reveal some sort of regime-switching behavior in exchange rates, we run a threshold VEC model in order to capture such nonlinearity. In fact, we identify that investor sentiment error-corrects regime-dependent: error-correction shows up being weak, when current exchange rates are close to long-run PPP, i.e. inside a range of about 16 percent around the corresponding PPP value, but strong, when exchange rates' misalignments are high, i.e. outside this specific range.

Overall, these three findings regarding investor sentiment closely match with well-established facts of empirical exchange rate modeling, i.e. longer-term validity of fundamentals, exchange rate's mean reversion towards long term PPP and stronger mean reversion the greater the distance of actual exchange rates from PPP values.

Tables 3

TABLE 3.1

Unit-root tests

	ADF	PP	KPS
sentiment	-1.25	-1.13	0.11
[prob. value]	[0.1936]	[0.2328]	-
Δsentiment	-22.59	-31.89	0.08
[prob. value]	[0.0000]	[0.0000]	-
inflation	-2.28	-2.92	0.13 *
[prob. value]	[0.1802]	[0.0456]	-
Δinflation	-18.62	-26.11	0.03
[prob. value]	[0.0000]	[0.0000]	-
dollar-rate	-1.12	-1.27	0.18 **
[prob. value]	[0.2390]	[0.1885]	
Δdollar-rate	-16.10	-19.75	0.05
[prob. value]	[0.0000]	[0.0000]	-
bonds	-2.20	-2.62	0.13 *
[prob. value]	[0.0275]	[0.0904]	-
Δbonds	-21.54	-26.37	0.04
[prob. value]	[0.0000]	[0.0000]	-

Notes: The chosen unit-root test specifications depend on intercepts' and trend variables' significances–i.e. if significant, then the additional regressor is included. We chose the integration of maximum twelve lagged differences. Appropriate lag-length selections in the Augmented Dickey-Fuller tests (ADF) are determined by the modified Akaike-procedure. In order to calculate the bandwidths for the Philips-Perron tests (PP) as well as for the Kwiatkowski-Phillips-Schmidt-Shin tests (KPS), we use Andrew's procedure, whereas Bartlett's kernel is chosen for the spectral estimations. Δ symbolizes the first difference of the respective variable. All tests are based upon 165 observations, containing observations from December 1991 to August 2005. The variables are investor sentiment (sentiment), relative-rate of year-to-year inflation (inflation), euro/US-dollar rate (dollar-rate) and the bond yield difference (bonds). Asterisks refer to the significance level: *: ten percent, **: five percent, ***: one percent.

TABLE 3.2

Long-horizon regression tests

	1-mon.	6-mon.	12-mon.	24-mon.	36-mon.	48-mon.	60-mon.
β	0.0021	0.0002	0.0014	0.0054	0.0086	0.0089	0.0082
$\beta^{(adj.)}$	0.0020	0.0023	0.0026	0.0069*	0.0097***	0.0088***	0.0073***
[$prob.^{(adj.)}$]	[0.3833]	[0.2109]	[0.1906]	[0.0822]	[0.0051]	[0.0002]	[0.0001]

Notes: All regressions are estimated using Newey-West standard errors, in which the lag-lengths depend on the number of return periods minus one. The vector of control variables, z_t, contains differences in domestic vs. foreign growth rates, stock returns, money growths and relative trade balance as well as respective interest rates, bond yields and inflation differences. The sample contains 165 monthly observations from December 1991 to August 2005.

The simulation procedure works as follows: first, long-horizon regressions of the exchange rate returns on the control variables and investor sentiment are run using Newey-West standard errors. Second, we estimate a VAR-model including the 1-month return and the control set, whereas investor sentiment's beta coefficient is set to zero in the exchange rate return equation. The arising residuals are stored. Third, using the latter, we conduct 10,000 bootstraps in order to generate recursively new time series, which in turn are used, fourth, to run Newey-West estimations in an analogous manner as in the first step. Fifth, simulated t-values are calculated by pulling up investor sentiment's beta coefficients, which we correct by subtracting thereof the mean beta estimation of the bootstraps and further, by dividing the latter term over the mean standard deviation estimation accordingly. Sixth, now we set up the simulated distributions, which in turn enable to calculate adequate probabilities of investor sentiment's betas, in which the latter have to be adjusted as well. β represents sentiment's original coefficient, whereas $\beta^{(adj.)}$ shows the respective adjusted coefficient, generated by the above-described bootstrap. $Prob.^{(adj.)}$ represents the p-value of the null, i.e. the adjusted coefficient is zero. Asterisks refer to the significance level: *: ten percent, **: five percent, ***: one percent.

TABLE 3.3

Misspecification tests of the VEC model

tests for autocorrelation			
LM-test (1):	X^2 (16)	= 21.31	[prob. value] = [0.167]
LM-test (2):	X^2 (16)	= 20.33	[prob. value] = [0.206]
LM-test (3):	X^2 (16)	= 6.15	[prob. value] = [0.986]
LM-test (4):	X^2 (16)	= 15.25	[prob. value] = [0.506]
LM-test (5):	X^2 (16)	= 14.08	[prob. value] = [0.592]
test for normality			
LM-test:	X^2 (8)	= 53.56***	[prob. value] = [0.000]
tests for ARCH			
LM-test (1):	X^2 (100)	= 110.69	[prob. value] = [0.218]
LM-test (2):	X^2 (200)	= 189.37	[prob. value] = [0.694]
LM-test (3):	X^2 (300)	= 341.12*	[prob. value] = [0.051]
LM-test (4):	X^2 (400)	= 427.92	[prob. value] = [0.161]
LM-test (5):	X^2 (500)	= 563.13**	[prob. value] = [0.026]

Notes: The test of normality distribution of the residuals is strongly rejected, indicating that residuals are not normally distributed. Additionally, the tests of ARCH-effects reveal heteroskedasticity in the data. Univariate tests reveal that normality is rejected due to skewness of investor sentiment and of the inflation difference as well as excess kurtosis of the latter. However, asymptotic results based upon the assumption of a Gaussian likelihood function, seem to be robust to some deviations of the residuals from the Gaussian distribution–i.e. heteroskedasticity and non-normality (see Johansen, 1995, 2006). Asterisks refer to the significance level: *: ten percent, **: five percent, ***: one percent.

TABLE 3.4

Cointegration rank determination (Trace tests)

	rank three	**rank two**	**rank one**	**rank zero**
eigenvalue	0.0193	0.0415	0.0963	0.2225
LR-test	3.15	10.03	26.44	67.20***
[prob. value]	[0.562]	[0.643]	[0.322]	[0.002]
LR-test #	2.51	9.20	24.44	64.75***
[prob. value] #	[0.679]	[0.720]	[0.440]	[0.004]

Notes: The LR-tests and the p-values marked with a hash are the Bartlett-corrected LR tests and the corresponding p-values, considered because of small sample-size effects on the power of the rank tests. Asterisks refer to the significance level: *: ten percent, **: five percent, ***: one percent.

TABLE 3.5

Multivariate unit-root tests

	sentiment	**inflation**	**dollar-rate**	**bonds**
LR-test - rank 1	35.52***	24.81***	33.25***	20.46***
[prob. value]	[0.000]	[0.000]	[0.000]	[0.000]
LR-test - rank 2	11.40***	3.54	10.16***	13.28***
[prob. value]	[0.003]	[0.170]	[0.006]	[0.001]
LR-test - rank 3	2.79*	1.73	0.68	3.75*
[prob. value]	[0.095]	[0.189]	[0.411]	[0.052]

Notes: Here, constants are restricted to the cointegration space. The numbers in brackets are the respective p-values. Since the Trace tests in Table 3.4 reveal a rank of one, we have to look on respective likelihood-ratio-tests. Hence, we find that the long-term relation does not constitute a unit-root underlying one of the endogenous variables. Asterisks refer to the significance level: *: ten percent, **: five percent, ***: one percent.

TABLE 3.6

Unrestricted VEC model estimation and model-fit

cointegration equation

	sentiment $^{(-1)}$ **=**	inflation $^{(-1)}$	dollar-rate $^{(-1)}$	bonds $^{(-1)}$	constant
β'	**1.00 =**	0.17	- 2.51	0.61	- 0.17

error-correction equations

	Δsentiment	**Δinflation**	**Δdollar-rate**	**Δbonds**
α	- 0.08***	0.07	0.00	0.11***
[t-value]	[- 5.03]	[1.18]	[0.31]	[2.91]
Δsentiment $^{(-1)}$	- 0.20***	- 0.02	0.04	0.03
[t-value]	[- 2.63]	[- 0.08]	[1.62]	[0.15]
Δinflation $^{(-1)}$	0.03*	- 0.00	0.00	- 0.06
[t-value]	[1.71]	[- 0.03]	[0.45]	[- 1.25]
Δdollar-rate $^{(-1)}$	0.62**	2.49**	0.06	- 1.17*
[t-value]	[2.34]	[2.36]	[0.65]	[- 1.75]
Δbonds $^{(-1)}$	- 0.08**	0.10	- 0.03***	0.04
[t-value]	[- 2.44]	[0.77]	[- 2.66]	[0.51]
R^2	0.17	0.06	0.08	0.06
adj. R^2	0.15	0.03	0.06	0.04
Akaike IC	-2.15	0.62	-4.31	-0.28

log likelihood of the system: 1461.20

Notes: This table shows the coefficients of the VEC model. The sample contains 165 monthly observations from December 1991 to August 2005. The variables of the system are investor sentiment (sentiment), relative-rate of year-to-year inflation (inflation), euro/US-dollar rate (dollar-rate) and the bond yield difference (bonds). The numbers in brackets are the respective t-values. Other variables were tested, amongst others production, trade balance and interest rates, which could not improve the estimation results and are therefore abandoned. We do not report LM-test statistics for binding cointegration restrictions, since no coefficients are restricted. Based upon calculated t-values, the cointegration parameters prove to be highly significant. Nevertheless, since latter test-statistics are not valid, they just provide rough indications, wherefore we do not present them. Asterisks refer to the significance level: *: ten percent, **: five percent, ***: one percent.

TABLE 3.7

Threshold VEC model estimation and model-fit

cointegration equation

		sentiment $^{(-1)}$ =	PPP term $^{(-1)}$	bonds $^{(-1)}$	constant
	β'	**1.00** =	-1.66	0.41	0.02

$\gamma = 0.1597$

error-correction equations

		α	Δsentiment $^{(-1)}$	ΔPPP term $^{(-1)}$	Δbonds $^{(-1)}$
REGIME 1	**Δsentiment**	- 0.06***	- 0.16	- 0.27	- 0.09**
	[t-value]	[- 3.13]	[- 1.61]	[- 0.57]	[- 2.42]
	ΔPPP term	0.00	0.06***	0.25***	- 0.02**
	[t-value]	[0.86]	[2.86]	[2.63]	[- 2.02]
	Δbonds	0.05	0.30*	- 1.79*	- 0.07
	[t-value]	[0.99]	[1.69]	[- 1.93]	[- 0.95]
REGIME 2	**Δsentiment**	- 0.25***	- 0.13	1.40**	- 0.06
	[t-value]	[- 4.97]	[- 1.13]	[2.54]	[- 1.41]
	ΔPPP term	0.01	0.06	0.14	- 0.03**
	[t-value]	[0.72]	[0.70]	[1.01]	[- 2.08]
	Δbonds	0.49***	- 0.52***	- 1.60	0.03
	[t-value]	[3.66]	[- 2.13]	[- 1.17]	[0.23]

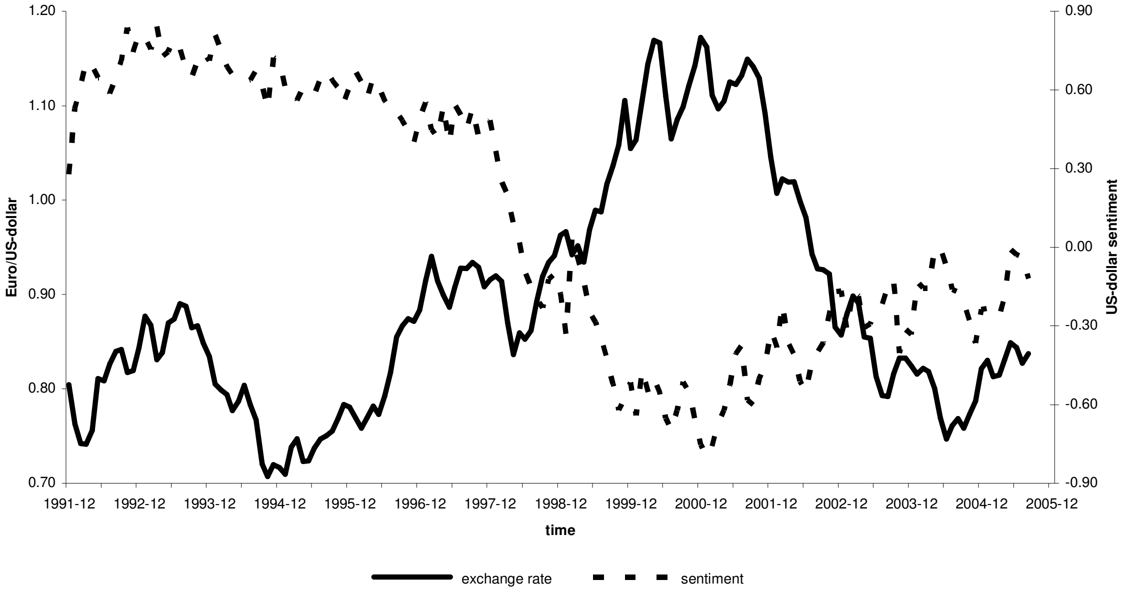
fixed regressor p-value for threshold effect	[0.09]
Wald p-value for equality of dynamic coefficients	[0.05]
Wald p-value for equality of ECM coefficients	[0.00]

Notes: We illustrate the coefficients of the threshold VEC model. Investor sentiment is set to one in the long-term space, whereas no further restrictions are set in the cointegration space or in the short-run relations. The sample contains 165 monthly observations from December 1991 to August 2005. The endogenous variables are investor sentiment (sentiment), the regressive term (PPP term) and the bond yield difference (bonds). The regressive term corresponds to the difference between the current euro/US-dollar and the related PPP rate. The numbers in brackets are the respective t-values. The latter variable, however, is based upon long-run validity of the relative PPP concept. Respective rates are calculated upon PPI differences between the euro area and the USA. Using CPI data, the results do not change qualitatively. Regime 1 includes 64 percent of the observations, whereas the remaining 36 percent belong to regime 2. The estimation of the related linear VEC model without threshold effect reveals qualitatively the same results as the ones reported in Table 3.6– -0.07 error-correction of investor sentiment. Again, based upon calculated t-values, the cointegration parameters are highly significant (see hereunto related notes in Table 3.6). Asterisks refer to the significance level: *: ten percent, **: five percent, ***: one percent.

Figures 3

FIGURE 3.1

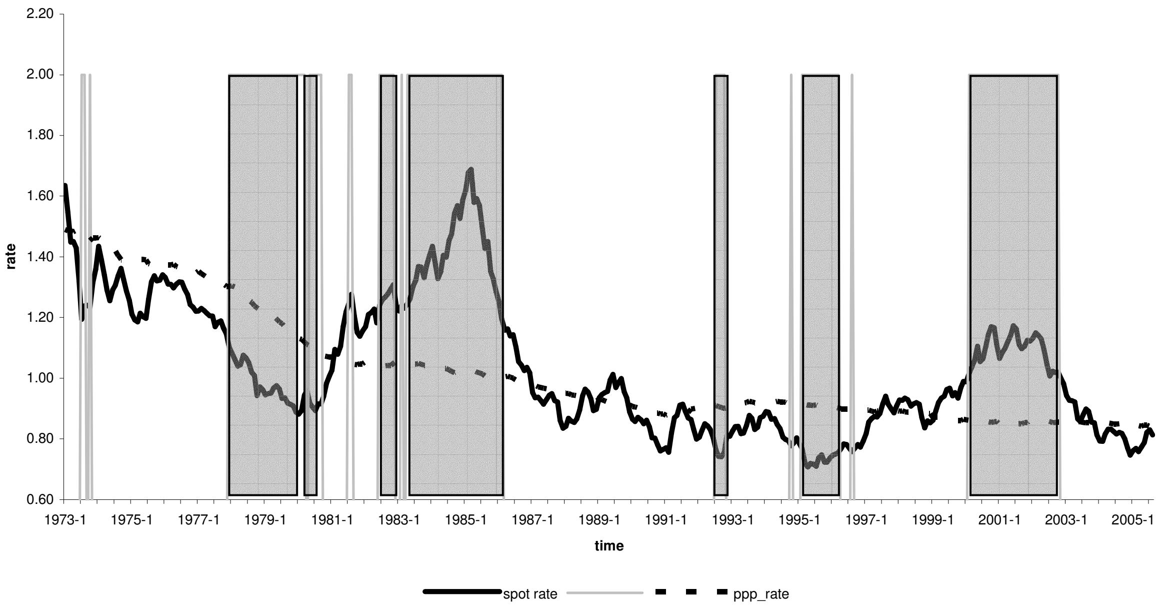
Euro/US-dollar rates (shifted 6 months forward) and sentiment



Notes: This figure shows US-dollar investor sentiment (right scaled) and the 6-month-subsequent euro/US dollar (left scaled). The sample contains 165 monthly observations from December 1991 to August 2005. Corresponding exchange rates until December 1998 are transformed based upon the official fixed exchange rate of 1.95583 between the D-mark and the euro. Investor sentiment is calculated upon qualitative 6-month euro/US-dollar forecasts–D-mark/US-dollar until December 1998 respectively–from the ZEW Financial Market Survey. We calculate investor sentiment as follows: the share of participants, which forecasts a stronger US-dollar vis-à-vis the euro, is subtracted from the share of participants, who forecast vice versa a weaker US-dollar. Since, both numbers are measured in relation to the total amount of participants, who forecasted the exchange rate, maximum and minimum value show up at one and minus one. However, investor sentiment never hits one of these borders.

FIGURE 3.2

Euro/US-dollar rates and PPP rates



Notes: This figure shows the spot rate of the euro/US-dollar and the related PPP rate. The sample contains 392 monthly observations from January 1973 to August 2005. Corresponding exchange rates until December 1998 are transformed based upon the official fixed exchange rate of 1.95583 between the D-mark and the euro. The related PPP rate is based upon long-run validity of the relative PPP concept. Respective rates are calculated upon PPI-differences between the euro area and the USA. Highlighted grey areas symbolize the periods, when the difference between the spot rate and the PPP rate results in 15.97 percent or more. Regime 1 includes 66 percent of the observations, whereas the remaining 34 percent belong to regime 2.

Appendix 3A

To replicate common of earlier studies, we perform several accuracy tests. Since most of the standard analyses are calculated upon point forecasts, we quantify our qualitative expectations data by using Carlson and Parkin's technique (1975). In doing so, we obtain point forecasts (consensus), which enables us to run standard accuracy tests.

Table A3.1 presents derived results, which are based upon the predefined six months forecast horizon. Furthermore, for comparable purposes, we run the same calculations upon the forward rate as well as the random walk without drift. Obviously, the derived consensus performs throughout worse than the competing forecast series, except upon the hit rate, which is defined as the share of correct trend forecasts. Consensus' mean error, the mean absolute error as well as the root mean square error are all larger than accordant errors of the forward rate and the random walk. Taken together and blinding out the hit rate, the forward rate performs in all tests the best. Again, drawing on the hit rate, the consensus performs undoubtedly better than the other forecasts, by generating a hit rate of more than 55 percent, whereas the forward rate forecast proves correctness in only approximately 34 percent of the observations.[71]

TABLE 3A.1

Tests of accuracy based on six months time horizon

	ME	MAE	RMSE	Theil's U	hit rate
consensus	-0.0242	0.0923	0.1112	1.3624	0.5564
forward rate	0.0061	0.0758	0.0938	1.1500	0.3383***
random walk	0.0043	0.0664	0.0816	-	-

Notes: In order to generate aggregate point expectations, we use Carlson and Parkin's quantification method (1975). This requires three assumptions. We assume that the subjective probability distributions, concerning the individual forecast realizations, are normally distributed. However, using the normal distribution for related means of the individual probability distributions is justified upon the Central Limit Theorem. Moreover, we set a symmetric scaling factor of three percent according to a related ZEW questionnaire, in which the survey participants revealed their perceived threshold wherefrom noticeable the exchange rate changes are perceived. Nevertheless, results did not change qualitatively by pulling up other thresholds around three percent. Random walk forecasts are calculated upon current exchange rates, implying no change forecasts. Asterisks refer to the significance level: *: ten percent, **: five percent, ***: one percent. ME represents the mean error based on US-dollar/euro forecasts and realized exchange rates. MAE shows the accordant mean absolute error whereas RMSE represents the root mean square error–significance levels of the error differences are calculated upon Theil's U. The hit rate shows the share of inherent accurate direction forecasts–significance levels are based upon χ^2-tests.

[71] Since a random walk without drift forecasts no change, the appropriate benchmark is set at 50 percent.

Appendix 3B

By using a grid search algorithm in connection with accordant LM-tests, we estimate jointly short-run and long-run coefficients as well as the threshold. Required confidence intervals for the grid search of the cointegration parameters (β) are evenly spaced around related parameter estimations derived from the accordant linear VEC estimation. Hence, the grid search examines all possible combinations of the parameter vector, β, and the threshold, γ, which meet the minimum regime size, i.e. the trimming parameter defines the required minimum fraction of the population in each regime. Due to our relatively small sample of 165 observations, we set the trimming parameter rather conservative at 0.20. By choosing the grid size for the cointegration coefficients and the threshold variable of 100 and 300, we run 1,000 bootstraps at a time. Furthermore, we use the Eicker-White covariance matrix in order to correct for arising heteroskedasticity in the residuals. Since the parameterization of the threshold model is a priori unknown, we base the null hypothesis upon the accordant linear model. Nevertheless, the asymptotic distributions of the arising LM-tests, which check the validity of the threshold model, figure out being intractable. In order to run inference analysis anyhow, Hansen and Seo (2002) suggest two alternative LM-tests via bootstrap techniques, which in contrast deliver appropriate asymptotic distributions. The "fixed regressor bootstrap", upon which we base our threshold tests, fixes in contrast to conventional bootstrap techniques, next to the estimated coefficients and the resulting residuals under the null, the original variable series as well as the estimated error-correction term. Modifying these residuals by adding i.i.d.-innovations of a standard normal distribution, then one regresses them on the variables–once for the whole sample and another time for the split samples determined by the threshold variable. By using jointly the latter generated coefficient matrixes and the modified residuals from the former complete regression, makes it possible to calculate the Eicker-White covariance matrix estimators. This in turn enables to calculate a LM-like statistic. By repeating these steps numerous times, simulated distributions of the test statistics with appropriate critical values are delivered. The alternative procedure is closer to standard bootstrapping, in which residuals are presumed being i.i.d., but without taking control of heteroskedasticity. Since Subchapter 3.4 reveals heteroskedasticity in our data, we stick to the fixed regressor bootstrap, which proves, accordant to Hansen and Seo (2002), to be robust to heteroskedasticity.

4 Heterogeneity in exchange rate expectations: evidence on the chartist-fundamentalist approach[72]

4.1 Introduction

It has become apparent that we cannot understand exchange rate behavior by relying on models with representative agents. All forms of these simplifying asset approach models have failed empirically (see Sarno and Taylor, 2002).[73] However, not only do they disappoint regarding their purpose, i.e. to explain the dynamics in exchange rates, they seem to be conceptually misleading, as well. There is now abundant evidence that market participants have quite heterogeneous expectations on future exchange rates.[74] This may explain why we observe a tremendous trading volume on foreign exchange markets, which is larger than the volume on the world's leading stock exchanges, not to mention trade in goods and services. Obviously, investor heterogeneity is key in understanding exchange rate dynamics and thus it is crucial to implement some form of heterogeneity in such models (see e.g. Lux, 1998, Westerhoff, 2003, De Grauwe and Grimaldi, 2006).[75] However, empirical studies on expectation heterogeneity have mainly studied cross-sectional differences, whereas this work is the first–according to our knowledge–to thoroughly examine the causes of heterogeneity in exchange rate expectations in the time-series dimension.

The goal of this research is to examine whether determinants of exchange rate heterogeneity–as indicated by the literature–hold in a time-series examination. In doing so, we rely on a dataset covering monthly expectations of about 300 professionals on three major exchange rates over 15 years. This data serves to measure dispersion of individual expectations as our proxy of expectation heterogeneity. Due to the very persistent nature of some of the time-series, we apply the vector error-correction (VEC) framework. Our universe of potential determinants is derived from three strands of literature (which we introduce in more detail below): first, and at the core of interest, we regard determinants introduced in

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[73] This literature begins with Meese and Rogoff (1983); their results have been frequently confirmed ever since, see e.g. Frankel and Rose (1995), Cheung, Chinn and Garcia Pascual (2005).

[74] See e.g. Frankel and Froot (1987), Ito (1990), MacDonald and Marsh (1996), Elliott and Ito (1999).

[75] See also Chen, Lux and Marchesi, 2001, Manzan and Westerhoff, 2005, Alfarano and Lux, 2007, Alfarano, Lux and Wagner, 2007.

models of heterogeneous agents–chartists and fundamentalists–that have been widely used (see e.g. Frankel and Froot, 1990, Brock and Hommes, 1998, Lux, 1998, De Grauwe and Grimaldi, 2006). Secondly, we consider the argument that noise traders create risk and thus heterogeneity (e.g. Flood and Rose, 1996, Mark and Wu, 1998), and, thirdly, we take up impulses from information heterogeneity about the macroeconomic fundamentals which may also explain heterogeneity in exchange rate expectations (e.g. Sims, 2003, Bacchetta and van Wincoop, 2006).[76] As the first strand, the modeling approach of chartists and fundamentalists, has dominated exchange rate research with respect to heterogeneous agents, the examination of the two other strands may serve as a means of verifying the robustness of the chartist-fundamentalist approach (C&F approach).[77]

We find that the universe of potential determinants of heterogeneity in exchange rate expectations boils down to three main variables, which provide support to models of chartists and fundamentalists: heterogeneity is positively related to, first, uncertainty among fundamentalists and, secondly, a shift from dominating fundamentalists to the minor group of chartists. Thirdly, these measures even hold if a risk premium is introduced, indicating uncertainty, which increases heterogeneity as well. Moreover, the consideration of macroeconomic variables measured in absolute, in change or alternatively in volatility form, does not contribute significantly to the explanation of expectation heterogeneity. Finally, risk captured by lagged exchange rate volatility explains heterogeneity only if we do not control for the three determinants introduced above. To conclude, the C&F approach proves to be useful in explaining dynamics of heterogeneity in exchange rate expectations.

Before giving more detailed results, we introduce the literature that motivates our analysis. The C&F approach is currently a common way of thinking about expectation heterogeneity in foreign exchange markets. One of the first observation of its potential relevance was the documentation that foreign exchange professionals rely heavily (and possibly also successfully) on technical analysis (see Goodman, 1979). This finding has been expanded into a set of stylized facts. Its main insight related to our research implies that technical analysis is, indeed, of high importance among foreign exchange professionals such as dealers and fund managers, a finding which has held since the 1970s until the present day

[76] Referring to Mankiw and Reis' (2002) "sticky information model", Mankiw, Reis and Wolfers (2003) test its implications on inflation expectations amongst others, arising from related macroeconomic variables.

[77] The term "chartist-fundamentalist approach" is often used in the literature, among others by Lux (1998), Westerhoff (2003), Manzan and Westerhoff (2005, 2007) and Alfarano, Lux and Wagner (2007).

(see Menkhoff and Taylor, 2007). The idea of switching between these kinds of analyses is based on the fact that technical and fundamental analyses coexist and are typically used by the same persons. Frankel and Froot paved the way with a series of papers aimed in this direction during the mid-1980s; the most complete account of their thinking is documented in Frankel and Froot (1990). They derive fundamentalists' and chartists' weight from a process, in which decision makers learn the right model from their past performance. Whereas fundamentalists anticipate that exchange rates move towards their long-run equilibrium, modeled via balanced current accounts, chartists take positions in line with recent exchange rate changes, i.e. they extrapolate exchange rate trends.

Frankel and Froot's (1990, 1990a) contribution comprises much of the current C&F approach's intuition; their design is specific, however, and aims at explaining the US-dollar in the 1980s. Thereafter, Brock and Hommes (1998) simulate the dynamics of a stock market also by relying on heterogeneous agents, who choose between different trading strategies due to their prior returns. In fact, the authors generate complex endogenous price dynamics, which match stylized facts of financial time series. Since then, several papers have contributed towards refining and extending this line of research; however, the basic intuition remained unchanged.[78] Due to this fact, we adhere to an indicative example of the C&F approach, i.e. in this case De Grauwe and Grimaldi's model (2006).

De Grauwe and Grimaldi (2006) assume–in line with Frankel and Froot (1990) and others–that market participants choose between a fundamentalist and a chartist trading strategy.[79] Fundamentalists are geared to the fundamental exchange rate, stemming from e.g. the purchasing power parity concept (PPP), whereas chartists extrapolate the current trend in the exchange rate.[80] The fundamental rule predicts higher expected returns and lower risks the farther exchange rates are from equilibrium. This implies that expectation heterogeneity decreases in situations, which are characterized by increasing exchange rate misalignment. On the other hand, the chartists' impact has proved to be less clear-cut. Obviously, their market share increases, the stronger the trend in the exchange rate becomes. Nevertheless, it depends on the general composition of the market, whether heterogeneity actually decreases or increases. In our sample, participants rank themselves mainly as fundamentalist and only

[78] Latest contributions include Wieland and Westerhoff (2005), Manzan and Westerhoff (2005, 2007), Alfarano and Lux (2007), Alfarano, Lux and Wagner (2007), Boswijk, Hommes and Manzan (2007), and Chiarella, Dieci and He (2007).

[79] In the following, we use the terms chartist and technical trading synonymously.

[80] In fact, De Grauwe and Grimaldi do not base their exchange rate on one single fundamental concept; however, their model presumes that corresponding fundamentals follow a random walk.

about 30% claimed to be chartist (see ZEW, 2004).[81] Thus, subsequent switches from fundamentalism to chartism will increase expectation heterogeneity.

As a second strand of literature we consider noise trading models, such as Jeanne and Rose (2002). They derive a positive relation between heterogeneity and the exchange risk premium (see Froot and Frankel, 1989) by analyzing the impact of noise trading on exchange rates (although they focus primarily on the current exchange rate regime). Their model shows that the appearance of more unsophisticated traders drives noise trading up and subsequently affects expectation heterogeneity, which in turn causes distortions of uncovered interest parity. In this manner, noise traders drive a wedge between the expected exchange rate and the forward rate and thus, they create heterogeneous expectations and risk (see also Flood and Rose, 1996, Mark and Wu, 1998).

Finally, a third strand of literature is provided by studies linking uncertainty about fundamentals to expectation heterogeneity. Bacchetta and van Wincoop (2006) implement information heterogeneity in a standard monetary model. Assuming the existence of dispersed information without any investor holding superior information, investors have to find out about fundamental information from unobserved trades. As time goes by, agents learn fundamentals and thus (rational) confusion gradually declines, which incorporates the intermediate situation of information based heterogeneity of expectations. In a different approach, Bacchetta and van Wincoop (2007a) apply the concept of rational inattention to foreign exchange (see also Sims, 2003, and more recently Reis, 2007). It is argued that potential gains from learning the complete information set are small, so agents are not fully informed, hold different sets of information and make infrequent portfolio decisions.[82] Accordingly, heterogeneity should rise in periods of higher news frequency, which would in turn increase the differences between agents' information sets. Such periods may be indicated by higher volatility of fundamentals or alternatively, by higher exchange rate volatility.[83]

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[81] The prevalence of fundamentalists in our sample is not surprising, given that the experience from various surveys shows that fund managers and analysts – which dominate our sample – prefer fundamental analysis, while foreign exchange dealers rely more on chart analysis (see Menkhoff and Taylor, 2007).

[82] Mankiw, Reis and Wolfers (2003) test Mankiw and Reis' "sticky information model" (2002). In particular, they do so by analyzing heterogeneity in inflation expectations. Amongst other determinants, changes and volatility in inflation seem to be the most important.

[83] Frankel and Froot (1990a) find a correlation between exchange rate volatility and dispersion, which they attribute to model heterogeneity – such as the C&F approach – rather than to heterogeneity in information.

Our relatively long and broad dataset allows us to examine the importance of the above discussed strands of literature in professional expectation data. In actual fact, we find conforming evidence with inherent implications of the C&F approach: heterogeneity in exchange rate expectations increases with decreasing deviation of the actual exchange rate from purchasing power parity (PPP)–indicating declining consensus among fundamentalists. This corresponds well with Kilian and Taylor's (2003) study, which shows that when exchange rates deviate from PPP-values substantially, subsequent adjustments towards their equilibriums are significantly stronger. Moreover, rapid changes in the exchange rate–indicating a shift towards chartism–increase expectation heterogeneity which, once again, matches with the C&F approach. In addition to that, another significant determinant shows up, as presumed by the second strand of literature, i.e. a rising exchange risk premium boosts expectation heterogeneity. Further variables as deduced by the third strand, such as volatility in exchange rate fundamentals or in exchange rates, do not provide *additional* insights. This pattern holds exactly for US-dollar as well as GB-pound versus euro and largely for JP-yen versus euro.

The remainder is structured as follows. Subchapter 4.2 describes the data we use in our analysis. Ancillary results revealing the existence of expectation heterogeneity are presented in Subchapter 4.3. The following Subchapter 4.4 contains the main results concerning the determinants of heterogeneity and Subchapter 4.5 concludes.

4.2 Data

Our analysis is built on two sorts of data: first, we use a dataset comprising 15 years of individual exchange rate expectations in order to calculate heterogeneity and, secondly, we use a large dataset of standard fundamental determinants of exchange rates.

By generating dispersion, as a means of representing our measure of heterogeneity in exchange rate expectations, we rely on individual expectations from the well-established financial market survey of the Centre for European Economic Research (ZEW) in Mannheim, Germany. The survey provides information on a monthly census of financial market professionals, questioning their 6-months forecasts of various financial and macroeconomic variables. Our sample contains expectations for the US-dollar/euro, GB-pound/euro and JP-yen/euro (until end of 1998 /D-mark respectively), from December 1991 until August 2006, which sums up each with 177 observations. Compared to other financial market surveys, the ZEW's survey structure is conventional and similar to Consensus Forecasts (London).

Nevertheless, it is worth mentioning that there has been wide participation with about 300 responses on average. Moreover, the design of the survey is of a qualitative nature, in that participants are only required to judge whether the corresponding variable goes up, down or stays unchanged. Due to the fact that our analyses require quantitative forecasts, we have to transform the data by means of a quantification technique. We do so by using Carlson and Parkin's method (1975), which in turn enables us to run appropriate analyses.

The expectation data is introduced in Table 4.1 which contains descriptive statistics of the aggregated exchange rate expectations. Two figures present the core variable in our analyses, i.e. heterogeneity in exchange rate expectations. For each of the three exchange rates, Figure 4.1 shows the histogram of dispersion, whereas Figure 4.2 presents its time-series next to the corresponding exchange rate. Overall, one can see remarkable variation in heterogeneity.

Since the main purpose of our work lies in discovering the determinants of heterogeneity, we need further data. To begin with, we use daily exchange rate data of the US-dollar/euro, GB-pound/euro and JP-yen/euro (-/D-mark respectively) from the Deutsche Bundesbank, in order to calculate amongst others, exchange rate changes and respective volatilities. Moreover, we consider core fundamentals, which are used in standard exchange rate models. Taking the monetary model as the reference model, these variables are the following: differences of changes in money and income as well as of interest rates between the euro zone (Germany until December 1998 respectively) and the United States, Great Britain and Japan, respectively. In detail, we use a broader definition of money, i.e. M3, and a narrower one, M2. In order to proxy income growth on a monthly basis, we rely on industrial production; additionally, quarterly GDP is interpolated to generate a monthly frequency. With respect to interest rates, we use 6-month Libor rates. Furthermore, considering Frankel's (1979) real interest differential model we also incorporate 10-year government bond yields. Finally, and somewhat more pragmatically, we use further variables beyond our reference model. First, inflation is often seen to be a better proxy to capture price trends than money aggregates. Secondly, the trade balance is often assessed as a further exchange rate determinant (see e.g. Obstfeld and Rogoff, 1995) and, thirdly, capital flows reach beyond money market instruments and bonds which is why we consider stock index returns, as well (see Hau and Rey, 2006).[84]

[84] 6-month Libor rates and stock indices are taken from EcoWin. M2, M3, industrial productions, GDP, CPI inflation and trade balances stem from IMF's International Financial Statistics. German

In the following subchapter we examine, which of the above introduced variables–as suggested by the three strands of literature–are related to heterogeneity in exchange rate expectations.

4.3 Determinants of expectation heterogeneity

To get a first idea about the relevant explanatory variables in order to explain heterogeneity in exchange rate expectations, we conduct basic regression analyses. More specifically, we identify three variables of interest, which we will thus pick up again in Subchapter 4.4. Before we discuss our results, we define the variables, which have to be constructed from raw data.

The following variables are deduced from the first strand of literature, underlying the C&F approach. Frankel and Froot (1990) explicitly draw on a relation between the expectation formation, the related time horizon and the preferred kind of information. They characterize fundamentalists as forming regressive expectations and being subject to a longer time horizon whereas chartists form extrapolative expectations and are shorter term oriented. Accordingly, considering fundamentalists' equilibrium expectations, we rely on the concept of PPP, which is well-known and popular among professionals as a tool to generate exchange rate equilibrium values. It follows that the absolute difference between the current exchange rate and its PPP-value determines fundamentalists' exchange rate expectations.[85] Regarding chartists' stance, we simply take the most recent 1-month change of the exchange rate, again in absolute terms. We feel quite confident that these two variables–a regressive variable based upon PPP and a 1-month extrapolative term–adequately capture the behavior of chartists and fundamentalists according to the C&F-approach.

With respect to the second strand of the literature, we apply the standard definition of the risk premium, i.e. the difference between the exchange rate expectation and the accordant forward rate (see e.g. Froot and Frankel, 1989, Bams, Walkowiak and Wolff, 2004).

This brings us to the third strand of literature, hypothesizing that further fundamentals determine heterogeneity. We examine the influence of those variables, which have been introduced in Subchapter 4.2, in three ways: first, we take them in algebraic signed form in

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government bond yields are taken from the Deutsche Bundesbank and US, British as well as Japanese yields from the Federal Reserve, the Bank of England and the Bank of Japan, respectively.

[85] The PPP-values are based upon long-run validity of the relative PPP-concept. Respective nominal values are derived from the average real exchange rate by using actual Consumer Price Indices.

order to allow for potential asymmetries.[86] Secondly, we consider fundamentals in their absolute form, which somewhat reduces complexity, since it does not allow for the above effects. Thirdly, we calculate their volatilities by relying on the 1-month standard deviation in order to capture potential second-moment-elements in dispersion. A full list of the considered variables is given in Appendix 4.1.

As a first analysis, we run univariate OLS-regressions, where we regress each of the above variables separately on expectation heterogeneity. To cut a long story short, there are only few results worth mentioning. In particular, no fundamental shows a significant relation with heterogeneity in exchange rate expectations, independent of its measured form. This is somewhat surprising, when compared to literature on inflation expectations (see Mankiw, Reis and Wolfers, 2003), but possibly less so when we remember that hardly exist any stable relations exist between exchange rate fundamentals and exchange rates except for the long run (e.g. MacDonald, 1999, Sarno and Taylor, 2002).

The few relations we find are presented in Table 4.2. The table shows the R-squares of regressions of the regressive term, the extrapolation variable and the risk variable, as well as exchange rate volatility on heterogeneity. Obviously, it is better to measure the series in absolute terms to explain dispersion instead of considering asymmetric effects in expectation heterogeneity with respect to the determinants' signs. However, with regard to conducting multivariate regressions, we see in Table 4.3 that the correlation of volatility with dispersion is completely absorbed by the other variables, for any exchange rate. Volatility becomes insignificant whereas the other variables remain significant in the multivariate setting.[87]

Overall, we find that the bulk of potentially relevant variables boils down to three, i.e. the two variables derived from the C&F approach and the risk premium. Moreover, since we do not reveal any sign of asymmetric effects underlying dispersion, we define these variables in absolute terms. In the next subchapter, we apply a VEC approach in order to account for the persistent behavior of some of the variables and thus to discriminate between temporary and permanent effects.

[86] See Elliott, Komunjer and Timmermann (2005) studying heterogeneity in output forecasts, and further studies of expectation heterogeneity in inflation, Mankiw, Reis and Wolfers (2003) and Capistrán and Timmermann (2006).

[87] Since Durbin Watson statistics indicate strong autocorrelation, we implement dispersion with lag one in the multivariate regressions.

4.4 Expectation heterogeneity in a VEC approach

The VEC model reveals permanent and temporary effects, with some differences between the three exchange rates under consideration. However, we emphasize that all three empirical models have a similar structure, indicating the existence of common determinants of heterogeneity in exchange rate expectations.

There are two justifications for choosing the VEC approach. First, we cannot rule out a priori, that some explanatory variables of the multivariate regressions presented in Subchapter 4.3 are in fact endogenous–to quote an example, dispersion could have an impact on the risk premium. Secondly, given that some of the time-series are very persistent, an error-correction approach appears justified in order to pick up the common stochastic trends, which could be present amongst the variables.[88]

Our baseline model contains the four variables identified in Subchapter 4.3, i.e. dispersion as our measure of expectation heterogeneity, the PPP-deviation term, the 1-month extrapolation variable and the risk premium. In addition to this, we test each exchange rate model separately for constants and dummy variables.89 So, our baseline model shows up as follows:

$$\Delta \mathbf{x}_{1,t} = A_0 \cdot \Delta \mathbf{x}_{2,t} + \Gamma_{1.1} \cdot \Delta \mathbf{x}_{1,t-1} + \cdots + \Gamma_{1.t-k+1} \cdot \Delta \mathbf{x}_{1,t-k+1} + \boldsymbol{\alpha} \cdot \boldsymbol{\beta}' \mathbf{x}_{t-1} + \boldsymbol{\Phi}_1 \cdot D_t + \boldsymbol{\mu}_0 + \boldsymbol{\varepsilon}_t \quad (4.1)$$

$$\text{with } \{\mathbf{x}_t\} = \{\mathbf{x}_{1,t}, \mathbf{x}_{2,t}\} \quad \text{and } \{\boldsymbol{\alpha}\} = \{\boldsymbol{\alpha}_1, \boldsymbol{\alpha}_2\}, \quad \text{whereas } \boldsymbol{\alpha}_2 = 0,$$

$$\text{with } \boldsymbol{\varepsilon}_t \sim N_p(0, \Sigma) \quad \text{and } \{\mathbf{x}_t\} = \{\mathbf{x}_{1,t}, \mathbf{x}_{2,t}\}.$$

Vector X_1 includes dispersion, the PPP term and the risk premium. However, since the extrapolation variable is stationary, it would definitely attract a common stochastic trend in the system for itself. Additionally, we do not expect the speed in exchange rate changes to be explained in this system, so we treat the difference in the exchange rate as weakly exogenous, i.e. entering X_2. Furthermore, we include economic reasonable permanent effects via dummy

[88] Treating misleadingly nonstationary data as stationary, we would generate spurious regressions without any economic meaning. On the other hand, treating persistent variables as unit-roots makes statistical inference more reliable than otherwise (see Johansen, 1995, 2006).

[89] Separated for each model, we use the residual series generated by the system estimation and set accordant dummies, when standardized errors exceed critical values. Considered dummies need to be statistically significant in the respective model and additionally, have to be accompanied by a reasonable economic explanation (see Nielsen, 2004).

variables in D. Note that these dummies, affecting at least one of the cointegration relations, would be additionally incorporated in X_2.

Consulting the specification tests, we construct the specific models for dispersion in the US-dollar, the GB-pound and the JP-yen, respectively. By examining for significant outliers in our data, respective test results notify that we need to consider two dummy variables in the VEC models. Regarding the GB-pound, two permanent-intervention dummies have to be considered, one in December 1998 and the other in September 2000. Regarding the JP-yen, we need only the permanent-intervention dummy in September 2000. Considering the US-dollar, a dummy effect appears in June 1993, but we do not include it in the model since we cannot find an economic explanation–its consideration does not impact the results in any way. Furthermore, whilst US-dollar and GB-pound trace tests show one cointegration relation to be sufficient in the respective systems, the JP-yen in contrast, requires two long-term relations (see Table 4.4). Finally, in the course of testing the models for the existence of unit-roots, no variable appears to be well approximated by an I(1)-process (see misspecification tests in Appendix 4.2 and, for further evidence, the multivariate unit-root tests in Appendix 4.3).[90] Thus, we handle structurally similar models for dispersion in all three exchange rates.

Table 4.5 shows the results of the unrestricted model estimation of US-dollar dispersion. Regarding the long-term relation, dispersion increases significantly when the PPP-deviation becomes smaller and the exchange rate trend or the exchange risk premium rises. As the first two determinants are derived from the C&F approach, our findings confirm the relevance of the C&F approach from a new perspective. The source of innovation lays in testing implicit relations regarding expectation heterogeneity in exchange rates. Findings are in accordance with underlying model assumptions and thus confirm the C&F approach. Moreover, the risk variable, which is unrelated to the C&F approach variables, has the sign as expected by the noise trading literature.[91] Turning to dispersion's short-term relation, dispersion error-corrects significantly towards its long-term equilibrium. Moreover, in the short run, the extrapolation variable strongly pushes dispersion. This impact works in such a manner that the speed of the exchange rate change positively impacts dispersion, indicating the enormous relevance of extrapolation in the short run.[92]

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[90] By selecting the lag-length of the models, we rely on LR-tests, which show one lag to be sufficient.

[91] However, the influence of risk may also be caused by information heterogeneity (see Bacchetta and van Wincoop, 2006).

[92] We do not discuss the other error-correction equations as they are not of interest to this research.

The structure of the model applied to the GB-pound is identical to that applied to the US-dollar, with the exception of two permanent dummies, which enter the error-correction equations, i.e. "blips" or one-time effects (see Table 4.6). The December 1998 dummy seems to be associated with a pronounced change in uncertainty regarding the prospective date of the introduction of the euro in the United Kingdom. In our analyses, this should only affect the GB-pound, since the notion of either the US or Japan joining the euro is absurd and, indeed, this effect does not appear in one of the other models. With regard to the September 2000 dummy, we connect this reaction to a highly controversial change of the ECB's monetary policy. On September 15th, the ECB raised its key interest rate for the first time, to vitalize the weak euro. However, financial markets assessed this as insufficient and sentiment in the euro dropped even further. This argument along ECB's policy raises the question of why we do not find such an effect in the US-dollar equation. Possibly, it is absorbed by the PPP-deviation term which is most pronounced in US-dollar dispersion among the three models.

The model for the JP-yen differs slightly from the others as can be seen from Table 4.7. As regards the long-term relations, dispersion in the JP-yen reacts positively when the PPP-deviation decreases or the risk premium increases, which is in line with the two other models. However, the influence of the extrapolation term on expectation heterogeneity turns out to be different. Heterogeneity in the JP-yen error-corrects to a second cointegration relation, in which the risk premium depends positively on the extrapolative term and on the PPP-deviation. Considering both cointegration relations, the effect arising from the PPP-deviation term on expectation heterogeneity appears somewhat ambiguous. One may speculate on whether this ambiguity results from Japanese monetary policy. It is known in this regard that the Bank of Japan deliberately influences the JP-yen via extremely low interest rates, as well as exchange rate interventions (see e.g. Frenkel, Pierdzioch and Stadtmann, 2004, Ito and Yabu, 2004), which in turn could potentially affect the respective exchange risk premium.

Despite certain particularities of the three models, we emphasize that the baseline structure holds: we find that the C&F variables and the exchange risk premium show the expected influences on heterogeneity in exchange rate expectations. To check for robustness, we consolidate the unrestricted VEC models to obtain the parsimonious specifications. To conclude, we confirm that dispersion's error-correction remains unchanged regarding all three models; as well as extrapolation's positive influence on dispersion in the short run.

4.5 Conclusions

Exchange rate dynamics have not been well understood for the last 30 years. We know that traditional models with representative agents fail seriously when confronted with real-world data. Thus, it is not surprising that simulation results generated by models with heterogeneous agents are more in line with the stylized facts of foreign exchange markets. Many of these models belong to the chartist-fundamentalist approach. Since their empirical analyses rely on simulation studies, our work contributes by analyzing the determinants of expectation heterogeneity in exchange rates using econometric techniques. Thus, we examine the relevance of the C&F approach from a different perspective.

We take advantage of our comparatively huge dataset, covering 15 years of exchange rate expectations. By calculating dispersion, i.e. our measure of heterogeneity in exchange rate expectations, we analyze its potential determinants suggested by the exchange rate literature. We find that influences arising from chartists' and fundamentalists' behavior are most useful in explaining heterogeneity, which is in line with the C&F approach.

Considering the long-term effects, heterogeneity decreases when the exchange rate is farther away from its fundamental equilibrium; according to the C&F approach this happens because in this case, professionals tend more and more to anticipate exchange rate's mean-reversion towards equilibrium. In addition, a stronger change in the exchange rate increases heterogeneity; according to the C&F approach this is caused by a subsequent shift of opinion, moving from the dominating fundamentalists to the minority group of chartists.

This basic pattern is complemented by a positive influence from the exchange rate risk on heterogeneity. It seems plausible that a risk premium reflects uncertainty; however, this pattern is consistent with competing interpretations. Risk may be caused by noise traders (Jeanne and Rose, 2002) or by uncertainty about the relevant set of information (Bacchetta and van Wincoop, 2006). Nevertheless, whatever the reason is, this does not contradict the importance of the C&F approach. Its relevance is moreover strengthened by the finding that the fundamentals or the fundamentals' volatility are not important in explaining heterogeneity in exchange rate expectations, at least not in our sample.

Tables 4

TABLE 4.1

Descriptive statistics of consensus expectations

	US-dollar		**GB-pound**		**JP-yen**	
	cons.	disp.	cons.	disp.	cons.	disp.
mean	1.133	0.070	0.718	0.042	1.319	0.043
std.	0.120	0.017	0.065	0.011	0.136	0.009
25%-q.	1.049	0.058	0.671	0.035	1.231	0.036
75%-q.	1.225	0.078	0.762	0.047	1.402	0.048
min.	0.881	0.043	0.628	0.024	0.975	0.028
max.	1.369	0.132	0.877	0.086	1.696	0.080

Notes: The data series are based upon corresponding 6-months expectations data from Dec. 1991 until Aug. 2006. All series are measured in levels and relate above-mentioned currencies to the D-mark until Dec. 1998 and thereafter to the euro. The variables are abbreviated as follows: aggregated point forecast–i.e. consensus (cons.) and dispersion (disp.). Using the method of Carlson and Parkin (1975) to derive aggregate point expectations requires two assumptions. First, each individual forecast is based upon a subjective probability distribution concerning the outcome of this forecast. However, applying the logistic distribution did not qualitatively change the results. Secondly, the corresponding means of the individual probability distributions follow-up a normal distribution, which can be justified via the Central-Limit Theorem. Furthermore, we choose a symmetric scaling of three percent, which displays a threshold. Hence, forecasters perceive noticeable changes in the exchange rate, if the latter proves to be three percent or more. Based upon a particular survey, the participants of the ZEW Financial Market Survey were asked to reveal the individual thresholds associated with their different forecasts. Nevertheless, choosing other thresholds–around three percent–did not reveal qualitatively different results.

TABLE 4.2

Univariate OLS-regressions of dispersion

$$y_t = \alpha + \beta \cdot x_t + \varepsilon_t \qquad \text{with } \varepsilon_t \sim N(0,\sigma^2)$$

$$y_t = \alpha + \beta \cdot |\, x_t \,| + \varepsilon_t \qquad \text{with } \varepsilon_t \sim N(0,\sigma^2)$$

	US-dollar	**GB-pound**	**JP-yen**
extrapol.	-0.006	-0.006	0.000
|extrapol.|	0.100	0.067	0.092
[split: (+), (-)]	[0.062, 0.145]	[0.094, 0.045]	[0.078, 0.098]
PPP-dev.	0.018	0.059	0.522
|PPP-dev.|	0.029	0.059	0.550
[split: (+), (-)]	[0.014, 0.032]	[n.a., 0.059]	[0.626, -0.016]
Risk	0.113	0.299	0.476
|risk|	0.436	0.468	0.512
[split: (+), (-)]	[0.534, 0.259]	[-0.000, 0.565]	[0.044, 0.534]
vola.	0.124	0.242	0.236

Notes: The regressions are calculated upon monthly data, covering Dec. 1991 until Aug. 2006. Dispersion series are based upon accordant six months expectations, whereas above-mentioned currencies are related to the D-mark until Dec. 1998 and thereafter to the euro. The numbers document adjusted R-squares of univariate OLS-regressions, in which dispersion is calculated on the displayed variable next to a constant. We do not show corresponding probability values, as we focus solely on the explained variances of dispersion. The variables are abbreviated as follows: Current 1-months exchange rate extrapolation (extrapol.), regressive term–i.e. difference between the actual exchange rate and its fair value based upon relative PPP using CPI–(PPP-dev.), risk premia–i.e. the expected (consensus) exchange rate change minus the relative bond rate (risk) and exchange rate volatility–i.e. corresponding 1-month standard-deviation–(vola.). Please note that strokes indicate that the respective variable appears in absolute measure. Moreover, splits separate the observations upon the signs of the respective variable, in the way that adjusted R-squares are calculated separately for positive and negative values.

TABLE 4.3

Multivariate OLS-regressions of dispersion

$= \alpha + {}' \cdot X +$ with $\sim N(0,\Omega)$

	US-dollar	GB-pound	JP-yen
const.	0.027***	0.026	0.015***
disp. $_{(-1)}$	0.423***	0.655***	0.488***
|PPP-dev.|	-0.033***	-0.004	0.023***
|risk|	0.229***	0.059**	0.076***
|extrapol.|	0.249***	0.078	0.089***
vola.	0.024	0.187	-0.006
adj. R^2	0.641	0.746	0.755

Notes: The regressions are calculated upon monthly data, covering December 1991 until August 2006 by using Newey-West standard errors. Dispersion series are based upon accordant six months expectations, whereas above-mentioned currencies are related to the D-mark until December 1998 and thereafter to the euro. The variables are abbreviated as follows: constant (const.), lagged dispersion (disp. $_{(-1)}$), regressive term–i.e. difference between the actual exchange rate and its fair value based upon relative PPP using CPI–(PPP-dev.), risk premia–i.e. the expected (consensus) exchange rate change minus the relative bond rate (risk), current exchange rate extrapolation (extrapol.) and exchange rate volatility–i.e. corresponding 1-month standard-deviation–(vola.). Please note that strokes indicate that the respective variable appears in absolute measure. Sticking to exchange rate volatility is solely appertained, to underline the irrelevance of exchange rate volatility. Without the latter, R^2's obviously remain nearly the same, and furthermore, the other regressors do not change in a meaningful way. Asterisks refer to the level of significance: *, **, *** to ten, five and one percent.

TABLE 4.4

Cointegration rank determination (Trace tests)

		rank three	rank two	rank one	rank zero
US-dollar	LR-test	-	2.973	17.010	52.788***
	[prob. value]	[n.a.]	[0.833]	[0.385]	[0.003]
	LR-test #	-	2.879	16.655	51.446***
	[prob. value] #	[n.a.]	[0.844]	[0.410]	[0.005]
GB-pound	LR-test	-	2.570	9.378	60.420***
	[prob. value]	[n.a.]	[0.880]	[0.916]	[0.000]
	LR-test #	-	2.416	9.053	58.961***
	[prob. value] #	[n.a.]	[0.896]	[0.929]	[0.001]
JP-yen	LR-test	-	6.705	46.968***	94.519***
	[prob. value]	[n.a.]	[0.353]	[0.000]	[0.000]
	LR-test #	-	6.361	45.663***	94.519***
	[prob. value] #	[n.a.]	[0.390]	[0.000]	[0.000]

Notes: The underlying VEC models are estimated using the Maximum Likelihood-method (ML-method), covering 177 monthly observations, from December 1991 to August 2006. The likelihood-ratio-tests and the probability values marked with a hash are the Bartlett-corrected LR-tests and p-values, necessary to consider sample-size effects on the power of the rank determination. Asterisks refer to the level of significance: *, **, *** to ten, five and one percent. It figures out, that solely considering the US-dollar and the GB-pound, in each case one long-term relation underlies the data, since higher-order LR-tests do not reject the null hypothesis of one unit-root less. Contrary to the others, the JP-yen reveals two long-term relations.

TABLE 4.5

The unrestricted VEC model for the US-dollar

$$\Delta \mathbf{x}_{1,t} = \boldsymbol{\theta}' \cdot \Delta x_{2,t} + \Gamma_{1.1} \cdot \Delta \mathbf{x}_{1,t-1} + \boldsymbol{\alpha} \cdot \boldsymbol{\beta}' \cdot x_{t-1} + \boldsymbol{\varepsilon}_t$$

$$\text{with } \{\mathbf{x}_t\} = \{\mathbf{x}_{1,t}, x_{2,t}\}, \quad \text{with } \{\boldsymbol{\alpha}\} = \{\boldsymbol{\alpha}_1, 0\} \text{ and } \boldsymbol{\varepsilon}_t \sim N_p(0, \Sigma).$$

cointegration equation:

	disp. $_{(-1)}$		risk $_{(-1)}$	PPP-dev. $_{(-1)}$	extrapol. $_{(-1)}$	const.
$\beta'_{(1)}$	1.000***	=	0.298***	-0.066**	0.710***	0.048***

error-correction equations:

	Δdisp.	Δrisk	ΔPPP-dev.
$\alpha_{(1)}$	-0.421***	-0.114	-0.309**
[t-value]	[-5.310]	[-1.096]	[-2.041]
$\Delta disp._{(-1)}$	-0.123	-0.021	0.190
[t-value]	[-1.318]	[-0.175]	[1.061]
$\Delta risk_{(-1)}$	0.030	0.002	-0.411***
[t-value]	[0.388]	[0.022]	[-2.828]
$\Delta PPP\text{-}dev_{(-1)}$	0.053	0.041	0.264***
[t-value]	[1.372]	[0.818]	[3.582]
$\Delta extrapol._{(0)}$	0.309***	0.130**	0.015
[t-value]	[6.718]	[2.163]	[0.166]
$\Delta extrapol._{(-1)}$	-0.018	-0.078	-0.060
[t-value]	[-0.341]	[-1.129]	[-0.589]
adj. R^2	0.289	0.030	0.131
sum $resid^2$	0.021	0.037	0.078

Notes: The VEC model is estimated using the ML-method. The sample period covers December 1991-August 2006. The variables are calculated in absolute values and are abbreviated as follows: dispersion (disp.), risk premium (risk), regressive term (PPP-dev.)–i.e. current exchange rate minus fair value upon the relative PPP concept using CPI data–as well as 1-month exchange rate extrapolation (extrapol.). Using calculated t-values, cointegration parameters are highly significant. Nevertheless, since the test-statistics are not valid, they are limited to providing rough indications about the significances, which is why we do not represent them. So we conduct Wald-tests so that the asterisks relate to the Bartlett-corrected test statistics, which we assume follow a $\chi 2$-distribution with degree of one. The log-likelihood of the system yields 2,264.205. Asterisks refer to the regressors' level of significance in the short-term relations: *, **, *** to ten, five and one percent.

TABLE 4.6

The unrestricted VEC model for the GB-pound

$$\Delta \mathbf{x}_{1,t} = \boldsymbol{\theta}' \cdot \Delta x_{2,t} + \Gamma_{1.1} \cdot \Delta \mathbf{x}_{1,t-1} + \boldsymbol{\alpha} \cdot \boldsymbol{\beta}' \cdot x_{t-1} + \Phi_1 \cdot D_t + \boldsymbol{\varepsilon}_t$$

$$\text{with } \{\mathbf{x}_t\} = \{\mathbf{x}_{1,t}, x_{2,t}\}, \quad \text{with } \{\boldsymbol{\alpha}\} = \{\boldsymbol{\alpha}_1, 0\} \quad \text{and } \boldsymbol{\varepsilon}_t \sim N_p(0, \Sigma).$$

cointegration equation:

	disp. (-1)		risk (-1)	PPP-dev. (-1)	extrapol. (-1)	const.
$\beta'_{(1)}$	1.000^{***}	=	0.237^{**}	-0.014^{*}	0.582^{***}	0.073^{*}

error-correction equations:

	Δdisp.	Δrisk	ΔPPP-dev.
$\alpha_{(1)}$	-0.275^{***}	0.132^{**}	-0.349^{*}
[t-value]	[-5.629]	[2.265]	[-1.747]
Δdisp.(-1)	-0.017	0.195^{**}	0.674^{**}
[t-value]	[-0.261]	[2.521]	[2.539]
Δrisk(-1)	0.011	-0.134^{*}	-0.197
[t-value]	[0.186]	[-1.819]	[-0.780]
ΔPPP-dev.(-1)	-0.036^{**}	0.043^{**}	0.170^{**}
[t-value]	[-1.998]	[2.029]	[2.329]
Δextrapol.(0)	0.155^{***}	0.033	0.440^{***}
[t-value]	[6.011]	[1.068]	[4.174]
Δextrapol.(-1)	-0.006	0.027	0.193^{*}
[t-value]	[-0.206]	[0.817]	[1.709]
Δdu0009(0)	0.017^{***}	-0.001	0.004
[t-value]	[3.829]	[-0.181]	[0.224]
Δdu9812(0)	0.036^{***}	-0.003	0.020
[t-value]	[7.828]	[-0.573]	[1.089]
adj. R^2	0.408	0.093	0.111
sum resid^2	0.003	0.005	0.058

Notes: The VEC-model is estimated using the ML-method. The sample period covers December 1991-August 2006. The variables are calculated in absolute values and are abbreviated as follows: dispersion (disp.), risk premium (risk), regressive term (PPP-dev.)–i.e. current exchange rate minus fair value based upon the relative PPP concept using CPI data–as well as 1-month exchange rate extrapolation (extrapol.). Specification tests show the necessity of implementing a mean-shift dummy in September 2000 (du0009) and a permanent-intervention dummy in December 1998. Using calculated t-values, cointegration parameters are highly significant. Nevertheless, since the test-statistics are not valid, they are limited to providing rough indications about the significances, which is why we do not represent them. So we conduct Wald-tests so that the asterisks relate to the Bartlett-corrected test statistics, which we assume follow a $\chi 2$-distribution with degree of one. The log-likelihood of the system yields 2,579.982. Asterisks refer to the regressors' level of significance in the short-term relations: *, **, *** to ten, five and one percent.

TABLE 4.7

The unrestricted VEC model for the JP-yen

$$\Delta\mathbf{x}_{1,t} = \boldsymbol{\theta}'\cdot\Delta x_{2,t} + \Gamma_{1.1}\cdot\Delta\mathbf{x}_{1,t-1} + \boldsymbol{\alpha}\cdot\boldsymbol{\beta}'\cdot x_{t-1} + \Phi_1\cdot D_t + \boldsymbol{\varepsilon}_t$$

$$\text{with } \{\mathbf{x}_t\} = \{\mathbf{x}_{1,t}, x_{2,t}\}, \quad \text{with } \{\boldsymbol{\alpha}\} = \{\boldsymbol{\alpha}_1, 0\} \quad \text{and } \boldsymbol{\varepsilon}_t \sim N_p(0,\Sigma).$$

cointegration equation:

	disp. $_{(-1)}$	**risk** $_{(-1)}$	**PPP-dev.** $_{(-1)}$	**extrapol.** $_{(-1)}$	**const.**
$\beta'_{(1)}$	1.000^{***} =	0.400^{***}	-0.032^{***}	n.a.	0.033^{***}
$\beta'_{(2)}$	n.a.	1.000^{***} =	0.224^{***}	0.660^{***}	-0.012^{*}

error-correction equations:

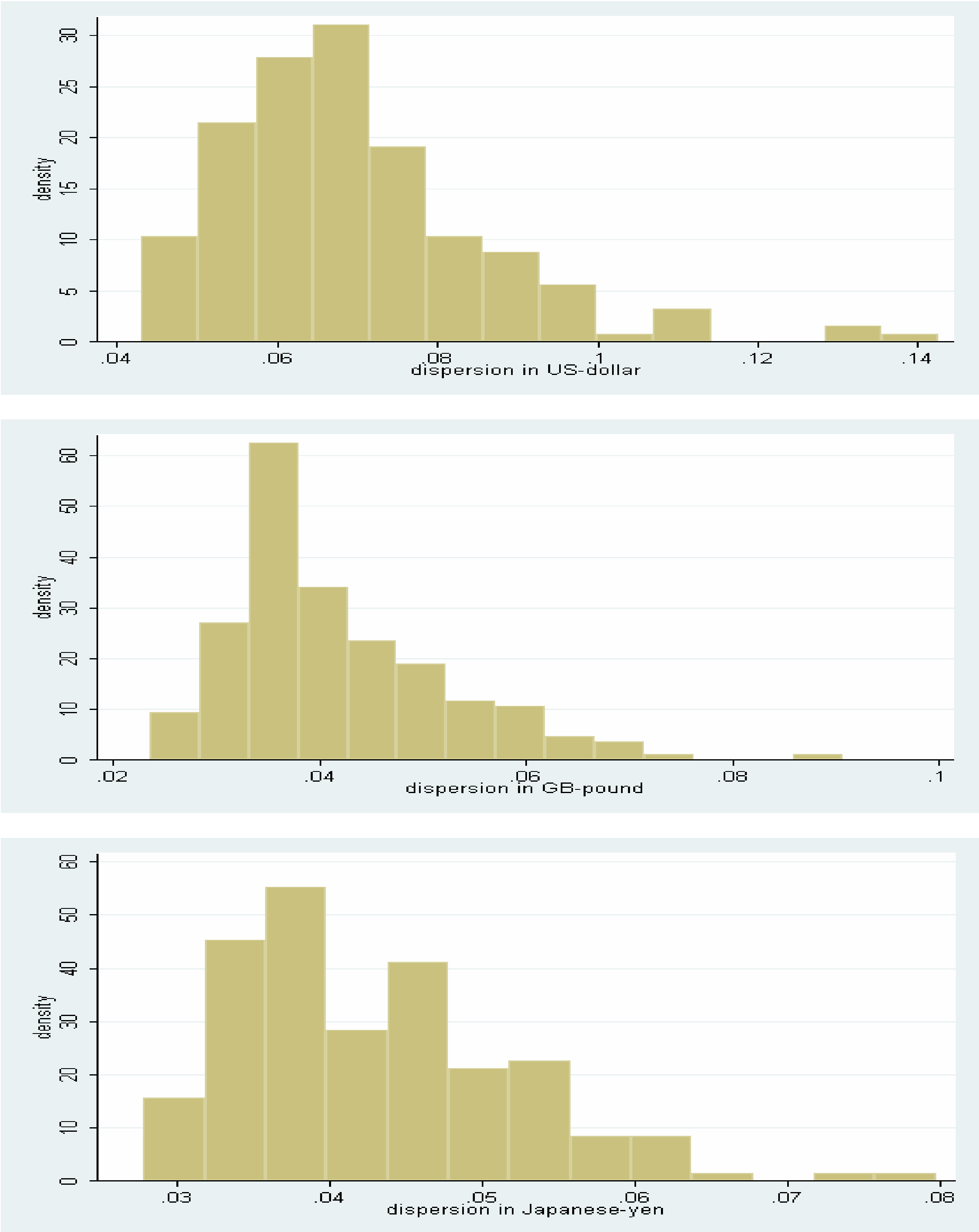
	Δdisp.	**Δrisk**	**ΔPPP-dev.**
$\alpha_{(1)}$	-0.450^{***}	-0.234^{**}	0.640
[t-value]	[-6.422]	[-2.566]	[1.476]
$\alpha_{(2)}$	-0.136^{***}	-0.217^{***}	0.091
[t-value]	[-5.315]	[-6.534]	[0.576]
$\Delta disp._{(-1)}$	0.020	0.221^{**}	-0.397
[t-value]	[0.272]	[2.288]	[-0.864]
$\Delta risk_{(-1)}$	0.047	-0.107	-0.942^{***}
[t-value]	[0.857]	[-1.479]	[-2.751]
$\Delta PPP\text{-}dev._{(-1)}$	-0.001	-0.006	0.037
[t-value]	[-0.082]	[-0.329]	[0.449]
$\Delta extrapol._{(0)}$	0.081^{***}	0.084^{***}	-0.060
[t-value]	[5.103]	[4.048]	-[0.613]
$\Delta extrapol._{(-1)}$	-0.011	-0.046^{**}	-0.024
[t-value]	[-0.630]	[-2.104]	[-0.230]
$\Delta du0009_{(0)}$	0.023^{***}	0.000	0.065^{**}
[t-value]	[5.060]	[0.028]	[2.377]
adj. R^2	0.364	0.265	0.070
sum $resid^2$	0.003	0.006	0.123

Notes: The VEC-model is estimated using the ML-method. The sample period covers December 1991-August 2006. The variables are calculated in absolute values and are abbreviated as follows: dispersion (disp.), risk premium (risk), regressive term (PPP-dev.)–i.e. current exchange rate minus fair value based upon the relative PPP concept using CPI data–as well as 1-month exchange rate extrapolation (extrapol.). Specification tests show the necessity of implementing a permanent-intervention dummy in September 2000 (du0009). Using calculated t-values, the cointegration parameters are highly significant. Nevertheless, since the test-statistics are not valid, they are limited to providing rough indications about the significances, which is why we do not represent them. So we conduct Wald-tests so that the asterisks relate to the Bartlett-corrected test statistics, which we assume follow a $\chi 2$-distribution with degree of three. The log-likelihood of the system yields 2,468.597. Asterisks refer to regressors' level of significance in the short-term relations: *, **, *** to ten, five and one percent.

Figures 4

FIGURE 4.1

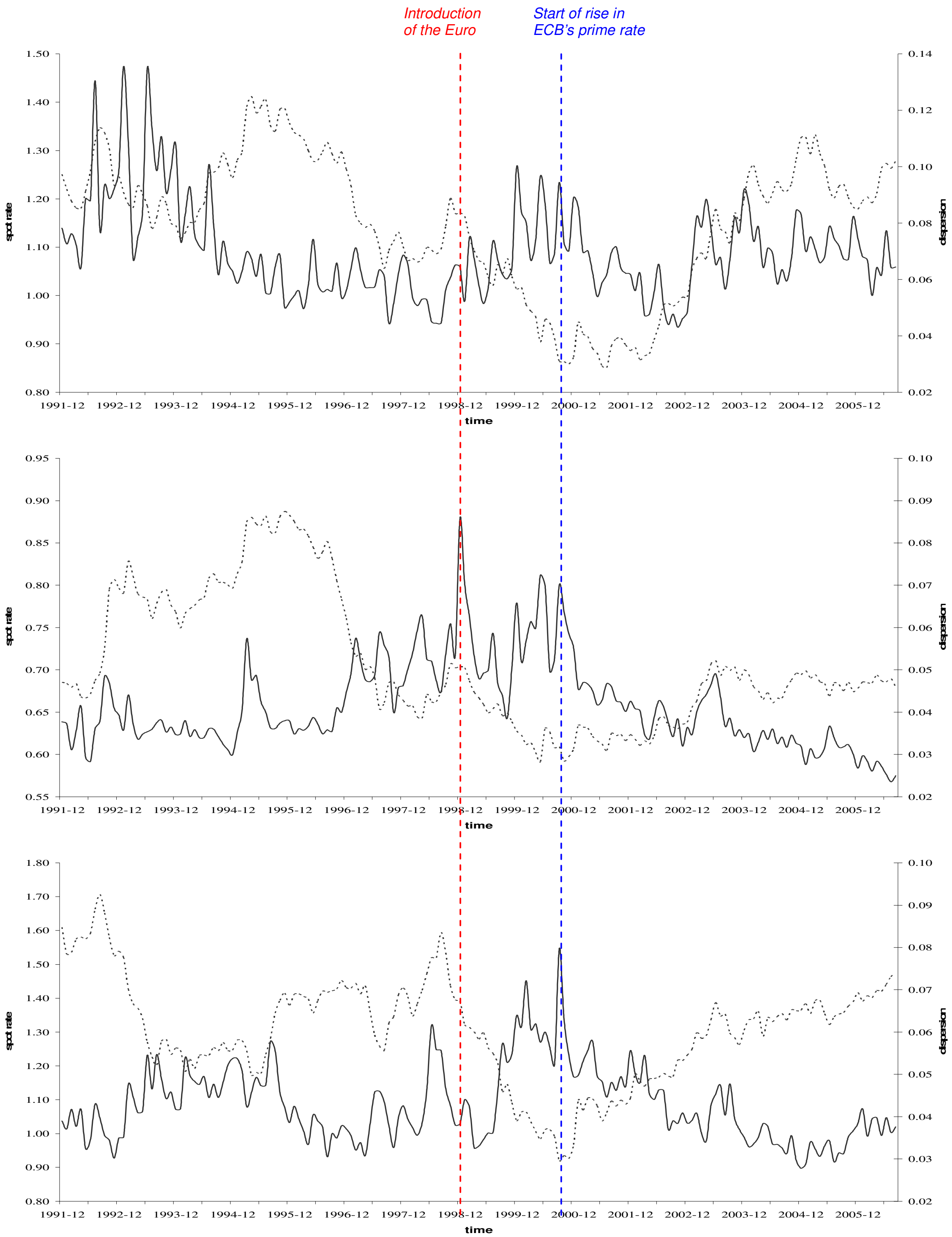
Histograms of dispersion in US-dollar, GB-pound and JP-yen



Notes: The dispersion series are based upon 6-month expectations data from Dec. 1991 until Aug. 2006. These histograms show the distribution of dispersion, when moving from top to bottom, in the euro/US-dollar, euro/GB-pound and euro/JP-yen (each with the D-Mark/- respectively).

FIGURE 4.2

Dispersion in US-dollar, GB-pound and JP-yen



Notes: The dispersion series are based upon 6-month expectations data from Dec. 1991 until Aug. 2006. The graphs show the time series of dispersion and related spot rates separately–moving from top to bottom–in the euro/US-dollar, euro/GB-pound and euro/JP-yen (each with the D-Mark/- respectively). Dashed horizontal lines represent spot rates, whereas solid lines show the corresponding dispersion series. Further, two dashed vertical lines represent the dummy events–i.e. the left related to December 1998 and the right to September 2000.

Appendix 4

TABLE A 4.1

Consulted set of explanatory variables on dispersion

	signed value	absolute value	volatility
Δmoney M2 *	x	x	x
Δmoney M3 *	x	x	x
Δindustrial production *	x	x	x
ΔGDP *	x	x	x
CPI inflation *	x	x	x
Δrelative trade balance *	x	x	x
6-month LIBOR rate *	x	x	x
10-year bond yields *	x	x	x
Δstock index *	x	x	x
1-month Δexchange rate	x	x	-
6-month Δ exchange rate	x	x	-
PPP-deviation (CPI)	-	x	-
risk premium	-	x	-
exchange rate volatility	-	-	x

Notes: Our sample contains monthly data from December 1991 until August 2006, which amounts to 177 observations, with the exception of the financial series, for which we use daily data in order to consider the dates of the individual expectations. All variables marked with an asterisk are generated by the difference between the euro zone and the United States, Great Britain and Japan (Germany until December 1998, respectively). Data in money (M2, M3), industrial production, GDP, CPI as well as trade balance stem from the IMF's International Financial Statistics. Furthermore, 6-month Libor rates, stock indices are taken from EcoWin. Daily data on German government bond yields are picked up from the Deutsche Bundesbank, US yields from the Federal Reserve GB yields, British yields from the Bank of England and accordant Japanese yields from the Bank of Japan. Daily exchange rate data of the US-dollar/euro, GB-pound/euro and JP-yen/euro (until December 1998 -/D-mark, respectively) stem again from the Deutsche Bundesbank.

TABLE A 4.2

Misspecification tests for VEC models

	US-dollar		GB-pound		JP-yen	
tests for autocorrelation						
	X^2	[prob. value]	X^2	[prob. value]	X^2	[prob. value]
LM-test (1):	10.700	[0.297]	9.888	[0.360]	13.894	[0.126]
LM-test (2):	20.692**	[0.014]	1691	[0.995]	14.198	[0.115]
LM-test (3):	9.382	[0.403]	15.768	[0.072]	7.541	[0.581]
LM-test (4):	14.755*	[0.098]	5.546	[0.784]	11.237	[0.260]
LM-test (5):	9.001	[0.437]	16.030	[0.066]	7.343	[0.602]
test for normality						
LM-test (.):	25.591***	[0.000]	10.060**	[0.122]	22.995***	[0.001]
tests for ARCH						
LM-test (1):	48.789*	[0.076]	72.171	[0.000]	32.578	[0.632]
LM-test (2):	70.963	[0.512]	95.233***	[0.035]	99.153**	[0.019]

Notes: The underlying VEC-models are estimated using the ML-method, covering 177 monthly observations, from December 1991 to August 2006. The multivariate maximum-likelihood-test of order two shows some autocorrelation for the US-dollar (but up to order ten, no further autocorrelation exists). However, it seems noteworthy, that this traces back to residual correlation between dispersion's and risk premium's short-term relation, i.e. amounting to 0.662. Based on the parsimonious version of the model and correcting for related simultaneous effects, autocorrelation dies out. The test for normality reveals that the residuals do not closely follow a normal distribution. Accordant univariate tests reveal that this is due to skewness and kurtosis in dispersion and the risk premium. Moreover, tests for ARCH-effects do not indicate heteroskedasticity in the data. However, results based upon the Gaussian-likelihood are asymptotically robust to some types of deviations of the residuals from the Gaussian distribution–i.e. heteroskedasticity and non-normality (see, Johansen, 2006). Asterisks refer to the level of significance: *, **, *** to ten, five and one percent. However, accordant VEC estimations are shown in Table 4.5-4.7, where further details can be found in the notes.

TABLE A 4.3

Multivariate LR-tests of unit-roots

		disp.	risk	PPP-dev.
US-dollar	rank 1	10.526***	26.946***	27.326***
	[prob. value]	[0.005]	[0.000]	[0.000]
GB-pound	rank 1	11.917***	38.982***	47.393***
	[prob. value]	[0.003]	[0.000]	[0.000]
JP-yen	rank 1	25.393***	32.063***	34.042***
	[prob. value]	[0.000]	[0.000]	[0.000]
	rank 2	19.7890***	29.334***	27.833***
	[prob. value]	[0.000]	[0.000]	[0.000]

Notes: The underlying VEC-models are estimated using the ML-method, covering 177 monthly observations, from December 1991 to August 2006. The variables are calculated in absolute values and are abbreviated as follows: Dispersion (disp.), risk premium (risk), regressive term (PPP-dev.)–i.e. current exchange rate minus fair value upon the relative PPP concept using CPI data–as well as 1-month exchange rate extrapolation (extrapol.).Included constants are restricted to the cointegration space. The numbers in brackets are corresponding probability values of the tests. Since the Trace tests in Table 4.4 reveal the ranks, separated for each exchange rate, we concentrate on respective likelihood-ratio-tests. The above results show clearly, that the uncovered long-term relations do not constitute a unit-root underlying one of the endogenous variables. Asterisks refer to the level of significance: *, **, *** to ten, five and one percent.

5 Exchange rate forecasters' performance and rationality[93]

5.1 Introduction

For more than 20 years we know that professional exchange rate forecasters form inaccurate consensus expectations (Frankel and Froot, 1987). This result has been confirmed for various samples and can thus be regarded a stylized fact.[94] From the beginning of this research on exchange rate expectations there occurred another worrying result as forecasts could have been better by incorporating available information on interest rates (Froot and Frankel, 1989). Even worse, such expectational errors of consensus forecasts exist until today (Bacchetta and van Wincoop, 2007). These facts of inaccuracy and ignorance raise obvious questions on the rationality of market participants and on the efficiency of foreign exchange markets. It is not clear why would professional market participants consistently form unnecessarily bad expectations?

Our research wants to challenge this view by providing new evidence. In order to measure the performance of exchange rate forecasters we take individual data and focus on individual forecasting performance over up to 14 years. We find indeed that forecasters in this comprehensive sample do not behave irrational in the above described sense as their average forecasting performance is slightly better than random forecasts. In detail, their directional forecasts are more often correct than wrong and trading strategies built on them would yield more often profits than losses. This finding about average performance seems to exclude systematic forecasting errors, however, it is not consistent enough to exclude random behavior.[95] Therefore, it is revealing that we find significant differences in performance which can be related to determinants of forecasting performance. Reassuringly, better forecasters show ability across currencies and they possess knowledge on fundamentals indicated by better interest rate forecasts. Moreover, they are more experienced and have less personnel responsibilities. Overall, this evidence provides a very different picture of the market than the

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[93] Co-authors: Ronald MacDonald, University of Glasgow, UK, and Lukas Menkhoff, Leibniz Universität Hannover, Germany.

[94] See early Dominguez, 1986, and the surveys by Takagi, 1991, MacDonald, 2000.

[95] The average performance we find is slightly better than random forecasts but not consistently so as we will show later. Thus there remains some uncertainty about the degree of forecasters' performance which we think is unavoidable in efficient markets. Clearly, irrationally bad forecast are a sign of inefficiency, however, significantly good forecast indicate inefficiency too.

above findings of inaccuracy and ignorance–instead, evidence seems to be well compatible with rational behavior of foreign exchange professionals.

The starting point of our research is to leave the analysis of median (or consensus) forecasts as they are fictive. In reality, *individual* forecasters give their expectations (see Frankel and Froot, 1987). Moreover, these expectations are often not formed as point forecasts but as directional expectations as is the case in our survey data. Comparative evidence indicates that *directional* forecasts perform better and that trading strategies built on them may be profitable–which we analyze here as well (see Leitch and Tanner, 1991, MacDonald and Marsh, 1996, Elliott and Ito, 1999). In order to learn more about possible systematic determinants of forecasting performance, we use the advantage of our dataset with truly individual information. We are thus able to link individual expectations to further individual characteristics. The latter consist of two types of information: first, we are interested to learn whether good exchange rate forecasts are based on fundamental information. For this purpose we use expectation formation of forecasters on those exchange rate fundamentals that form the core of asset market models, such as the monetary model of exchange rates, i.e. interest rates, inflation rates and growth rates. Second, we have information about personal characteristics, such as age, experience, education etc. which we use to determine the performance of forecasters.

This study is related to three strands of literature. First, we use our large data base to reproduce analyses on accuracy and rationality of median forecasts as conducted by Frankel and Froot (1987) among others. We find similar results indicating that any new findings in our research are not caused by an irregular sample. The second strand of literature we relate to is studies analyzing individual exchange rate expectations which we introduce in more detail in Section 2 below. Most of this literature focuses on heterogeneity, i.e. the cross-section, but does not analyze individual time-series properties. Those analyzing the time-series often have to rely on short samples. An exception inspiring our work is Elliott and Ito (1999) who analyze an 11 years period of 42 firms' yen/US-dollar forecasts. They find small profits on average but do not provide much information on individual forecasts. Moreover, as firms–not individuals–contribute to their survey, these expectations cannot be linked to individual characteristics. There is a third strand of literature, which is also related to ours, although not from foreign exchange, and which is shortly discussed in Section 2 too. The study of analysts and fund managers in general shows that there are professionals who significantly outperform the market and that outperformance is related to better knowledge about fundamentals and some personal characteristics, such as experience. We regard these findings as a reasonable guide that our findings in foreign exchange may be well in line with general insights in the rationality of financial market professionals and thus tentative market efficiency.

The paper is structured into seven further parts. Section 2 relates our research to the literature, Section 3 introduces into data used. Then Section 4 reveals heterogeneous performance among our forecasters, Section 5 relates performance to the same persons' forecasts of exchange rate fundamentals and Section 6 links performance to forecasters' personal characteristics. In order to test robustness of our findings the main analyses are repeated in Section 7 for other performance measures, i.e. profits and risk-adjusted profits. Section 8 concludes.

5.2 Related literature

The literature on foreign exchange does not provide strong motivation trying to forecast exchange rates. In fact, the Messe and Rogoff (1983) verdict still holds that there is no fundamental model able to generally explain–not to speak of forecasting–currency movements (see recently Cheung et al., 2005): instead, exchange rates seem to be largely disconnected from economic fundamentals, the "disconnect puzzle" (Obstfeld and Rogoff, 2000). So exchange rate forecasting is a tedious task, which makes the finding of inaccuracy and irrationality easier digestible.

However, practice provides a challenging contrast to academic pessimism. In fact, we observe a gigantic volume in currency transactions which easily sweeps that of the largest stock exchanges and which seems also being fuelled by speculation. In foreign exchange trading, the share of financial institutions–mainly asset managers–increases, whereas among them large currency hedge funds aggressively taking positions. Thus, there is no doubt that professionals, who are relevant in the market–which indicated by the size of their salaries and by the volume of assets under management–put money behind their forecasts which questions the conventional academic wisdom of enduring "systematic expectational errors" by professional exchange rate forecasters (Frankel and Froot, 1987, p.150).[96]

In addition there is also evidence from academic research indicating that economic fundamentals are empirically related to exchange rates, although not close and robust enough to generate simple models. Nevertheless, the monetary model's fundamentals are linked to

[96] According to the Bank of International Settlements (2005), the average daily turnover in April 2004 measured in billions of US-dollar for the US-dollar/euro, the JP-yen/US-dollar and the GB-pound market was 501, 296 and 254 respectively.

exchange rates (see e.g. Rapach and Wohar, 2002, Kilian and Taylor, 2003, and Sarno, Valente and Wohar, 2004). Furthermore, promising forecasting exercises by using these models have been demonstrated recently by Abhyankar, Sarno and Valente (2005).

Therefore, it does not seem precluded that some forecasters may be able to interpret fundamentals in a useful way, so that some forecast superior to others. We follow the advice of Frankel and Froot (1987, p.152) who close their seminal paper on the analysis of median expectations by suggesting that "investigating heterogeneous investor expectations would be a useful avenue for future research". Indeed, research has identified various aspects of individual forecasting behavior which we shortly review in the following with respect to our focus, i.e. performance of forecasters and their characteristics.

Forecasting performance has been very early addressed in two studies covering a small group of financial services professionally providing exchange rate forecasts. Goodman (1979) finds for 10 financial services over two and a half years in 1976 to 1978 that they are often well able to forecast 6 exchange rates at two horizons, i.e. 3 and 6 months. Goodman focuses on the kind of analytical method preferred, i.e. either fundamental or technical analysis, finding that only technicians provide valuable forecasts. Fundamentalists' performance slightly improves at the 6 months horizon compared to 3 months. Levich (1979) significantly extends this first study by covering 9 financial services, forecasting 9 exchange rates at four horizons (1, 3, 6 and 12 months) over 12 years, 1967 to 1979. Largely in line with Goodman he finds that forecasters have knowledge, although to a very different degree, and that direction forecasts are much better (and profitable) than point forecasts. However, these results were overruled during the 1980s by the above mentioned studies establishing the insights of average inaccuracy and irrationality on the consensus forecasts, possibly because the latter studies employed much larger samples.[97]

The first study analyzing a broader sample of individual exchange rate forecasts is Ito (1990). He examines the yen-dollar exchange rate expectations collected by the Japan Center for International Finance (JCIF) in the period May 1985 to June 1987. The data consist of 51 observations due to mostly biweekly collections. Moreover, the data set has a panel dimension due to 44 firms participating which are grouped into six industries. The largest sub-sample is the 15 banks and brokers, followed by 20 non-financial firms from 3 industries

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[97] Further evidence on small samples contributes to the impression of heterogeneity: Blake et al. (1986) do not find ability in the exchange rate forecasting performance of three British institutions over five exchange rates at two horizons during three to four years, whereas Allen and Taylor (1990) do find some ability in their tracking of technical analysts' exchange rate forecasts.

(9 export-oriented companies, 6 trading companies, 5 import-oriented industries) and 9 non-bank financial firms from 2 more industries (5 life insurance companies, 4 securities companies). The most important finding is heterogeneity in expectation formation demonstrated by significant individual effects in the panel analysis. In addition, the study raises questions on forecasters' rationality.[98] Most interesting from our point of view is, first, that "most of the market participants violate necessary conditions of the rational expectations hypothesis" (Ito, 1990, p.445). Second, however, false expectations may be due to small sample size as Ito (1990, p.437) states with respect to yen appreciation after September 1985 and in general with respect to Peso problems (Ito, 1990, p.444).

Another source of forecasting data is provided by Consensus Economics. This data consists of monthly forecasts of about 150 institutions from the large industrialized countries, including mainly commercial and investment banks, but also industrial corporations and forecasting agencies. Respondents give expectations on various exchange rates at four horizons. The individual dimension of this data is examined by MacDonald and Marsh (1994) who analyze the complete response of 30 forecasters on a maximum of three exchange rates, starting from October 1989 to December 1991. Again, forecasts are mostly inaccurate and irrational. Moreover, the profit measure leads to a slightly better overall result than the root mean square error, although still only 27% of all forecasts generated a profit. As a limitation of this study, the time period encompasses just 27 observations and states–confirming Frankel and Froot (1987)–instability of findings over time.

An extension of this data set is provided by MacDonald and Marsh (1996), covering full three years from 1989 to 1992, considering all available forecasts–leading to a maximum of 107 forecasters–and also comparing performance measures in some detail. They find that 30% of all forecasts made generate excess profits compared to a random walk, i.e. a no-change prediction (MacDonald and Marsh, 1996, Table 5.4). The performance of point forecasts is tentatively worse than profits. The relationship between accuracy and profitability is positive. The performance on short horizon (3 months) is positively related to the one on longer horizons (12 months). However, top performers in one currency are not necessarily

[98] This is supported by Wakita's (1989) analysis of a slightly extended sample ranging from May 1985 to March 1988.

also among the best in another currency, although this examination is limited to just 22 forecasters due to incomplete responses.[99]

The first sample being long enough to cover lasting up- and downswings of exchange rates is Elliott and Ito (1999, p.435) who extend the sample from Ito (1990) to an eleven years period until May 1996 and find that "survey data can be used to obtain on average positive profits". Interestingly this finding is contrasted by the fact that the random walk model outperforms the forecasters measured by accuracy (the average squared forecast error). Another innovation of this paper is to investigate whether profits compensate for risk. There is evidence that profits are quite volatile over time and that they are related to a common measure of risk, i.e. the difference between the forward rate and the average expected rate (Frankel and Froot, 1987). However, profits are not related to another possible understanding of risk, i.e. dispersion of forecasts.

We summarize three main findings of these studies on individual exchange rate expectations: first, there is indeed heterogeneity, and the persistent biases of individuals indicate that they behave consistently different which makes it important to analyze individual forecasts and its determinants. Second, there is always the possibility of extreme exchange rate changes, i.e. unpredictable events, which possibly distorts performance and thus motivates the use of longer samples. Third, evidence indicates that inaccurate point forecasts may be nevertheless good directional and profitable forecasts, which puts a natural emphasis on the latter measurement.

As forecasters seem to be so different in performance and approach it would be interesting to have more information about determinants of their behavior. One important question for exchange rates is whether good forecasts are related to knowledge about economic fundamentals. Having the Meese and Rogoff (1983) verdict in mind it is not clear at all whether such a relation exists. In this respect, Loh and Mian (2006) find for stock market analysts that those who forecast earnings more accurate also give more profitable stock recommendations. In foreign exchange we do not know of any such study.

Beyond the use of economic fundamentals, literature has identified further personal characteristics that might help to understand (forecasting) performance. Chevalier and Ellison (1999) find that good education improves performance of fund managers. Another important variable is professional experience. More experienced analysts underreact less to prior

[99] Marsh and Power (1996) examine these 22 forecasters and assess their implicit portfolios build on long or short positions in three exchange rates. Although some forecasters seem to give profitable advice, only one forecaster does consistently so by significantly beating the no change alternative.

earnings information (Mikhail et al., 2004) and issue rather bold and accurate than herding forecasts (Clement and Tse, 2005).

Fortunately, our dataset is comprehensive enough to address all of these questions. The information is on individuals, it spans up to 14 years and covers about 150 professionals. As we have the anonymous codes of forecasters we can link their exchange rate expectations to their expectations of fundamentals as well. Finally, due to the truly individual data (which is not firm-related information as in the JCIF and Consensus Economics data) we can link forecasts to some personal characteristics of forecasters. Overall, the information on performance is more comprehensive than before and the link to forecasters' characteristics is new to this literature.

5.3 Data

Our analysis is based upon a micro dataset, comprising 15 years of individual forecasts from the established Financial Market Survey (Finanzmarkttest) of the Centre for European Economic Research (ZEW) in Mannheim, Germany. The individual forecasts constitute the data from which monthly aggregate statistics, such as consensus forecasts, are computed from December 1991 until today and which are passed to the financial media, e.g. Bloomberg and Reuters.

Compared to other surveys, the ZEW's survey structure is conventional and similar to Consensus Forecasts (London), since round about 75% of the participants of the survey work in the banking or bank related sector (i.e. retail banks, investment banks, investment funds, etc.), whereas the others are either associated to the insurance or industrial sector. Participation with about 300 responses on average is even better than at Consensus Forecasts with about 150 responses. The survey asks for qualitative answers as participants judge whether the respective variable goes up, down or remains unchanged. The survey raises information on a monthly census of financial market professionals, questioning their 6-months forecasts of various financial and macroeconomic variables.

We study the micro data from December 1991 until July 2006, which sums up to 176 months for our study; more precisely, we analyze the individual forecasts for the US-dollar/euro, GB-pound/euro and JP-yen/euro (until end of 1998 D-mark instead of euro) as well as related US, British and Japanese exchange rate fundamentals, i.e. forecasts of inflation, economic growths and interest rates.

Since we study individual forecast series, we have to conduct several adjustments, concerning the dataset. The initial sample observations regarding the US-dollar/-, GB-pound and Japanese-yen/euro forecasts appear in the first row of Table 5.1. The second row indicates that approximately 36% of all initial forecasts are dropped because of consistency matters. One reason is that participants associated to specific identification numbers (id) are sometimes replaced by new colleges because of e.g. job changes. In such cases, we assign the new participants internally a new id and we track the previous participants, as far as they continue participating at the survey, by keeping their original id. Moreover, to ensure reliable analysis of each participant's performance quality, we set the minimum rate of participation to 50%. In fact, this should ensure eliminating accidental forecast accuracy. So only these forecasters are considered who participated in the survey at least 88 times of a total of 176, which reduces the forecasts of about 25%. Finally, in this study we target on personal information of the forecasters in order to link forecast performance with specific personal information. This limits respective analyses to participants for whom such information is available which leads to another reduction of the forecasts by about 13% (see the fourth row of Table 5.1).

Some further characteristics of the final dataset are reported in Table 5.2. This information stem from a specific questionnaire conducted in October 2006. All in all forecasters' characteristics do not differ meaningfully on average between the three exchange rates. Even though the amount of women participating in the survey has in recent years risen continuously, most of them do not pass the minimum participation rate; so the share of women is fairly low. The average age accounts to 48, whereas experience in financial market practice averages 21 years. So our representative forecaster reveals being middle-aged and fairly experienced. This corresponds to the fact that 41 percent of participants head at least a department. Moreover 54% of participants have personnel responsibilities, 80% have operational responsibility. Finally, 67% of the participants have an academic background by holding either a bachelor, master or doctor degree.

Since we are interested in links between forecasting power in exchange rates and competence in fundamental analysis, we base our analysis on related expectations data. As already mentioned the ZEW-survey questions forecasts in exchange rates as well as in several other economic variables. Considering the monetary model as our reference model we draw on related inflation, interest and economic growth forecasts for the US, Great Britain and Japan respectively. Regarding the exchange rate forecasts, we use daily exchange rates of the US-dollar/euro, GB-pound/euro and JP-yen/euro (-/D-mark respectively). With respect to our fundamental forecasts, we use the following monthly data for the euro zone (Germany until December 1998 respectively), the United States, Great Britain and Japan respectively: CPI-indices in order to calculate inflation rates, industrial productions to proxy income growth rates on a monthly basis and regarding interest rates, we use 6-month Libor rates.[100]

A graphical presentation of the main data, i.e. consensus forecasts and corresponding exchange rate changes over time, is shown in Figure 5.1, separately for the US-dollar, GB-pound and JP-yen.[101] At first glance one can see that the direction of consensus exchange rate expectations is rather sluggish compared to realized exchange rate changes. This implies that there may be periods of "wrong" expectations and indeed, just looking at the US-dollar figure shows, that such wrong expectations occurred in the early 1990s and in particular between 1998 and 2001. Accordingly, we can reproduce the standard finding of the literature, i.e. inaccurate (biased) expectations over longer periods of time. However, the sign of the bias does sometimes switch which indicates (as mentioned in some studies before, see Section 2) that sample length may be important. If we consider the whole 14 years period there is indeed no significant bias for any of the three exchange rates. Moreover, the graphical impression that expectations for the yen may have often the same sign as realized exchange rate changes is confirmed by calculations: the hit rate of consensus expectations is 64.2% for the yen, 58.3% for the dollar but only 48.1% for the pound (Appendix 5.2). On average 56.2% of expectations go into the right direction which is a first strong indication that exchange rate expectations are not systematically distorted in general, although this often occurs over periods of several years.

Whereas we can directly use our qualitative data to calculate a consensus directional forecast, comparison of three-variate expectations–i.e. up, down or no change–with realized exchange rate changes requires a definition of a "no change"-band. We proceed by using a very simple but straight forward technique to derive forecast thresholds.[102] These thresholds are either assumed or, if at-hand, taken from respective questionnaires among forecasters.

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[100] Daily exchange rate data are obtained from the Deutsche Bundesbank, whereas 6-month Libor rates are taken from EcoWin. Industrial productions and CPI inflation stem from IMF's International Financial Statistics. German government bond yields are taken from the Deutsche Bundesbank and US, British as well as Japanese yields from the Federal Reserve, the Bank of England and the Bank of Japan respectively.

[101] Properties of the individual exchange rate forecasts are shown in Appendix 5.1 including consensus, dispersion and actual exchange rate data.

[102] Actually, several studies follow the other way round, using specific thresholds in order to quantify qualitative forecasts (see Dasgupta and Lahiri, 1992, Balcombe, 1996, Nardo, 2003, and Pesaran and Weale, 2006).

Fortunately, the ZEW raised individual thresholds via questionnaire, separated for all forecast series. So we use related median thresholds, separated for the different variables. Although we do not claim that this is a perfect proceeding, we judge it as being simple and transparent. Since we are not aware about any other appropriate alternative, we stick to this procedure which enables us to run appropriate analyses.

Finally, it seems noteworthy that we do know the exact dates when participants gave their forecasts. Since these forecasts are collected each month in a period of two weeks, the forecasters underlie in principle different market conditions. To account for this fact we calculate forecast outcomes by considering the precise days individually.

5.4 Heterogeneous performance of forecasters

This section shows that exchange rate forecasters differ with respect to their performance and that these differences are statistically significant and consistent across currencies.

Forecasters in the ZEW survey make directional forecasts, i.e. they predict either an exchange rate to go up, down or to remain unchanged over the next six months. So these forecasts can directly be compared to realizations of the exchange rates over the same horizon. The only open issue is to define the band of no change. Fortunately, the ZEW has asked its survey participants about this band and responses show that it has a width of three percent into both directions from the present exchange rate. Accordingly, we regard an exchange rate change by less than three percent over the next six months as consistent with a no-change prediction.

As we thus have three alternatives that a forecaster can choose from, there will be only one correct alternative, whereas two mistakes can be made. In particular when the exchange rate goes up or down, there is a more or less severe forecasting mistake possible, depending on whether the forecasters predicted no change–which is a comparatively small mistake–or whether the forecaster predicted the wrong direction of change–which is a comparatively big mistake. In order to cover the severity of wrong forecasts we do not simply code right or wrong forecasts, but we code three possibilities, i.e. right, small mistake and big mistake. The codes for these alternatives are either 2, 1 or 0, so that higher codes indicate better forecasts. Forecasting performance is thus measured as directional performance and the measure can be understood as a hit rate.

Figure 5.2 gives, separated for the three exchange rates, the frequency distribution of hit rates that about 150 forecasters realized during the sample period. One can directly see that there is a lot of divergence in forecasting performance. Taking the first graph in Figure 5.2, regarding the US-dollar, almost all forecasters realize an average hit rate between 0.9 and 1.3, the median is at about 1.1. The realized hit rates for the GB pound and JP yen show somewhat higher values than for the US-dollar as individual hit rates lie basically in the range between 1.0 and 1.4, the pound results being comparatively higher.

Another way of analyzing differences between forecasters is estimating the following panels for each exchange rate: the dependent variable is the forecast performance as defined above, i.e. codes of 0, 1, or 2, and the explaining variables consist of individual dummies and year dummies. Table 5.3 shows the year dummies, which are mostly significant,[103] and gives in the last line the LR-statistic which rejects the Null that the model has the same explanatory power with and without individual dummies. This indicates for another approach (than the histograms shown above) that heterogeneity is important.[104]

These analyses are informative regarding divergence of performance but not yet regarding the level of performance. In order to assess the individuals' quality of forecasting performance, an appropriate benchmark would be the performance of an uninformed forecaster who makes exchange rate predictions just by chance. So, the realized hit rate of random forecasts is calculated. Therefore, we take the exchange rate time series and allocate to each month either an "up", "down" or "no change" according to the effective six month change. This results in a concrete distribution of changes for our period of time. We take this given distribution and simulate on this basis 10,000 random time series, and then we calculate hit rates by comparing the random time series–expressing forecasting by chance–with effective exchange rate changes. Obviously, the average simulated random hit rate can differ according to the time series properties of the underlying exchange rate.[105] We find for our sample that the benchmark to be beaten in case of the US-dollar is a simulated hit rate of 1.0975, for the pound the value is 1.2530 and 1.0928 for the yen–these values as well as the respective 95% confidence bands are also shown in Figure 5.2.

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[103] This indicates that sample period matters and that short samples may distort aggregate and individual results.

[104] The same qualitative result is found from a non-parametric test (see Appendix 5.3).

[105] In particular we do not assume that exchange rates change according to a distribution where one third of cases each is exchange rate up, down and no change. In fact, the simulated distribution of the GB-pound/euro hit rates differs from the two other simulated distributions, because relatively many actual GB-pound/euro changes have occurred in the indeterminate interval, i.e. "no change".

This information about the random forecast performance and the individual forecast performances–as it is graphically presented in Figure 5.2–is used to explicitly show best and worst forecasters in the sample. Table 5.4 gives respective information about hit rates realized for the US-dollar. The best forecaster realizes an average hit rate of 1.31 on 101 participations, which is at the one percent level significantly different from a random forecast. Overall, there are six individuals significantly better than the random forecast at the 5% level. Interestingly, there are also 14 individuals significantly worse at the same level of significance. Extending our attention to the 10% level of significance gives 19 successful versus 17 unsuccessful forecasters of the US-dollar.

Also considering individual forecasting performance at the two other exchange rates considered gives an interesting result (see Appendices 4 and 5): among 146 pound forecasters, there are 24 significantly better than a random forecast at the 5% level of significance but even 37 are worse. The picture is different again for the yen, where 58 are better and only 2 worse than the benchmark at the 5% level of significance.

Overall, we find statistically successful and unsuccessful forecasters for all three exchange rates. Although the mean performance is very different for the three exchange rates–i.e. comparatively best for the yen, worse for the dollar and very heterogeneous for the pound–the coexistence of successful "hot hands" and unsuccessful "cold hands" is a new aspect in the foreign exchange literature.[106] This finding raises the question whether skill depends on the specific exchange rate or whether it depends on general ability. Fortunately, most individuals in our sample, i.e. 145 persons, give forecasts for all three exchange rates. We can thus relate their hit rates across exchange rates and consistently find positive correlations. Table 5.5 shows that the hit rate of US-dollar forecasts can be significantly "explained" by the quality of pound forecast but not by yen forecasts. Among the three relations between currencies, it is only the dollar-yen exchange rate where the spillover is not significant. Nevertheless, even this coefficient is positive and the others are significantly positive, which indicates that performance in forecasting exchange rates is also driven by a general ability and not just specific to certain exchange rates.

This provides a strong motivation to further investigate possible determinants of forecasting performance and in particular to investigate a possible role of knowledge.

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[106] Of course, already the early studies of Goodman (1979) and Levich mention this fact but for a very small group of 9 or 10 participants only.

5.5 Forecasting exchange rate and forecasting its fundamentals

In this section we examine the question, whether individual heterogeneity in forecasting performance can be traced to the performances in other economic variables. Principally, we follow the idea that the forecasting success in exchange rates is related to the accuracy of fundamental research, i.e. the analysis of exchange rate fundamentals. Since we have access to individuals' exchange rate forecasts and also to their forecasts in fundamental variables–all formed at the same time–we can investigate whether such relationships indeed exist.

There are several reasons, why such an analysis proves to be promising. First, it is shown in the empirical literature that exchange rates are connected to fundamentals in the long run (see recent studies e.g. Rapach and Wohar, 2002, Kilian and Taylor, 2003, and Sarno and Valente, 2006). Second, longer term exchange rate expectations underlie strong fundamental considerations (see Cheung and Wong, 2000 and MacDonald, 2000). Third, we showed already in Section 3 that the majority of participants of the Financial Market Survey belong to groups, which follow longer-term considerations such as analysts and fund managers. Fourth, a related study on the stock market by Loh and Mian (2006) reveals such a fundamental relationship. In fact, they show a fundamental link between the profitability of analysts' stock recommendations and the accuracy of their earnings forecasts. Taken together, this motivates us to analyze, whether the quality in fundamental analysis comes along with forecast success in exchange rates. A priori, we thus expect average hit rates of exchange rate fundamentals to be positively correlated with exchange rate hit rates. With respect to the considered fundamental variable set, we choose the monetary model as baseline and thus consider inflation, economic growth and the interest rate for Euroland, the US, Great Britain and Japan respectively.

In fact, using the exchange rate fundamentals of the monetary model for all three exchange rates we find overall a significant relationship between forecast successes in exchange rates and superior interest rates forecasts. Besides, GB-pound forecasts prove to be significantly better on average than US-dollar and JP-yen forecasts.

Pulling up a rule-of-thumb calculation, we note that the neutral hit rate generates a value of 1.1. Since most of the average hit rates lay right of 1.1, we acknowledge that the majority of the forecasters at least do not form poor forecasts. We do not want to over-interpret these results, since nothing is said about statistical significance so far. Nevertheless, this finding serves as an indicator concerning the overall accuracy of the individual exchange rate forecasts.

In line with our procedure in Section 4, we have to generate qualitative forecast errors for all respective fundamentals. However, since these variables underlie different statistical characteristics than the exchange rate, different threshold values have to be considered. Again, we use the threshold values, which have been revealed by the Centre for Economic European Research among its participants via specific questionnaires. Subsequent reported threshold values are measured in percentages of the respective variables. They each indicate if a specific participant classifies a variable to go up or down; respective average numbers are incorporated into our calculations as follows: 4.5 percent for economic growth, interest rates and inflation as well.

Table 5.6 represents the corresponding results of the relations in forecasting performances separated for the US-dollar/euro, GB-pound/euro and the JP-yen/euro. Regarding the US-dollar, more forecast success in domestic interest rates significantly correlates with higher forecast power in exchange rates. Further, US inflation hit rates influence negatively related exchange rate hit rates; however, the latter relationship is not significant at the 5 percent level. Turning to the GB-pound, again foreign inflation influences forecast success in exchange rates only at the ten percent level, but now positively. More important, higher hit rates in domestic and GB-interest rates as well, come significantly along with higher hit rates in exchange rates. Finally, looking at the JP-yen, only hit rates in Japanese interest rates correlate positively and significantly with those of the exchange rate. So in respect to all three exchange rate equations, we find only significant connections with one or both (domestic and foreign) interest rate hit rates, but consistent with our prior, the signs prove to be positive.

In order to deepen these findings, we now analyze all exchange rate equations simultaneously. Table 5.7 shows corresponding results of the merged data, where the JP-yen is set as the basic currency. Different forecast success between the US-dollar, the GB-pound and the JP-yen exchange rate can be attributed to different complexities of respective exchange rates. In order to control for these constant country effects, we implement a US-dollar dummy and a GB-pound dummy.

In fact, the only variables which are significant at the five percent level are domestic and foreign interest rate hit rates as well as the GB-pound dummy. Furthermore, domestic inflation and the US-dollar dummy are significant at the 10 percent level. Restricting the model to significant variables via a top down approach, only the two interest rates and the GB-pound dummy remain in the model.

In sum, superior analyses in domestic and foreign interest rates are strongly related with larger forecast success in exchange rates. The significant influence arising from the GB-pound dummy confirms the former observation in respect to Figure 5.2, where exchange rate forecasts of the GB-pound appear better than of the other exchange rates. However, the latter finding reveals a constant effect, independent of the performance of fundamental analysis.

5.6 Personal characteristics of successful exchange rate forecasters

Due to available personal characteristics of exchange rate forecasters we find that there are two significant influences on performance: professional experience in financial markets helps, whereas responsibility for personnel harms.

The bottleneck in analyzing a possible influence from personal characteristics is data availability. Indeed, this data is not regularly compiled but partly stems from additional survey that the ZEW sometimes conducts among participants of the ZEW financial market survey. As a consequence, the response to this survey provides another restriction to our sample, further reducing the number of respondents to 93 individuals. However, we consider the forecasts of each exchange rate independently and thus analyze 279 cases.

In particular we examine the possible impact from the seven items documented in Table 5.2 on forecasting performance. As the average forecasting performance differs much between currencies (see Section 4) we include exchange rate dummies in the regression. Table 5.8 shows the role of personal characteristics in explaining forecasting performance. Specification (1) gives the result when all variables are considered. It shows that beyond the constant and exchange rate dummies only one personal characteristic seems to be important, i.e. a detrimental influence from personnel responsibilities. In another specification we reduce the variables considered to those that remain significant. This leads to specification (2) where a second personal characteristic of importance appears, i.e. a positive influence from experience.

As personal characteristics may be related to forecasting ability in fundamentals too, we include fundamental forecast performance in the regression used in Table 5.8. Thereby, we heighten the stakes for personal characteristics to become significant. It is thus reassuring that results of the extended regression shown in Table 5.9 nicely confirm the findings from above. Overall, the R-squared of this model increases compared to the model estimated in

Table 5.8 from 0.27 to 0.38. It is also interesting to see that the major influences found in Table 5.7–i.e. considering the impact of fundamentals forecast performance but not of personal characteristics–remain unchanged, although the number of observations is reduced from 442 to 279. We regard this as a sign of robustness and it also shows that personal characteristics are important beyond fundamental forecast, although the latter is comparatively more important than personal characteristics.

5.7 The relation between directional forecasting success and profits

As a robustness test we examine whether directional forecasting success translates into profits. We find, indeed, and in accordance with earlier studies that our results hold in a qualitative sense when the directional performance measures used so far is substituted by profits.

Professionals participating at the ZEW survey give their directional expectations and it seems reasonable to form a trading strategy based on these expectations. Accordingly, we assume that the expectation of an "up" of the US-dollar is translated into a US-dollar long strategy, a "down" into a short position and a "no change" in a neutral position. Although the expectations are formed for six month horizons, the possibility of new information should be considered, so that effectively a position may be changed whenever the expectation changes which may occur once per month. Then, the return for each month is calculated, assuming that the asset value is always the same; in particular, this procedure excludes cumulating profits. Finally, these (gross) profits resulting purely from exchange rate changes are complemented by net profits where the interest rate difference against the euro is taken into account.[107] Thus Table 5.10 shows the average yearly returns for the best and the worst 25 foresters in the US-dollar/euro, which would have been realized by following corresponding forecasts month-by-month.

Based on this procedure, Figure 5.3 gives the distribution of returns for about 150 individuals, separated for the three exchange rates. This picture is obviously very similar to the above introduced frequency distribution of hit rates (Figure 5.2). If we take the zero profit position as a benchmark, we also recognize that trading strategies based on forecasters'

[107] The translation of expectations in trading strategies requires making some assumptions and is thus open to criticism. Therefore, we regard the profit calculations as a robustness exercise only and prefer to stick as close as possible to the available information, i.e. directional expectations, and assess them via the hit rate measure.

expectations would yield some profits in most cases. Overall, forecasters' performance measured by profits produces the same qualitative picture as the hit rate measure: professionals' expectations are more often accurate than inaccurate.

Clearly, the same qualitative result does not necessarily imply that it is driven by the same persons. Thus, we examine the relations–person by person–between the performance measured by hit rates and measured by profits, for the three exchange rates each. Table 5.11 shows that there is a highly significant positive relation. This relation holds using either an OLS regression or (non)parametric correlations (see also Figure 5.4).

5.8 Conclusions

This research wants to shed new light on a long-standing puzzle in international finance, i.e. the finding of inaccurate and even irrational consensus exchanger rate expectations of professionals. In order to gain more insight we employ a new dataset which has three advantages: first, it is truly individual (and not firm) data, second, it is quite long (14 years) and broad (we rely on about 150 persons), third and most interesting, individuals' exchange rate expectations can be linked to more information, i.e. expectation formation on exchange rate fundamentals and forecasters' personal characteristics.

We use this comprehensive dataset to reveal three main findings: first, professional exchange rate forecasters have more often accurate directional exchange rate expectations than not, although they perform different to a significant degree, second, they make use of their knowledge about relevant fundamentals and, third, their performance is influenced by experience (positively) and by personnel responsibilities (negatively).

These findings contribute to an assessment of foreign exchange markets that is similar to that of other financial markets: professionals on this market do not behave irrational in that they consistently form unnecessarily bad expectations but their expectations reflect their different degree of knowledge and ability. These results are not due to a particular dataset. Translating the directional expectations into consensus point forecasts for shorter samples–i.e. repeating the exercises of Frankel and Froot (1987) and others–reproduces their finding as these consensus expectations are often inaccurate and irrational. However, this does not apply to the full sample. Moreover, we stick to what participants of this survey do, in that they individually give their directional expectations.

The distribution of forecasting performance differs significantly between individuals. Reassuringly, the average forecasting performance seems to be slightly in the positive domain, i.e. forecasts on average are rather correct than wrong (make rather profits than losses), which is the expected result for functioning markets: performance is not too good or too bad which both would question efficiency. As this could also be due to random forecasting behavior, rationality of forecasters is more convincingly revealed by two structural findings: expectations differ, reflecting the distribution of knowledge in the market and forecasting performance differs, reflecting the distribution of individual knowledge and ability.

Tables 5

TABLE 5.1

Sample selection criteria and related observations

	sum of forecasts	number of forecasts		
		US-dollar	GB-pound	JP-yen
initial sample	156,040	53,750	51,384	50,906
consistent sample	100,315	34,482	33,192	32,641
50%participation sample	60,540	20,965	19,834	19,741
final sample	40,344	13,859	13,280	13,205

Notes: The Initial sample has to be corrected since we focus on identified persons, i.e. consistency criteria. Since participants of the survey change occasionally their professions, sometimes it happens that someone adopts the identity number (ID) of the former college. This would obviously bias our forecast series, therefore, we track on new individuals lodging them internally under new ID's and if possible, tracking changing participants on their new job under their ID. Furthermore, adopting the participation criteria, we set a minimum participation rate of 50%, meaning that only these persons are considered, who participate at least 88 times at the survey (in total, we deal with 176 months). Finally, we use personal information, which requires a selection via the personal criteria.

TABLE 5.2

Personal characteristics of the forecasters

	US-dollar	GB-pound	JP-yen
share of **women**	2%	1%	1%
average **age** in years	48	48	48
average **experience** in years	21	21	21
share of participants with **academic background**	68%	67%	67%
share of participants holding a **chief position**	40%	41%	42%
share of participants with **operational responsibilities**	80%	80%	80%
share of participants with **personal responsibilities**	53%	54%	55%

Notes: These characteristics are based upon the reduced sample after adopting the personal criteria, see Table 5.1. This information follow of a specific questionnaire conducted in October 2006. The share of women in questionnaire is higher than displayed above, because the share of female participants was low in the beginning years of the survey and has risen continuously until today. The characteristic experience is targeted explicitly on financial markets. Participants are considered having an academic background if they hold a bachelor, master or doctor degree. Furthermore, we judge participants as capturing a chief position, if they head at least a department. So, operational and personal responsibilities are defined the way that participants underlying some form of accountability–in respect to the latter one, this must not correspond to the chief position. Finally, round about 75% of the participants of the survey work in the banking sector (i.e. retail banks, investment banks, investment funds, etc.), whereas the others are either associated to the insurance or industrial sector. So, the survey's composition turns out being very similar to others, e.g. Consensus Forecasts London with 75% working in financial institutions.

TABLE 5.3

Differences among forecasters' performances: fixed-effects model

$$|e_t^i| = \mu_i + \gamma_j + \varepsilon_t^i$$

	US-dollar		GB-pound		JP-yen	
1992	-0.48***	[0.000]	0.25*	[0.344]	0.89***	[0.000]
1993	-0.55***	[0.000]	-0.37***	[0.000]	0.46***	[0.000]
1994	-0.46***	[0.000]	-0.22	[0.000]	0.56***	[0.000]
1995	-2.00***	[0.000]	-0.93***	[0.000]	0.42***	[0.000]
1996	-0.36***	[0.000]	-0.55***	[0.000]	0.64***	[0.000]
1997	-0.23***	[0.000]	-0.60***	[0.000]	0.80***	[0.000]
1998	-0.27***	[0.000]	-0.69***	[0.000]	0.04	[0.513]
1999	-0.74***	[0.000]	-0.83***	[0.000]	-0.04	[0.412]
2000	-1.12***	[0.000]	-1.77***	[0.000]	-0.22***	[0.000]
2001	-1.08***	[0.000]	-0.59***	[0.000]	0.26***	[0.000]
2002	-0.85***	[0.000]	-0.76***	[0.000]	0.85***	[0.000]
2003	-0.20***	[0.000]	-0.35	[0.000]	0.90***	[0.000]
2004	-0.38***	[0.000]	-0.82***	[0.000]	0.53***	[0.000]
2005	-0.63***	[0.000]	-0.42***	[0.000]	0.83***	[0.000]
2006	-0.69***	[0.000]	0.12*	[0.060]	0.63***	[0.000]
threshold 1	-1.37***	[0.000]	-1.93***	[0.000]	-0.59***	[0.000]
threshold 2	-0.11	[0.271]	-0.35***	[0.007]	0.83***	[0.000]
n_i	153		146		146	
n_t	15		15		15	
N	20,351		19,235		19,134	
Pseudo R^2	0.08		0.08		0.05	
log likelihood	-20,134.34		-17,560.72		-18,451.11	
LR-statistic# (degrees of f.)	3,389.64*** (167)	[0.000]	3,003.75*** (160)	[0.000]	2,105.49*** (160)	[0.000]
LR-statistic* (degrees of f.)	231.02*** (152)	[0.000]	582.36*** (145)	[0.000]	287.67*** (145)	[0.000]

Notes: The sample contains 176 months from December 1991 until July 2006. The dependent variable is the absolute forecast error of the respective exchange rate (US-dollar, GB-pound or Japanese Yen against the euro– until December 1998 against the D-mark, respectively). Each forecast is based upon a forecast horizon of 6-month, depending on the exact day of individual forecasting (participants have two weeks time in order to respond, where we take each individual date of forecast). We set the expectation threshold at 3%. However, we are dealing with an unbalanced panel because our sample period does not contain on each day a forecast. In fact, since we compute qualitative data, the calculated errors can take the values 0, 1 and 2. The latter outcome 2 represents a correct qualitative forecast, 1 a simple forecast error (e.g. forecast of no change but actually the exchange rate fell) and 0 a double forecast error (e.g. forecast of a rise but actually the exchange rate fell). The minimum participation is set at 50%, so we consider only individuals who participated at least at 88 months. We use an ordered probit fixed-effects model with the Huber/White-sandwich estimator for the variance, so the individual effects are implemented via dummies (to conserve space–individual parameters are not shown). Next we control for year effects, since we do not assume the difficulty of forecasting exchange rates as being always equal. The number of participating analysts, years and forecasts in our sample are denoted by n_i, n_t and N separated for each exchange rate. The LR-statistic# tests for the relevance of the whole model and is assumed being chi-square with above given degrees of freedom. However, focusing on apparent differences in the accuracy across analysts while conditioning on year effects, we run the LR-statistic*, which is chi-square with above given degrees of freedom. Asterisks refer to the regressors' level of significance in the short-term relations: *, **, *** to ten, five and one percent.

TABLE 5.4

Best and worst 25 forecasters in the US-dollar (hit rates)

strong hands	[probability]	participation	weak hands	[probability]	participation
1.31***	[0.001]	101	0.76***	[0.000]	93
1.28***	[0.002]	151	0.81***	[0.000]	98
1.24**	[0.021]	97	0.91***	[0.001]	149
1.24**	[0.021]	169	0.92***	[0.003]	135
1.23**	[0.032]	88	0.92***	[0.004]	119
1.22**	[0.036]	125	0.93***	[0.005]	144
1.22*	[0.051]	153	0.93***	[0.005]	101
1.21*	[0.053]	112	0.93***	[0.005]	146
1.21*	[0.059]	118	0.93***	[0.006]	153
1.21*	[0.061]	166	0.94***	[0.009]	134
1.21*	[0.062]	157	0.95**	[0.012]	169
1.21*	[0.067]	96	0.97**	[0.030]	94
1.21*	[0.074]	141	0.97**	[0.035]	140
1.20*	[0.078]	142	0.97**	[0.036]	143
1.20*	[0.079]	103	0.98*	[0.052]	108
1.20*	[0.079]	108	0.98*	[0.053]	113
1.20*	[0.080]	172	0.99*	[0.062]	143
1.20*	[0.097]	91	1.00	[0.102]	108
1.20*	[0.100]	142	1.00	[0.102]	147
1.20	[0.104]	148	1.01	[0.127]	153
1.19	[0.113]	93	1.01	[0.127]	151
1.19	[0.137]	96	1.01	[0.156]	154
1.18	[0.149]	119	1.01	[0.159]	147
1.18	[0.151]	130	1.01	[0.159]	146
1.18	[0.158]	153	1.01	[0.161]	142

Notes: The results are based upon 176 monthly observations from December 1991 until July 2006. We assume a 6-month forecast horizon and set the expectation threshold at 3%. The hit rates range from 0 to 2, with 2 representing a correct qualitative forecast, 1 a simple forecast error (e.g. forecast of no change but actually the exchange rate falls) and 0 a double forecast error (e.g. forecast of a rise but actually the exchange rate falls). The minimum participation (part.) is set at 50%, so we consider only individuals who participated at least at 88 months with sample mean participation of 133, minimum of 88 and maximum of 173 months. Though, 152 individuals remain with a mean hit rate of 1.09. Corresponding P-values of the realized hit rates are calculated via bootstrap technique. Asterisks refer to the regressors' level of significance in the short-term relations: *, **, *** to ten, five and one percent.

TABLE 5.5

Interrelations between hit rate performances

$$fx_i^{hr} = \alpha + \beta \cdot fx_j^{hr} + e_i \qquad \text{with } j \neq i.$$

	US-dollar		GB-pound		JP-yen	
const.	0.82***	[0.000]	0.49***	[0.004]	0.83***	[0.000]
US-dollar	-	[n. a.]	0.22**	[0.042]	0.08	[0.299]
GB-pound	0.13**	[0.042]	-	[n. a.]	0.21***	[0.000]
JP-yen	0.09	[0.299]	0.42***	[0.000]	-	[n. a.]
N	145		145		145	
R^2	0.05		0.13		0.05	
adj. R^2	0.04		0.12		0.09	
F-statistic	3.73**	[0.027]	10.47***	[0.000]	2.57*	[0.049]

Notes: We run OLS estimations, each exchange rate as the dependent variable, respectively. Asterisks refer to the regressors' level of significance in the short-term relations: *, **, *** to ten, five and one percent. Single correlations between the exchange rates show up as following: US-dollar and GB-pound 0.2064, US-dollar and JP-yen 0.1469, GB-pound and JP-yen 0.3203.

TABLE 5.6

Hit rates performance of FX and fundamental forecasts

$$fx_i^{hr} = \alpha + \theta \cdot X_i^{hr} + e_i$$

	US-dollar		GB-pound		JP-yen	
const.	1.04***	[0.000]	0.36	[0.110]	0.92***	[0.000]
inflation	-0.05	[0482]	-0.17*	[0.092]	-0.03	[0.743]
inflation*	-0.12*	[0.093]	0.16	[0.104]	-0.01	[0.618]
growth	-0.11	[0.106]	-0.05	[0.591]	-0.07	[0.345]
growth*	-0.01	[0. 920]	0.09	[0.424]	0.10	[0.311]
interest	0.29***	[0.001]	0.24**	[0.021]	0.02	[0.794]
interest*	-0.00	[0.993]	0.35***	[0.000]	0.15***	[0.008]
N	152		145		145	
R^2	0.11		0.30		0.07	
adj. R^2	0.07		0.27		0.03	
F-statistic	2.87**	[0.011]	9.82***	[0.000]	1.81	[0.101]

Notes: The results are based upon 176 monthly observations from December 1991 until July 2006. We assume 6-month forecast horizons for the exchange rates and the fundamentals as well. We set expectation thresholds at different rates: Exchange rates 3%, inflation, growth and interest rates at 4.5%, respectively. The hit rates range from 0 to 2, with 2 representing a correct qualitative forecast, 1 a simple forecast error (e.g. no change forecast but actually the respective rate falls) and 0 a double forecast error (e.g. forecast of a rise but actually the respective rate falls). We run regressions separated for the exchange rates using OLS. The minimum participation is set at 50%, so we consider only individuals who participated at least at 88 months. Following mean hit rates result, when we set the latter restriction: US-dollar 1.10, GB-pound 1.22 and JP-yen 120. Asterisks refer to the regressors' level of significance in the short-term relations: *, **, *** to ten, five and one percent.

TABLE 5.7

Hit rate performance of FX and fundamental forecasts

$$fx_i^{hr} = \alpha + \theta \cdot X_i^{hr} + \kappa \cdot D_j + e_i$$

	full model		restricted model	
const.	0.71***	[0.000]	0.55***	[0.000]
inflation	-0.10*	[0.059]	-	[n. a.]
inflation*	-0.01	[0.562]	-	[n. a.]
growth	-0.07	[0.152]	-	[n. a.]
growth*	0.06	[0.334]	-	[n. a.]
interest	0.19***	[0.001]	0.13***	[0.008]
interest*	0.22***	[0.000]	0.27***	[0.000]
D_1 (US-dollar)	-0.03*	[0.086]	-	[n. a.]
D_2 (GB-pound)	0.08***	[0.000]	0.09***	[0.000]
N	442		442	
R^2	0.37		0.35	
adj. R^2	0.35		0.35	
F-statistic	31.13***	[0.000]	79.90***	[0.000]

Notes: The sample contains 176 monthly observations from December 1991 until July 2006. We run a combined regression for all three exchange rates using OLS. We assume a 6-month forecast horizons for the exchange rates and the fundamentals as well and set the expectation threshold at different rates: Exchange rates 3%, inflation, growth and interest rates at 4.5%, respectively. The hit rates range from 0 to 2, with 2 representing a correct qualitative forecast, 1 a simple forecast error (e.g. no change forecast but actually the respective rate falls) and 0 a double forecast error (e.g. forecast of a rise but actually the respective rate falls). We add two country dummies in order to control for country effects with dummy 1 represents the US and dummy 2 GB. The minimum participation is set at 50%, so we consider only individuals who participated at least at 88 months. Following mean hit rate results, when we set the latter restriction: 1.1713. Asterisks refer to the regressors' level of significance in the short-term relations: *, **, *** to ten, five and one percent.

TABLE 5.8

Hit rate performance of FX and personal information

$$fx_i^{hr} = \alpha + \kappa \cdot D_j + \omega \cdot Y_i + e_i$$

	full model		restricted model	
const.	1.14***	[0.000]	1.18***	[0.000]
D_1 (US-dollar)	-0.09***	[0.000]	-0.09***	[0.000]
D_2 (GB-pound)	0.03**	[0.029]	0.03**	[0.030]
sex	-0.03	[0.505]	-	[n. a.]
age	0.00	[0.563]		[n. a.]
experience	0.00	[0.748]	0.00***	[0.009]
academic	-0.01	[0.619]	-	[n. a.]
chief	0.01	[0.562]	-	[n. a.]
operations	0.01	[0.443]	-	[n. a.]
personal	-0.04**	[0.013]	-0.04***	[0.006]
N	279		279	
R^2	0.2708		0.2589	
adj. R^2	0.2465		0.2483	
F-statistic	11.10***	[0.000]	24.45***	[0.000]

Notes: The sample contains 176 monthly observations from December 1991 until July 2006. We run a combined regression for all three exchange rates using OLS. We assume a 6-month forecast horizons for the exchange rates and set the expectation threshold at 3%. The hit rates range from 0 to 2, with 2 representing a correct qualitative forecast, 1 a simple forecast error (e.g. no change forecast but actually the respective rate falls) and 0 a double forecast error (e.g. forecast of a rise but actually the respective rate falls). The minimum participation is set at 50%, so we consider only individuals who participated at least at 88 months. We add two country dummies in order to control for country effects with dummy 1 represents the US and dummy 2 GB. Moreover we control for the following personal characteristics of the participants: Sex (1 male, 0 female), age, experience (in years), academic (1 university degree, 0 not), chief (1 yes, 0 no) operations (1 operational responsibilities, 0 not) and personal (1 personal responsibilities, 0 not). Asterisks refer to the regressors' level of significance in the short-term relations: *, **, *** to ten, five and one percent.

TABLE 5.9

Hit rate performance of FX, fundamental forecasts and personal information

$$fx_i^{hr} = \alpha + \theta \cdot X_i^{hr} + \kappa \cdot D_j + \omega \cdot Y_i + e_i$$

	full model		restricted model	
const.	0.62***	[0.000]	0.57***	[0.000]
inflation	-0.16**	[0.032]	-	[n. a.]
inflation*	0.01	[0.806]	-	[n. a.]
growth	-0.08	[0.184]	-	[n. a.]
growth*	0.14*	[0.062]	-	[n. a.]
interest	0.20***	[0.008]	0.13*	[0.052]
interest*	0.22***	[0.000]	0.25***	[0.000]
D_1 (US-dollar)	-0.02	[0.362]	-	[n. a.]
D_2 (GB-pound)	0.09***	[0.000]	0.09***	[0.000]
sex	-0.03	[0.488]	-	[n. a.]
age	0.00	[0.749]	-	[n. a.]
experience	0.01	[0.251]	0.01**	[0.014]
academic	0.01	[0.341]	-	[n. a.]
chief	0.01	[0.272]	-	[n. a.]
operations	-0.01	[0.725]	-	[n. a.]
personal	-0.04***	[0.005]	-0.03***	[0.003]
N	279		279	
R^2	0.38		0.35	
adj. R^2	0.35		0.34	
F-statistic	10.81***	[0.000]	30.03***	[0.000]

Notes: The sample contains 176 monthly observations from December 1991 until July 2006. We run a combined regression for all three exchange rates using OLS. We assume a 6-month forecast horizons for the exchange rates and the fundamentals as well. We set the expectation thresholds at different rates: Exchange rates 3%, inflation, growth and interest rates at 4.5%, respectively. The hit rates range from 0 to 2, with 2 representing a correct qualitative forecast, 1 a simple forecast error (e.g. no change forecast but actually the respective rate falls) and 0 a double forecast error (e.g. forecast of a rise but actually the respective rate falls). The minimum participation is set at 50%, so we consider only individuals who participated at least at 88 months. Following mean hit rate results, when we set the latter restriction: 1.1756. We add two country dummies in order to control for country effects with dummy 1 represents the US and dummy 2 GB. Moreover we control for the following personal characteristics of the participants: Sex (1 male, 0 female), age, experience (in years), academic (1 university degree, 0 not), chief (1 yes, 0 no) operations (1 operational responsibilities, 0 not) and personal (1 personal responsibilities, 0 not). Asterisks refer to the regressors' level of significance in the short-term relations: *, **, *** to ten, five and one percent.

TABLE 5.10

Best and worst 25 forecasters in the US-dollar (returns)

winning hands	[probability]	participation	loosing hands	[probability]	participation
0.0908***	0.0000	98	-0.0592***	0.0039	136
0.0583***	0.0078	148	-0.0456**	0.0267	133
0.0561**	0.0103	110	-0.0436**	0.0343	170
0.0525**	0.0164	106	-0.0402*	0.0514	94
0.0509**	0.0199	173	-0.0388*	0.0604	91
0.0508**	0.0202	149	-0.0371*	0.0724	147
0.0500**	0.0221	161	-0.0346*	0.0943	120
0.0478**	0.0286	149	-0.0311	0.1320	141
0.0468**	0.0322	89	-0.0311	0.1325	108
0.0458**	0.0358	134	-0.0298	0.1488	109
0.0413*	0.0582	97	-0.0277	0.1800	91
0.0392*	0.0724	118	-0.0274	0.1855	158
0.0384*	0.0779	90	-0.0267	0.1964	158
0.0380*	0.0810	153	-0.0267	0.1968	113
0.0375*	0.0850	152	-0.0261	0.2062	151
0.0362*	0.0965	112	-0.0231	0.2639	93
0.0346	0.1117	136	-0.0230	0.2656	163
0.0342	0.1159	124	-0.0222	0.2832	104
0.0336	0.1227	157	-0.0221	0.2838	95
0.0335	0.1236	170	-0.0211	0.3074	154
0.0324	0.1362	168	-0.0172	0.4039	98
0.0309	0.1562	170	-0.0169	0.4121	148
0.0294	0.1769	130	-0.0164	0.4259	103
0.0290	0.1826	150	-0.0156	0.4492	144
0.0287	0.1869	126	-0.0156	0.4497	148

Notes: The results are based upon 176 monthly observations from December 1991 until July 2006. We assume a 6-month forecast horizon and set the expectation threshold at 3%. The excess return (gross returns) ranges between -0.5074 and 0.7266 (-0.4810 and 0.6687). The minimum participation (part.) is set at 50%, so we consider only individuals who participated at least at 88 months with sample mean participation of 133, minimum of 88 and maximum of 174 months. Though, 153 individuals remain with a mean excess return of 0.0549 (mean gross return of 0.0705). Corresponding p-values of the realized excess returns are calculated via bootstrap technique. Asterisks refer to the regressors' level of significance in the short-term relations: *, **, *** to ten, five and one percent.

TABLE 5.11

Relation between hit rates returns in exchange rate forecasting

$$fx_i^{re} = \alpha + \beta \cdot fx_i^{hr} + e_i$$

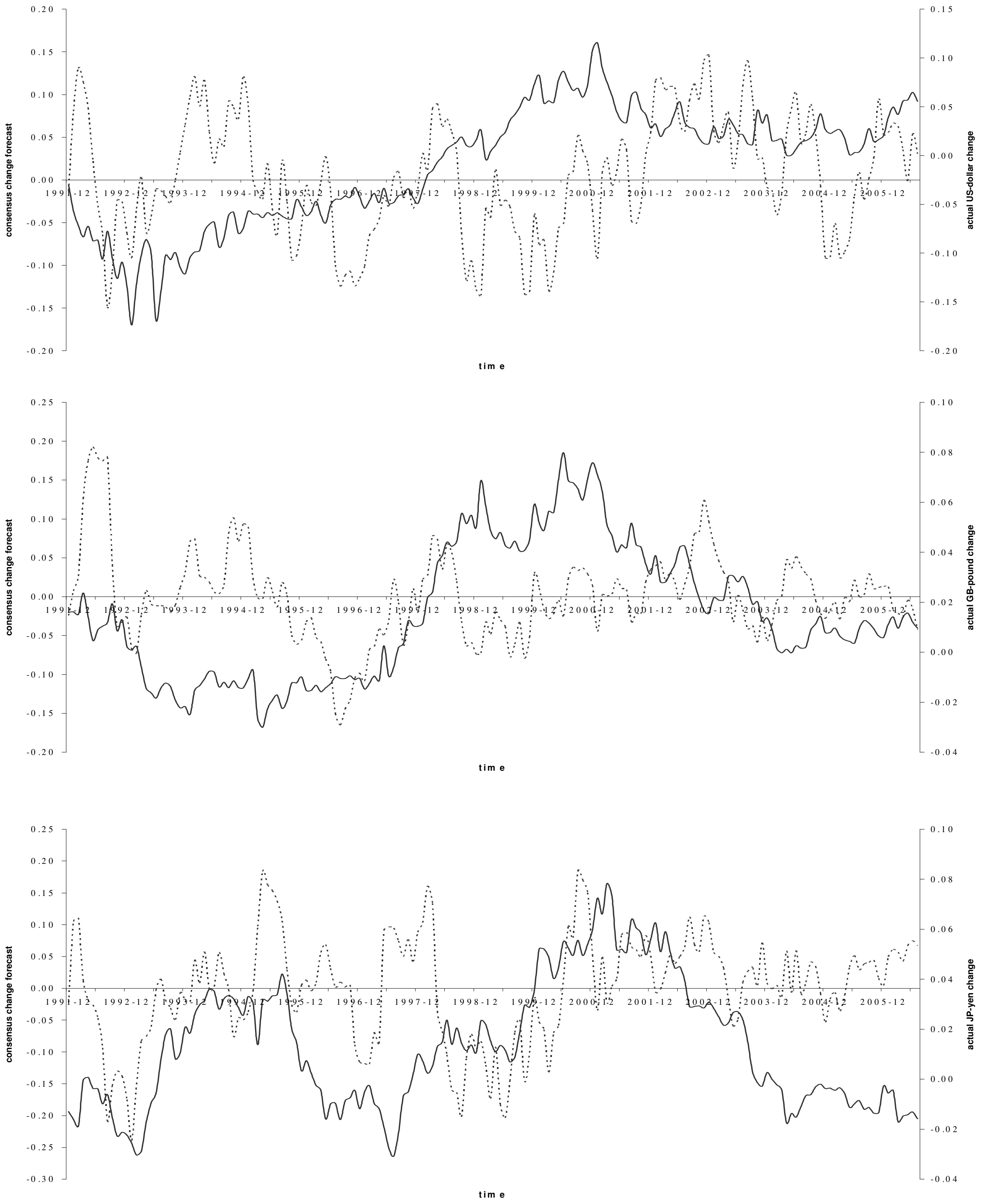
	US-dollar		GB-pound		JP-yen	
const.	-1.01***	[0.000]	-0.64***	[0.000]	-0.79***	[0.001]
hit rate	0.98***	[0.000]	0.52***	[0.000]	0.80***	[0.000]
N	152		146		146	
R^2	0.1793		0.1637		0.1024	
adj. R^2	0.1738		0.1579		0.0961	
F-statistic	32.77***	[0.0000]	28.20***	[0.0000]	16.42***	[0.0001]

Notes: We run OLS estimations, each exchange rate as the dependent variable, respectively. Asterisks refer to the regressors' level of significance in the short-term relations: *, **, *** to ten, five and one percent. Single correlations between the two performance measurements show up as following: US-dollar 0.4234, GB-pound 0.4047 and JP-yen 0.3200. Further, rank-correlations add up to: US-dollar 0.4645, GB-pound 0.3488 and JP-yen 0.2730.

Figures 5

FIGURE 5.1

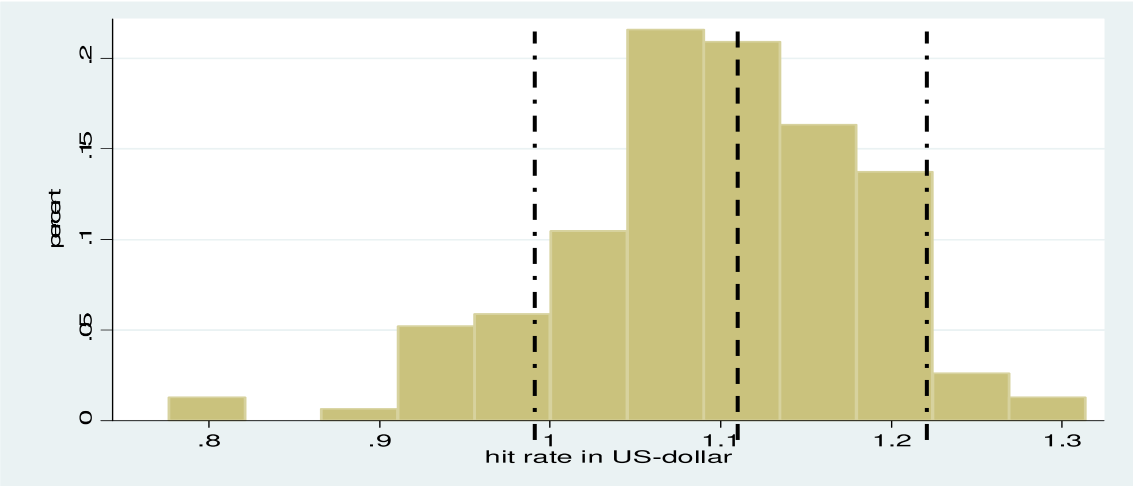
Consensus forecasts and corresponding 6-month exchange rate changes

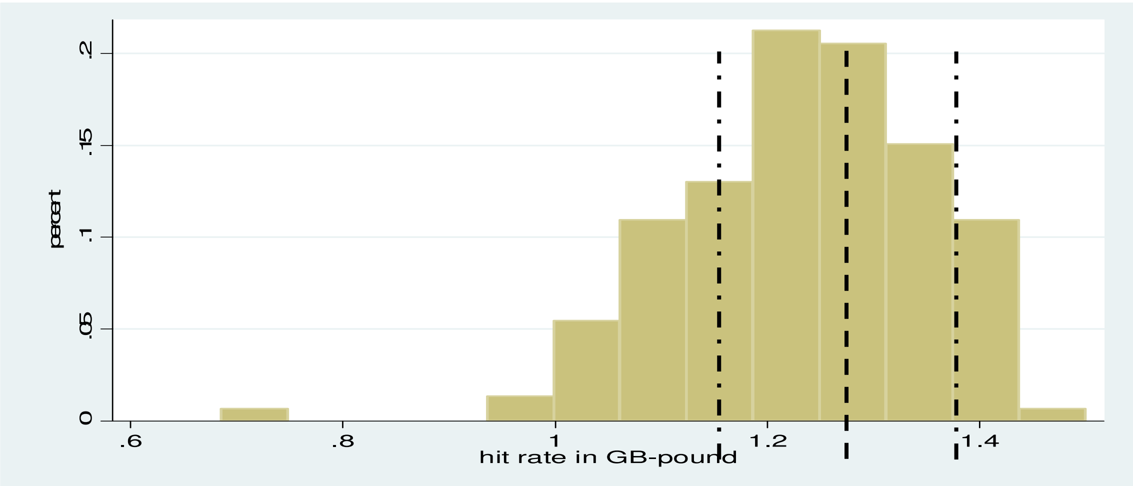


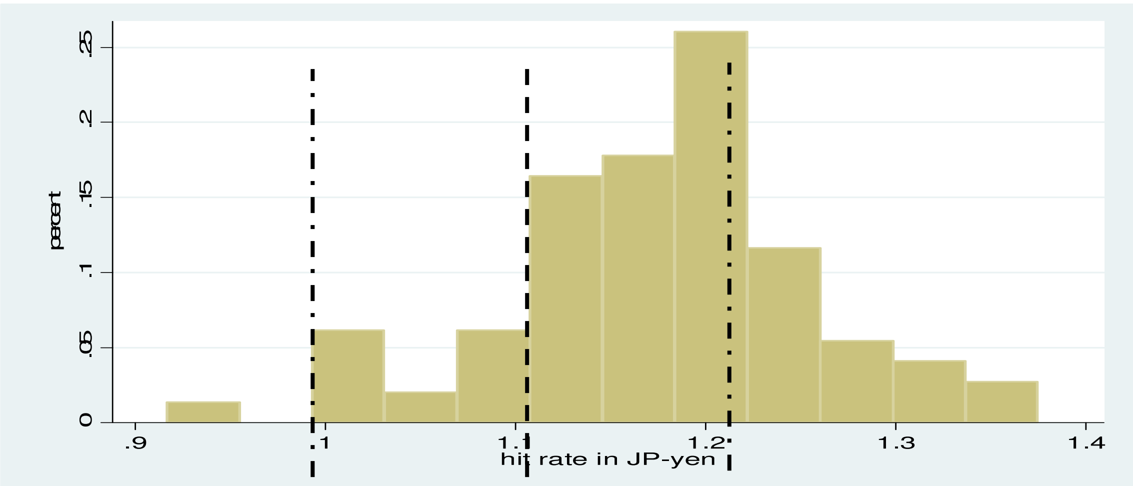
Notes: The sample contains 176 monthly observations from December 1991 until July 2006. The graphs show the time series of consensus (solid lines) and related spot rate changes (dashed lines) separately–moving from top to bottom–in the US-dollar/-, GB-pound/- and JP-yen/euro (until 1998, /D-Mark).

FIGURE 5.2

Histograms of hit rates on exchange rate forecasts



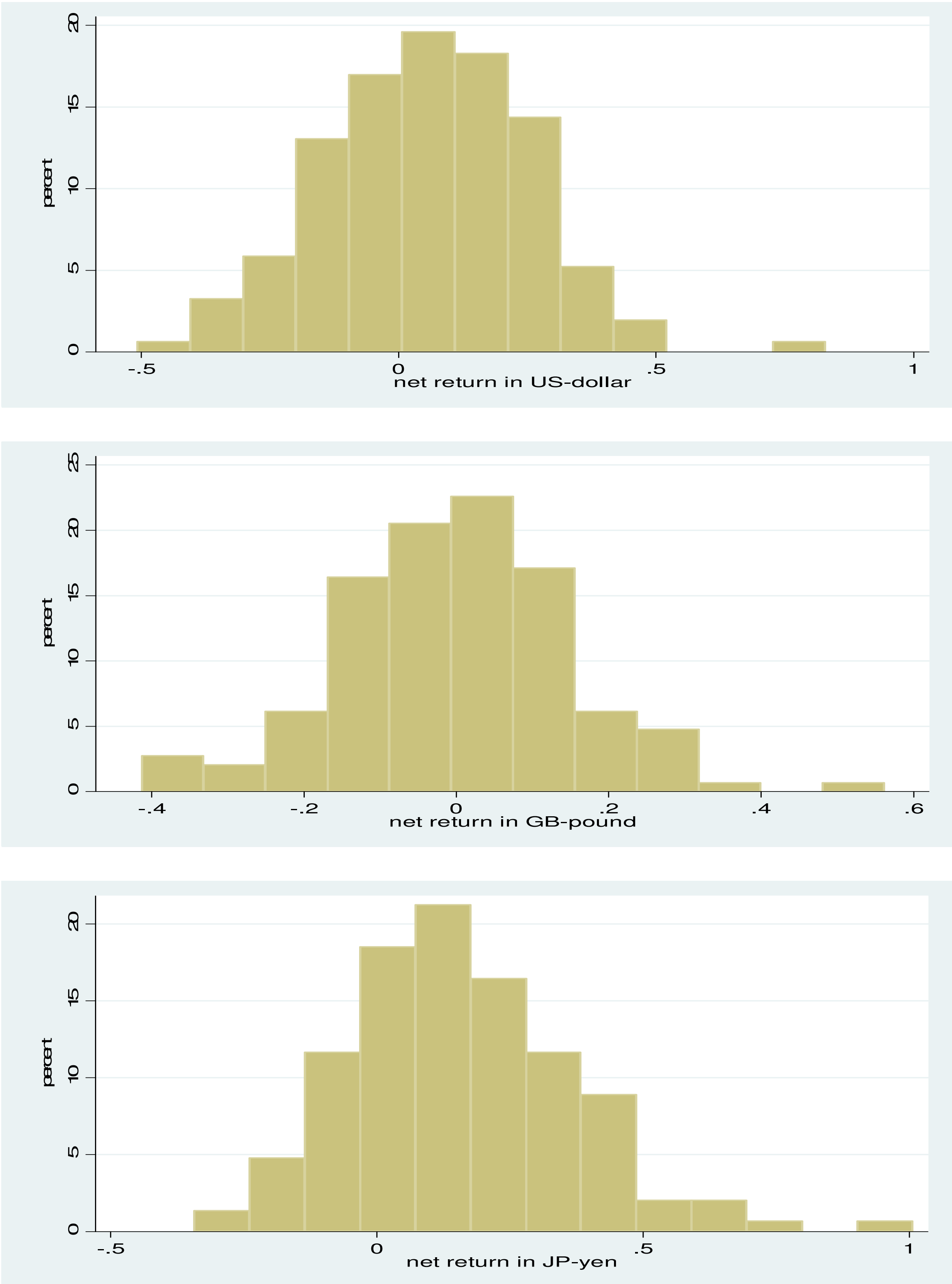




Notes: The hit rates are based upon the individual 6-month US-dollar/euro expectations from Dec. 1991 until July 2006. The hit rates range from 0 to 2, with 2 representing a correct qualitative forecast, 1 a simple forecast error (e.g. forecast of no change but actually the exchange rate falls) and 0 a double forecast error (e.g. forecast of a rise but actually the exchange rate falls). This histograms show the distributions of the hit rates, when moving from top to bottom, in the euro/US-dollar, euro/GB-pound and euro/JP-yen (each with the D-Mark/-respectively), considering only participants with at least 50% participation (see further information in Table 5.1).

FIGURE 5.3

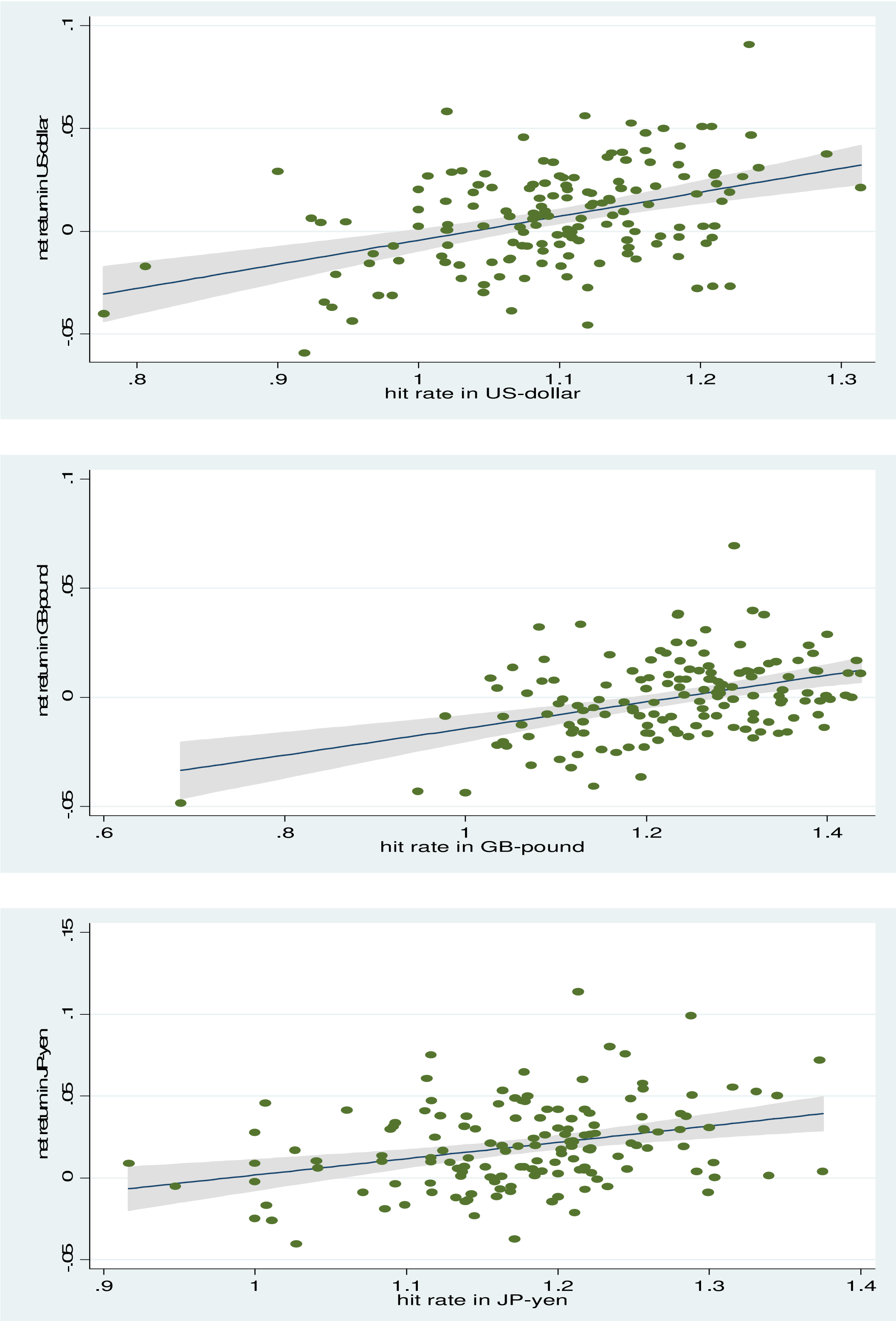
Histograms of net returns on exchange rate forecasts



Notes: The net returns are based upon the individual 6-month US-dollar/euro expectations from Dec. 1991 until July 2006. This histograms show the distributions of the net returns, when moving from top to bottom, in the euro/US-dollar, euro/GB-pound and euro/JP-yen (each with the D-Mark/- respectively), considering only participants with at least 50% participation (see further information in Table 5.1). The returns range for the US-dollar from -0.51 to 0.73, for the GB-pound from -0.41 to 0.56 and for the JP-yen from -0.34 to 0.90.

FIGURE 5.4

Scatter plots of (yearly) net returns and corresponding hit rates



Notes: The (yearly) net returns are based upon the individual 6-month US-dollar/euro expectations from Dec. 1991 until July 2006. The scatter-plots show the net returns and corresponding hit rates, when moving from top to bottom, in the euro/US-dollar, euro/GB-pound and euro/JP-yen (each with the D-Mark/- respectively), considering only participants with at least 50% participation (see further information in Table 5.1). The returns range for the US-dollar from -0.0592 to 0.0908, for the GB-pound from -0.0484 to 0.0695 and for the JP-yen from -0.0404 to 0.1138.

Appendix 5

Table A5.1

Descriptive statistics of aggregated forecasts and actual exchange rates

	US-dollar/euro	**GB-pound/euro**	**JP-yen/euro**
6-m. Δ FX	0.0031	0.0003	-0.0009
std. 6-m. Δ FX	0.0701	0.0581	0.0838
min. 6-m. Δ FX	-0.1488	-0.1649	-0.2392
max. 6-m. Δ FX	0.1459	0.1922	0.1847
Δ consensus	-0.0093	0.0153	0.0130
std. Δ consensus	0.0602	0.0260	0.0254
min. Δ consensus	-0.1736	-0.0300	-0.0308
max. Δ consensus	0.1155	0.0800	0.0783
Δ dispersion	0.0698	0.0412	0.0431
std. Δ dispersion	0.0161	0.0108	0.0089
min. Δ dispersion	0.0431	0.0234	0.0278
max. Δ dispersion	0.1323	0.0860	0.0795

Notes: The sample contains 176 monthly observations from December 1991 until July 2006. All variables are measured in changes and therefore marked with the symbol Δ. Using Carlson and Parkin's (1975) quantification procedure and setting a 3% threshold, we generate consensus forecasts. Asterisks refer to the significance level: *, **, *** to ten, five and one percent.

TABLE A 5.2

Bias and hit rate in consensus exchange rate forecasts

$$\Delta error_t = \alpha + \varepsilon_t$$

$$\text{with} \quad \Delta error_t = \Delta fx_t - \Delta fx^e_{t,t-6}.$$

	US-dollar/euro	GB-pound/euro	JP-yen/euro
Sub periods			
(1) bias (6-months)	0.0751***	0.0120	-0.0191
[prob. value] #	[0.000]	[0.556]	[0.304]
(2) bias (6-months)	-0.0487***	-0.0518***	-0.0417
[prob. value] #	[0.021]	[0.000]	[0.118]
(3) bias (6-months)	0.1667	-0.0062	0.0210**
[prob. value] #	[0.298]	[0.522]	[0.036]
total period			
Bias (6-months)	0.0146	-0.0154	-0.0143
[prob. value] #	[0.318]	[0.121]	[0.248]
hit rate	0.5833*	0.4808*	0.6418*
	[0.086]	[0.099]	[0.083]

Notes: The sample contains 176 monthly observations from December 1991 until July 2006. The sub periods are defined as follows: (1) 1992-1995, (2) 1996-2000 and (3) 2001-2006. The errors underlying the consensus bias are based upon the difference between the actual exchange rate change (1-month and 6-month, respectively) and the related consensus forecast. A positive (negative) sign means that the foreign currency-strength is on average overrated (underrated). Using Carlson and Parkin's (1975) quantification procedure and setting a 3% threshold, we generate consensus forecasts. All regressions are estimated by Newey-West standard-errors. The hit rate shows the share of inherent accurate direction forecasts–significance levels are based upon χ^2-tests–whereas respective positive (negative) trends are considered 2% (-2%) are exceeded. However, we present only hit rates for the total period, since for several sub periods several cells are not filled by any empirical observations, which in turn inhibit inferring statistical statistics. Asterisks refer to the significance level: *, **, *** to ten, five and one percent.

TABLE A 5.3

Differences among forecasters' performances: a nonparametric test

	US-dollar		**GB-pound**		**JP-yen**	
average rank	**expected prob.**	**realized prob.**	**expected prob.**	**realized prob.**	**expected prob.**	**realized prob.**
1.000	0.0000	0.0000	0.0000	0.0068	0.0000	0.0000
1.125	0.0001	0.0000	0.0001	0.0000	0.0001	0.0000
1.250	0.0005	0.0000	0.0005	0.0000	0.0005	0.0000
1.375	0.0018	0.0000	0.0018	0.0068	0.0018	0.0068
1.500	0.0049	0.0065	0.0049	0.0274	0.0049	0.0000
1.625	0.0111	0.0131	0.0111	0.0342	0.0111	0.0068
1.750	0.0218	0.0131	0.0218	0.0479	0.0218	0.0342
1.875	0.0377	0.0654	0.0377	0.0685	0.0377	0.0411
2.000	0.0583	0.0588	0.0583	0.0548	0.0583	0.0890
2.125	0.0813	0.0000	0.0813	0.0000	0.0813	0.0000
2.250	0.1027	0.0719	0.1027	0.0616	0.1027	0.1096
2.375	0.1179	0.1307	0.1179	0.0616	0.1179	0.0685
2.500	0.1235	0.1111	0.1235	0.0959	0.1235	0.0959
2.625	0.1179	0.1307	0.1179	0.1301	0.1179	0.1164
2.750	0.1027	0.1699	0.1027	0.0616	0.1027	0.1164
2.875	0.0813	0.1046	0.0813	0.0685	0.0813	0.0753
3.000	0.0583	0.0523	0.0583	0.1164	0.0583	0.0890
3.125	0.0377	0.0000	0.0377	0.0000	0.0377	0.0000
3.250	0.0218	0.0327	0.0218	0.0548	0.0218	0.0890
3.375	0.0111	0.0131	0.0111	0.0616	0.0111	0.0137
3.500	0.0049	0.0261	0.0049	0.0274	0.0049	0.0342
3.625	0.0018	0.0000	0.0018	0.0068	0.0018	0.0000
3.750	0.0005	0.0000	0.0005	0.0068	0.0005	0.0068
3.875	0.0001	0.0000	0.0001	0.0000	0.0001	0.0068
4.000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N	153		146		146	
M	25		25		25	
D*	0.09		0.14		0.11	
K-S	0.4246	[0.]	0.6357	[0.]	0.5136	[0.]

Notes: The sample contains 176 monthly observations from December 1991 until July 2006. N denotes the number of persons, M the number of possible outcome (average ranks) and D^* the largest difference between expected and realized cumulative density. K-S represents the Kolmogorov-Smirnov test statistic and is calculated as follows: $K\text{-}S = (M * N / (M + N))^{0.5} * D_{max}$. We show for each exchange rate the expected and the realized average density, respectively. Each analyst is ranked in 2-year periods (8 periods in sum) depending on its hit rate in the performance quartile (1 worst and 4 best). The possible outcomes equals to (4 - 1) * 8 + 1 and the possible sequences to 4^{16}. The test-statistic is calculated under the null hypothesis of no accuracy differences among the forecasters in the sample. Though, expected probabilities arise when multiplying calculated densities under null by the sample size, whereas realized probabilities are taken from the empirical sample. Asterisks refer to the regressors' level of significance in the short-term relations: *, **, *** to ten, five and one percent.

TABLE A 5.4

Best and worst 25 forecasters in the GB-pound (hit rates)

strong hands	[probability]	participation	weak hands	[probability]	participation
1.45***	[0.000]	150	0.95***	[0.000]	89
1.43***	[0.000]	104	1.00***	[0.000]	96
1.43***	[0.000]	88	1.03***	[0.000]	90
1.42***	[0.001]	111	1.03***	[0.000]	93
1.42***	[0.001]	137	1.04***	[0.000]	109
1.41***	[0.002]	118	1.04***	[0.000]	119
1.40***	[0.002]	89	1.05***	[0.000]	115
1.40***	[0.003]	140	1.06***	[0.000]	171
1.40***	[0.003]	153	1.07***	[0.000]	97
1.39***	[0.004]	152	1.07***	[0.000]	110
1.39***	[0.005]	145	1.07***	[0.000]	151
1.39***	[0.006]	118	1.07***	[0.000]	161
1.39***	[0.006]	144	1.09***	[0.000]	146
1.39***	[0.007]	168	1.09***	[0.000]	156
1.38***	[0.009]	107	1.09***	[0.000]	96
1.38**	[0.011]	132	1.10***	[0.001]	94
1.38**	[0.011]	103	1.10***	[0.001]	125
1.37**	[0.017]	113	1.11***	[0.001]	100
1.37**	[0.024]	156	1.11***	[0.001]	110
1.36**	[0.031]	150	1.12***	[0.002]	91
1.35**	[0.045]	173	1.12***	[0.003]	136
1.35**	[0.046]	159	1.12***	[0.003]	143
1.35**	[0.046]	125	1.12***	[0.003]	102
1.35**	[0.047]	145	1.13***	[0.005]	141
1.35*	[0.054]	172	1.13***	[0.005]	113

Notes: The results are based upon 176 monthly observations from December 1991 until July 2006. We assume a 6-month forecast horizon and set the expectation threshold at 3%. The hit rates range from 0 to 2, with 2 representing a correct qualitative forecast, 1 a simple forecast error (e.g. forecast of no change but actually the exchange rate falls) and 0 a double forecast error (e.g. forecast of a rise but actually the exchange rate falls). The minimum participation (part.) is set at 50%, so we consider only individuals who participated at least at 88 months with sample mean participation of 132, minimum of 88 and maximum of 173 months. Though, 146 individuals remain with a mean hit rate of 1.23. Corresponding P-values of the realized hit rates are calculated via bootstrap technique. Asterisks refer to the regressors' level of significance in the short-term relations: *, **, *** to ten, five and one percent.

TABLE A 5.5

Best and worst 25 forecasters in the JP-yen (hit rates)

strong hands	**[probability]**	**participation**	**weak hands**	**[probability]**	**participation**
1.37***	[0.000]	151	0.91***	[0.001]	107
1.37***	[0.000]	125	0.95**	[0.011]	95
1.35***	[0.000]	144	1.00	[0.105]	97
1.34***	[0.000]	161	1.00	[0.105]	102
1.33***	[0.000]	141	1.00	[0.105]	130
1.32***	[0.000]	88	1.01	[0.129]	169
1.32***	[0.000]	130	1.01	[0.153]	90
1.30***	[0.000]	151	1.01	[0.165]	150
1.30***	[0.000]	159	1.01	[0.173]	135
1.30***	[0.000]	156	1.03	[0.250]	111
1.29***	[0.000]	143	1.03	[0.299]	150
1.29***	[0.001]	167	1.03	[0.301]	119
1.29***	[0.001]	142	1.05	[0.446]	122
1.29***	[0.001]	118	1.06	[0.574]	132
1.29***	[0.001]	105	1.07	[0.709]	98
1.28***	[0.001]	152	1.09	[0.958]	156
1.28***	[0.002]	145	1.09	[0.966]	166
1.27***	[0.004]	168	1.09	[0.982]	153
1.26***	[0.004]	108	1.09	[0.983]	142
1.26***	[0.004]	139	1.09	[0.997]	162
1.26***	[0.004]	147	1.09	[0.997]	108
1.26***	[0.004]	89	1.09	[0.997]	108
1.26***	[0.004]	117	1.10	[0.899]	90
1.26***	[0.004]	121	1.11	[0.789]	111
1.25***	[0.006]	172	1.11	[0.717]	141

Notes: The results are based upon 176 monthly observations from December 1991 until July 2006. We assume a 6-month forecast horizon and set the expectation threshold at 3%. The hit rates range from 0 to 2, with 2 representing a correct qualitative forecast, 1 a simple forecast error (e.g. forecast of no change but actually the exchange rate falls) and 0 a double forecast error (e.g. forecast of a rise but actually the exchange rate falls). The minimum participation (part.) is set at 50%, so we consider only individuals who participated at least at 88 months with sample mean participation of 132, minimum of 88 and maximum of 172 months. Though, 146 individuals remain with a mean hit rate of 1.18. Corresponding P-values of the realized hit rates are calculated via bootstrap technique. Asterisks refer to the regressors' level of significance in the short-term relations: *, **, *** to ten, five and one percent.

TABLE A 5.6

Hit rates: persistent forecasters on exchange rates (5% level)

strong hands	JP-yen	GB-pound	US-dollar	weak hands	JP-yen	GB-pound	US-dollar
1	x		x	1		x	x
2	x	x		2	x	x	
3	x	x		3		x	x
4	x	x		4		x	x
5	x	x		5		x	x
6	x	x					
7	x		x				
8		x	x				
9	x	x					
10	x	x					
11	x	x					
12	x	x					
13	x	x					
14	x	x					
15	x	x					
16	x	x					
17	x	x					
18	x	x					
19	x		x				

Notes: When we just look at significant (5% level) forecasters, 106 individuals remain. Of the strong hands 13 are bankers (of which 7 are analysts) and are 5 insurers (of which none is analyst). Of the weak hands 3 are bankers (of which 2 are analysts) and 2 are industrials. However, for 1 strong insurer we miss accordant information and in respect to the weak hands we miss information for 2 industrials. So we have professional information for 18 strong guys which reveals 7 of them being an analyst (~39% in all) and for 3 weak guys of which are 2 analysts (~66% in all).

References

Abhyankar, Abhay, Lucio Sarno and Giorgio Valente (2005), Exchange rates and fundamentals: evidence on the economic value of predictability, *Journal of International Economics*, 66: 325-48.

Aggarwal, Raj, Sunil Mohanty and F. Song (1995), Are survey forecasts of macroeconomic variables rational?, *Journal of Business*, 68: 99-119.

Aggarwal, Raj, and David C. Schirm (1992), Balance of trade announcement and asset prices: influence on equity prices, exchange rates, and interest rates, *Journal of International Money and Finance*, 28: 347-61.

Alfarano, Simone and Thomas Lux (2007), A noise trader model as a generator of apparent power laws and long memory, *Macroeconomic Dynamics*, forthcoming.

Alfarano, Simone, Thomas Lux and Friedrich Wagner (2007), Time-variation of higher moments in a financial market with heterogeneous agents: an analytical approach, *Journal of Economic Dynamics & Control*, forthcoming.

Allen, Franklin, Stephen Morris and Hyun S. Shin (2006), Beauty contests and iterated expectations in asset markets, *Review of Financial Studies*, 19: 719-52.

Almeida, Alvaro, Charles Goodhart and Richard Payne (1998), The effects of macroeconomic ´news´ on high frequency exchange rate behaviour, *Journal of Financial and Quantitative Analysis*, 33: 383-408.

Andersen, Torben G. and Tim Bollerslev (1998), DM-dollar volatility: intraday activity patterns, macroeconomic announcements, and longer-run dependencies, *Journal of Finance*, 53: 219-65.

Andersen, Torben G., Tim Bollerslev, Francis X. Diebold and Clara Vega (2003), Micro effects of macro announcements: real-time price discovery in foreign exchange, *American Economic Review*, 93: 38-62.

Andersen, Torben G., Tim Bollerslev, Francis X. Diebold and Clara Vega (2005), Real-time price discovery in stock, bond and foreign exchange markets, NBER Working Paper, 11312.

Ang, Andrew, Bekaert, Geert and Min Wei (2007), Do macro variables, asset markets or surveys forecast inflation better?, *Journal of Monetary Economics*, 54: 1163-212.

Audretsch, David and Georg Stadtmann (2005), Biases in FX-forecasts: evidence from panel data, *Global Finance Journal*, 16: 99-111.

Bacchetta, Philip and Eric van Wincoop (2004), A scapegoat model of exchange-rate fluctuations, *American Economic Review*, 94: 114-33.

Bacchetta, Philippe and Eric van Wincoop (2006), Can information heterogeneity explain the exchange rate determination puzzle?, *American Economic Review*, 96: 552-76.

Bacchetta, Philippe and Eric van Wincoop (2007), Random walk expectations and the forward discount puzzle, *American Economic Review*, Papers and Proceedings, forthcoming.

Bacchetta, Philippe and Eric van Wincoop (2007a), Infrequent portfolio decisions: a solution to the forward discount puzzle, CEPR discussion papers.

Baker, Malcolm and Jeffrey Wurgler (2006), Investor sentiment and the cross-section of stock returns, *Journal of Finance*, 61: 1645-80.

Balcombe, Kelvin (1996), The Carlson-Parkin method applied to NZ price expectations using QSBO survey data, *Economics Letters*, 51: 51-7.

Bams, Dennis, Kim Walkowiak and Christian C. Wolff (2004), More evidence on the dollar risk premium in the foreign exchange market, *Journal of International Money and Finance*, 23: 271-82.

Bank of International Settlements (2005), Triennial central bank survey of foreign exchange and derivatives market activity in 2004, March 2005.

Baxter, Marianne and Alan C. Stockman (1989), Business cycles and the exchange rate regime: Some international evidence, *Journal of Monetary Economics*, 23: 377-400.

Beck, Stacie (1993), The Ricardian equivalence proposition: evidence from foreign exchange markets, *Journal of International Money and Finance*, 12: 154-69.

Bénassy-Quéré, Agnès, Sophie Larribeau and Ronald MacDonald (2003), Models of exchange rate expectations: how much heterogeneity? *Journal of International Financial Markets, Institutions and Money*, 13: 113-36.

Blake, David, Michael Beenstock and Valerie Brasse (1986), The performance of UK exchange rate forecasters, *Economic Journal*, 96: 986-99.

Bomhoff, Edward J. and Peter Korteweg (1983), Exchange rate variability and monetary policy under rational expectations: some Euro-American experiences 1973-79, *Journal of Monetary Economics*, 11: 169-206.

Boswijk, H. Peter, Cars H. Hommes and Sebastiano Manzan (2007), Behavioral heterogeneity in stock prices, *Journal of Economic Dynamics & Control*, 3: 1938-70.

Brock, William A. and Cars H. Hommes (1998), Heterogeneous beliefs and routes to chaos in a simple asset pricing model, *Journal of Economic Dynamics & Control*, 22: 1235-74.

Brown, Gregory W., Michael T. Cliff (2004), Investor sentiment and near-term stock market, *Journal of Empirical Finance*, 11: 1-27.

Brown, Gregory W., Michael T. Cliff (2005),Investor sentiment and asset valuation, *Journal of Business*, 78: 405-40.

Cai, Jun, Yan-Leung Cheung, Raymond S. Lee and Michael T. Melvin (2001), ´Once in-a-generation´ yen volatility in 1998: fundamentals, intervention, and order flow, *Journal of International Money and Finance*, 20: 327-47.

Canjels, Eugene, Gauri Prakash-Canjels and Alan M. Taylor (2004), Measuring market integration: foreign exchange arbitrage and the gold standard, *Review of Economics and Statistics*, 86: 1879-913.

Capistrán, Carlos and Allan Timmermann (2006), Disagreement and biases in inflation expectations, UCSD working paper.

Carlson, John A. and Melody Lo (2006), One minute in the life of the DM/US$: public news in an electronic market, *Journal of International Money and Finance*, 25: 1090-102.

Carlson, John A. and Michael Parkin (1975), Inflation expectations, *Economica*, 42: 123-38.

Cavaglia, Stefano, Willem F.C. Verschoor and Christian C.P. Wolff (1993), Further evidence on exchange rate expectations, *Journal of International Money and Finance*, 12: 78-98.

Chen, Shu-Heng, Thomas Lux and Michele Marchesi (2001), Testing for non-linear structure in an artificial financial market, *Journal of Economic Behavior & Organization*, 46: 327-42.

Cheung, Yin-Wong and Menzie D. Chinn (2001), Currency traders and exchange rate dynamics: a survey of the U.S. market, *Journal of International Money and Finance*, 20: 439-71.

Cheung, Yin-Wong and Yuk-Pang Wong (2000), A survey of market practitioners´ views on exchange rate dynamics, *Journal of International Economics*, 51: 401-19.

Cheung, Yin-Wong, Menzie D. Chinn and Antonio Garcia Pascual (2005), Empirical exchange rate models of the nineties: are any fit to survive?, *Journal of International Money and Finance*, 24: 1150-75.

Chevalier, Judith and Glenn Ellison (1999), Are some mutual fund managers better than others? Cross-sectional pattern in behavior and performance, *Journal of Finance*, 3: 875-99.

Chiarella, Carl, Roberto Dieci and Xue-Zhong He (2007), Heterogeneous expectations and speculative behaviour in a dynamic multi-asset framework, *Journal of Economic Behavior & Organization*, 62: 408-27.

Clement, Michael B. and Senyo Y. Tse (2005), Financial analyst characteristics and herding behavior in forecasting, *Journal of Finance*, 60: 307-41.

Coakley, Jerry, Robert P. Flood, Ana M. Fuertes and Mark P. Taylor (2005), Purchasing power parity and the theory of general relativity: the first tests, *Journal of International Money and Finance*, 24: 293-316.

Coakley, Jerry and Ana M. Fuertes (2000), Short run dynamics of real exchange rates, Manchester School, 68: 461-75.

Coakley, Jerry and Ana M. Fuertes (2006), Valuation ratios and price deviations from fundamentals, *Journal of Banking and Finance*, 30. 2325-46.

Copeland, Laurence S. (1984), The Pound Sterling/US Dollar exchange rate and the news, *Economics Letters*, 15: 109-13.

Copeland, Laurence S. (1984a), Oil, news and the petropound: some tests, *Economics Letters*, 16: 123-27.

Copeland, Laurence S. (1989), Exchange rates and news: a vector autoregression approach, in: Ronald MacDonald and Mark P. Taylor (eds.), *Exchange Rates and Open Economy Macroeconomics* (Basil Blackwell): 218-38.

Cornell, Bradford (1982), Money supply announcement, interest rates, and foreign exchange, *Journal of International Money and Finance*, 1: 201-08.

Cornell, Bradford (1983), The money supply announcement puzzle: review and interpretation, *American Economic Review*, 73: 644-57.

Cunningham, Thomas J. and Rosemary M. Cunningham, R. M. (1991), Another source of money supply announcement surprises, *Journal of Macroeconomics*, 13: 279-89.

Dasgupta, Susmita and Kajal Lahiri (1992), A comparative study of alternative methods of quantifying qualitative survey responses using NAPM data, *Journal of Business & Economic Statistics*, 10: 391-400.

De Grauwe, Paul and Marianna Grimaldi (2006), Exchange rate puzzles: a tale of switching attractors, *European Economic Review*, 50: 1-33.

Deaves, Richard (1990), Money supply announcement and market reactions in an open economy, *Journal of Money, Credit and Banking*, 22: 154-64.

Deaves, Richard (1991), Canadian weekly money supply announcement and financial reactions, *Canadian Journal of Economics*, 24: 282-99.

Diebold, Francis X. and Jose A. Lopez (1996), Forecast evaluation and combination, in: G. S. Maddala and C. R. Rao (eds.), *Handbook of Statistics*, 14, Amsterdam, 241-68.

Dominguez, Kathryn M. (1986), Are foreign exchange forecasts rational? New evidence from survey data, *Economics Letters*, 21: 277-81.

Dominguez, Kathryn M. and Freyan Panthaki (2006), What defines 'news' in foreign exchange markets?, *Journal of International Money and Finance*, 25: 168-98.

Dooley, Michael and Peter Isard (1982), A portfolio-balance rational-expectations model of the dollar-mark exchange rate, *Journal of International Economics*, 12: 257-76.

Dornbusch, Rudiger (1976), Expectations and exchange rate dynamics, *Journal of Political Economy*, 84: 1161-76.

Dornbusch, Rudiger (1980), Exchange rate economics: where do we stand?, *Brookings Papers on Economic Activity*, 1: 143-85+87-205.

Ederington, Louis H. (1993), How markets process information: news releases and volatility, *Journal of Finance*, 48: 1161-91.

Ederington, Louis H. (1995), The short-run dynamics of price adjustment to new information, *Journal of Financial and Quantitative Analysis*, 30: 117-34.

Edison, Hali J. (1997), The reaction of exchange rates and interest rates to news releases, *International Journal of Finance and Economics*, 2: 87-100.

Edwards, Sebastian (1982), Exchange rates and news: a multi-currency approach, *Journal of International Money and Finance*, 1: 211-24.

Edwards, Sebastian (1982a), Exchange rate efficiency and new information, *Economic Letters*, 9: 377-82.

Edwards, Sebastian (1983), Floating exchange rates, expectations and new information, *Journal of Monetary Economics*, 11: 321-36.

Ehrmann, Michael and Marcel Fratzscher (2005) Exchange rates and Fundamentals: new evidence form real-time data, *Journal of International Money and Finance*, 24: 317-41.

Elliott, Graham and Takatoshi Ito (1999), Heterogeneous expectations and tests of efficiency in the yen/dollar forward exchange rate market, *Journal of Monetary Economics*, 43: 435-56.

Elliott, Graham, Ivana Komunjer and Allan Timmermann (2005), Biases in macroeconomic forecasts: irrationality or asymmetric loss, UCSD working paper.

Engel, Charles (1996), A model of foreign exchange rate indetermination, NBER Working Paper, 5766.

Engel, Charles and Jeffrey Frankel (1984), Why interest rates react to money announcements, *Journal of Monetary Economics*, 13: 31-9.

Erwin, Douglas A. (1989), Trade deficit announcement, intervention, and the dollar, *Economics Letters*, 31: 257-62.

Evans, Martin D. (2002), FX trading and exchange rate dynamics, *Journal of Finance*, 57: 2405-47.

Evans, Martin D. and Richard K. Lyons (2002), Order flow and exchange rate dynamics, *Journal of Political Economy*, 110: 170-80.

Evans, Martin D. and Richard K. Lyons (2004), A new micro model of exchange rate dynamics, NBER Working Paper, 10379.

Evans, Martin D. and Richard K. Lyons (2007), Exchange rate fundamentals and order flow, NBER Working Paper, 13151.

Evans, Martin D. and Richard K. Lyons (2007a), How is macro news transmitted to exchange rates?, working paper, U.C. Berkeley.

Fair, Ray C. (2003), Shock effects on stocks, bonds, and exchange rates, *Journal of International Money and Finance*, 22: 307-41.

Fama, Eugene F. (1970), Efficient capital markets: a review of theory and empirical work, *Journal of Finance*, 25: 383-417.

Fama, Eugene F. (1984), Forward and spot exchange rates, *Journal of Monetary Economics*, 14: 319-38.

Fama, Eugene F. (1991), Efficient capital markets: II, *Journal of Finance*, 46: 1575-617.

Fatum, Rasmus and Barry Scholnik (2006), Do exchange rates respond to day-to-day changes in monetary policy expectations? Evidence from the Federal Funds futures Market, *Journal of Money, Credit and Banking*, 38: 1641-57.

Faust, Jon, John H. Rogers, Shing-Yi B. Wang and Jonathan H. Wright (2007), The high-frequency response of exchange rates and interest rates to macroeconomic announcements, *Journal of Monetary Economics*, 54: 1051-68.

Faust, Jon, John H. Rogers and Jonathan H. Wright (2003), Exchange rate forecasting: the errors we've really made, *Journal of International Economics*, 60: 35-59.

Ferson, Wayne E., Sergei Sarkissian and Timothy Simin (2003), Spurious regression in financial economics, *Journal of Finance*, 58: 1393-413.

Flood, Robert P. and Andrew K. Rose (1996), Fixes: of the forward discount puzzle, *Review of Economics and Statistics*, 128: 748-52.

Flôres, Renato, Philippe Jorion, Pierre-Yves Preumont and Ariane Szafarz (1999), Multivariate unit root tests of the PPP hypothesis, *Journal of Empirical Finance*, 6: 335-53.

Frankel, Jeffrey A. (1979), On the mark: a theory of floating exchange rate based on real interest differentials, *American Economic Review*, 69: 610-27.

Frankel, Jeffrey A. and Kenneth A. Froot (1987), Using survey data to test standard propositions regarding exchange rate expectations, *American Economic Review*, 77: 133-53.

Frankel, Jeffrey A. and Kenneth A. Froot (1987a), Short-term and long-term expectations of the yen/dollar exchange rate: evidence from survey data, *Journal of the Japanese and International Economies*, 1: 249-74.

Frankel, Jeffrey A. and Kenneth A. Froot (1990), Chartists, fundamentalists and the demand for dollars, in: Anthony S. Courakis and Mark P. Taylor (eds.), *Private behaviour and government policy in interdependent economies*, Oxford: Clarendon Press, 73-126.

Frankel, Jeffrey A. and Kenneth A. Froot (1990a), Chartists, fundamentalists, and trading in the foreign exchange market, *American Economic Review*, 80: 181-85.

Frankel, Jeffrey A. and Andrew K. Rose (1995), Empirical research on nominal exchange rates, in: Gene M. Grossmann and Kenneth S. Rogoff (eds.), *Handbook of International Economics*, Vol. III (Amsterdam et al.: North-Holland): 1689-729.

Franses, Philip H. and Dick van Dijk (2000), *Non-linear time series models in empirical finance*, Cambridge et al.: Cambridge University Press, 69-134.

Fratzscher, Marcel (2006), On the long-term effectiveness of exchange rate communication and interventions, *Journal of International Money and Finance*, 25: 146-67.

Frenkel, Jacob A. (1981), Flexible exchange rates, prices, and the role of "news": lessons from the 1970´s, *Journal of Political Economy*, 89: 665-705.

Frenkel, Jacob A. and Michael L. Mussa (1980), The Efficiency of Foreign Exchange Markets and Measures of Turbulence, *American Economic Review*, 70: 374-81.

Frenkel, Michael, Christian Pierdzioch and Georg Stadtmann (2004), The accuracy of press reports regarding the foreign exchange interventions of the Bank of Japan, *Journal of International Financial Markets, Institutions and Money,* 14: 25-36.

Froot, Kenneth A. and Jeffrey A. Frankel (1989), Forward discount bias: Is it an exchange risk premium?, *Quarterly Journal of Economics*, 104: 139-61.

Fung, Kwok-Wah, Alexander and Kin Lam (2004), Overreaction of index futures in Hong Kong, *Journal of Empirical Finance*, 11: 331-51.

Gehrig, Thomas and Lukas Menkhoff (2004), The use of flow analysis in foreign exchange: exploratory evidence, *Journal of International Money and Finance*, 23: 573-94.

Gehrig, Thomas and Lukas Menkhoff (2006), Extended evidence on the use of technical analysis in foreign exchange, *International Journal of Finance and Economics*, 11: 327-38.

Goodhart, Charles (1988), The foreign exchange market: a random walk with a dragging anchor, *Economica*, 55: 437-60.

Goodhart, Charles (1989), News and the foreign exchange market, LSE Financial Markets Group, discussing paper, 71.

Goodhart, Charles and Lorenzo Figliuoli (1991), Every minute counts in financial markets, *Journal of International Money and Finance*, 10: 23-52.

Goodhart, Charles, Stephan G. Hall, Brian Henry and Bahram Pesaran (1993), News effects in a high-frequency model of the sterling-dollar exchange rate, *Journal of Applied Econometrics*, 8: 1-13.

Goodhart, Charles and Richard G. Smith (1985), The impact of news on financial markets in the United Kingdom, *Journal of Money, Credit and Banking*, 17: 507-11.

Goodman, Stephen H. (1979), Foreign exchange rate forecasting techniques: implications for business and policy, *Journal of Finance*, 34: 415-27.

Gourinchas, Pierre-Olivier and Aaron Tornell (2004), Exchange rate puzzles and distorted beliefs, *Journal of International Economics*, 64: 303-33.

Hafer, Rik W. (1985), Comparing time-series and survey forecasts of weekly changes in money: a methodological note, *Journal of Finance*, 39: 1207-300.

Hakkio, Craig S. and Douglas K. Pearce (1985), The reaction of exchange rates to economic news, *Economic Inquiry*, 23: 621-36.

Hansen, Bruce E. and Byeongseon Seo (2002), Testing for two-regime threshold cointegration in vector error-correction models, *Journal of Econometrics*, 110: 293-318.

Hansen, Lars P. and Robert J. Hodrick (1980), Foreign exchange rates as optimal predictors of future spot rates: an econometric analysis, *Journal of Political Economy*, 88: 829-53.

Hardouvelis, Gikas A. (1984), Market perceptions of Federal Reserve policy and the weekly monetary announcement, *Journal of Monetary Economics*, 14: 225-40.

Hardouvelis, Gikas A. (1985), Exchange rates, interest rates, and money-stock announcement: a theoretical exposition, *Journal of International Money and Finance*, 4: 443-54.

Hardouvelis, Gikas A. (1988), Economic news, exchange rates and interest rates, *Journal of International Money and Finance*, 7: 23-35.

Hau, Harald and Hélène Rey (2006), Exchange rates, stock prices, and capital flows, *Review of Financial Studies*, 9: 273-317.

Hodrick, Robert J. (1992), Dividend yields and expected stock returns: alternative procedures for inference and measurement, *Review of Financial Studies*, 5: 357-86.

Hoffman, Dennis L. and Don E. Schlagenhauf (1985), The impact of news and alternative theories of exchange rate determination, *Journal of Money, Credit, and Banking*, 17: 328-46.

Hogan, Kedreth Jr. and Michael T. Melvin (1994), Sources of meteor showers and heat waves in the foreign exchange market, *Journal of International Economics*, 37: 239-47.

Imbs, Jean, Haroon Mumtaz, Morten Ravn and Hélène Rey (2005), PPP strikes back: aggregation and the real exchange rate, *Quarterly Journal of Economics*, 120: 1-43.

Irwin, Douglas A. (1989), Trade deficit announcements, intervention, and the dollar, *Economics Letters*, 31: 257-62.

Ito, Takatoshi (1990), Foreign exchange rate expectations: micro survey data, *American Economic Review*, 80(3): 434-49.

Ito, Takatoshi (1994), Short-run and long-run expectations of the yen/dollar exchange rate, *Journal of the Japanese and International Economies*, 8: 119-43.

Ito, Takatoshi and V. Vance Roley (1987), News from the U.S. and Japan which moves the yen/dollar exchange rate?, *Journal of Monetary Economics*, 19: 255-77.

Ito, Takatoshi and Tomoyoshi Yabu (2004), What prompts Japan to intervene in the forex market? A new approach to a reaction function, NBER Working Paper, 10456.

Jeanne, Olivier and Andrew K. Rose (2002), Noise trading and exchange rate regimes, *Quarterly Journal of Economics*, 117: 537-69.

Johansen, Sören (1995), *Likelihood-based inference in cointegrated vector auto-regressive models*, Oxford: Oxford University Press.

Johansen, Sören (2006), Cointegration: an overview, in: Terence C. Mills and Kerry Patterson (eds.), *Palgrave Handbook of Econometrics: Volume 1, Econometric Theory*, Basingstoke: Palgrave Macmillan: 540-77.

Karjakis, Costas and Suk-Joong Kim (1995), Exchange rates, interest rates and current account news: some evidence from Australia, *Journal of International Money and Finance*, 14: 575-95.

Kilian, Lutz and Mark P. Taylor (2003), Why is it so difficult to beat the random walk forecast of exchange rates?. *Journal of International Economics*, 60: 85-107.

Kim, Suk-Joong (1997), Testing the rationality of exchange rate and interest rate expectations: an empirical study of Australian survey-based expectations, *Applied Economics*, 29: 1011-22.

Kitchen, John (1996), Domestic and international financial market response to federal deficit announcement, *Journal of International Money and Finance*, 15: 239-54.

Klein, Michael W., Bruce Mizrach and Robert G. Murphy, R. G. (1991), Managing the dollar: has the Plaza agreement mattered?, *Journal of Money, Credit and Banking*, 742-51.

Koedijk, Kees G. and Christian C. Wolff (1996), Exchange rate returns, `news´, and risk premia, *Economics Letters*, 50: 127-34.

Locke, Peter R. and Steven C. Mann (2005), Professional trader discipline and trade disposition, *Journal of Financial Economics*, 76: 401-44.

Loh, Roger K. and G. Mujtaba Mian (2006), Do accurate earnings forecasts facilitate superior investment recommendations?, *Journal of Financial Economics*, 80: 455-83.

Longworth, David (1984), Exchange rates and ´news´: a comment, *Journal of Money and Finance*, 3: 119-21.

Lothian, James R. and Taylor, Mark P. (1996), Real exchange rate behavior: the recent float from the perspective of the last two centuries, *Journal of Political Economy*, 104: 488-510.

Love, Ryan and Richard Payne (2007), Macroeconomic news, order flow and exchange rates, *Journal of Financial and Quantitative Analysis*, forthcoming.

Lux, Thomas (1998), The socio-economic dynamics of speculative markets: interacting agents, chaos, and the fat tails of return distributions, *Journal of Economic Behavior & Organization*, 33: 143-65.

Lyons, Richard K. (2001), The microstructure approach to exchange rates, The MIT Press.

MacDonald, Ronald (1985), ´News´ and the 1920s experience with floating exchange rates, *Economics Letters*, 17: 379-83.

MacDonald, Ronald (1999), Exchange rates: do fundamentals matter?, *Economic Journal*, 109: 673-91.

MacDonald, Ronald (2000), Expectations formation and risk in three financial markets: surveying what the surveys say, *Journal of Economic Surveys*, 14: 69-100.

MacDonald, Ronald and Ian W. Marsh (1994), Combining exchange rate forecasts: What is the optimal consensus measure?, *Journal of Forecasting*, 13: 313-32.

MacDonald, Ronald and Ian W. Marsh (1996), Currency forecasters and heterogeneous: confirmation and consequences, *Journal of International Money and Finance*, 15: 665-85.

MacDonald, Ronald and Ian W. Marsh (1997), On fundamentals and exchange rates: a Casselian perspective, *Review of Economics and Statistics*, 79: 655-64.

MacDonald, Ronald and Mark P. Taylor (1992), The economics of exchange rates, *International Monetary Fund Staff Papers*, 39: 1-57.

MacDonald, Ronald and Marc P. Taylor (1994), The monetary model of the exchange rate: long-run relationships, short-run dynamics, and how to beat a random walk, *Journal of International Money and Finance*, 13: 276-90.

MacDonald, Ronald and Thomas S. Torrance (1988), On risk, rationality and excessive speculation in the Deutschemark-US-dollar exchange market: some evidence using survey data, *Oxford Bulletin of Economics and Statistics*, 50: 107-23.

MacKinlay, A. Craig (1997), Event studies in economics and finance, *Journal of Economic Literature*, 35: 13-39.

Mankiw, N. Gregory and Ricardo Reis (2002), Sticky information versus sticky prices: a proposal to replace the new Keynesian Phillips curve, *Quarterly Journal of Economics*, 117: 1295-328.

Mankiw, N. Gregory, Ricardo Reis and Justin Wolfers (2003), Disagreement about inflation expectations, *NBER Macroeconomics Annual 2003*, 209-48.

Manzan, Sebastiano and Frank Westerhoff (2005), Representativeness of news and exchange rate dynamics, *Journal of Economic Dynamics & Controls*, 29: 677-89.

Manzan, Sebastiano and Frank Westerhoff (2007), Heterogeneous expectations, exchange rate dynamics and predictability, *Journal of Economic Behavior & Organization*, forthcoming.

Mark, Nelson C. (1995), Exchange rates and fundamentals: evidence on long-run predictability, *American Economic Review*, 85: 201-18.

Mark, Nelson C. and Yangru Wu (1998), Rethinking deviations from uncovered interest parity: the role of covariance risk and noise, *Economic Journal*, 108: 1686-706.

Meese, Richard A. and Kenneth Rogoff (1983), Empirical exchange rate models of the seventies: do they fit out of sample?, *Journal of International Economics*, 14: 3-24.

Melvin, Michael T. and Xixi Yin (2000), Public information arrival, exchange rate volatility and quote frequency, *Economic Journal*, 110: 644-61.

Menkhoff, Lukas and Rafael R. Rebitzky (2008), Investor sentiment in the US-dollar: longer-term, nonlinear orientation on PP, *Journal of Empirical Finance*, forthcoming.

Menkhoff, Lukas, Rebitzky, Rafael R. and Michael Schröder (2008), Do dollar forecasters believe too much in PPP?, *Applied Economics*, forthcoming.

Menkhoff, Lukas and Ulrich Schmidt (2005), The use of trading strategies by fund managers: some first survey evidence, *Applied Economics*, 37: 1719-30.

Menkhoff, Lukas and Mark P. Taylor (2007), The obstinate passion of foreign exchange professionals: technical analysis, *Journal of Economic Literature*, forthcoming.

Mikhaila, Michael B., Beverly R. Waltherb and Richard H. Willis (2004) , Do security analysts exhibit persistent differences in stock picking ability?, *Journal of Financial Economics*, 74: 67-91.

Moosa, Imad A. and Abul Shamsuddin (2004), Expectation formation mechanisms, profitability of foreign exchange trading and exchange rate volatility, *Applied Economics*, 36: 1599-606.

Mussa, Michael (1976), The exchange rate, the balance of payments and monetary and fiscal policy under a regime of controlled floating, *Scandinavian Journal of Economics*, 78: 229-48.

Nardo, Michela (2003), The quantification of qualitative survey data: a critical assessment, *Journal of Economic Surveys*, 17: 645-68.

Newey, Whitney K. and Kenneth D. West (1987), A simple positive semi-definite heteroskedasticity and autocorrelation consistent covariance matrix, *Econometrica*, 55: 703-08.

Nielsen, Heino B. (2004), Cointegration analysis in the presence of outliers, *Econometrics Journal*, 7: 249-71.

Nolte, Ingmar and Winfried Pohlmeier (2007), Using forecasts of forecasters to forecast, *International Journal of Forecasting*, 23: 15-28.

Obstfeld, Maurice and Kenneth S. Rogoff (1995), Exchange rate dynamics redux, *Journal of Political Economy*, 103: 624-60.

Obstfeld, Maurice and Kenneth S. Rogoff (1996), Foundations of International Macroeconomics, MIT Press, Cambridge.

Obstfeld, Maurice and Kenneth S. Rogoff (2000), The six major puzzles in international macroeconomics: is there a common cause?, in: *NBER Macroeconomics Annual 2000*, Bernanke, Ben S. and Kenneth S. Rogoff (eds.), MIT Press, Cambridge, 339-90.

Papell, David H. (1997), Searching for stationarity: purchasing power parity under the current float, *Journal of International Economics*, 43: 313-32.

Pesaran, M. Hashem and Martin Weale (2006), Survey expectations, in: *Handbook of Economic Forecasting*, Clive Granger, and Alan Timmermann (eds.), North-Holland, 715-76.

Rapach, David E. and Mark E. Wohar (2002), Testing the monetary model of exchange rate determination: new evidence from a century of data, *Journal of International Economics*, 58: 359-85.

Reis, Ricardo (2007), Inattentive consumers, *Journal of Monetary Economics*, 53: 1761-800.

Reitz, Stefan and Mark P. Taylor (2006), The coordination channel of foreign exchange intervention: a nonlinear microstructural analysis, Deutsche Bundesbank Discussion Paper Series 1, 8/2006.

Rogoff, Kenneth (1996), The purchasing parity puzzle, *Journal of Economic Literature*, 34: 647-68.

Romer, David (1993), Rational asset-price movements without news, *American Economic Review*, 83: 1112-30.

Rose, Andrew K. (1984), Testing for "news" in foreign exchange markets, *Economic Letters*, 14: 369-76.

Sarno, Lucio (2005), Towards a solution to the puzzles in exchange rate economics: where do we stand?, *Canadian Journal of Economics*, 38: 673-708.

Sarno, Lucio and Mark P. Taylor (2001), Official intervention in the foreign exchange markets: is it effective and, if so, how does it work?, *Journal of Economic Literature*, 34: 839-68.

Sarno, Lucio and Mark P. Taylor (2002), *The economics of exchange rates*, Cambridge et al.: Cambridge University Press.

Sarno, Lucio and Giorgio Valente (2006), Deviations from purchasing power parity under different exchange rate regimes: Do they revert and, if so, how?, *Journal of Banking and Finance*, 30: 3147-69.

Sarno, Lucio, Giorgio Valente and Mark E. Wohar (2004), Monetary fundamentals and exchange rate dynamics under different nominal regimes, *Economic Inquiry*, 42: 179-93.

Schmeling, Maik (2007), Institutional and individual sentiment: smart money and noise trader risk?, *International Journal of Forecasting*, 23: 127-45.

Seo, Byeongseon (2003), Nonlinear mean reversion in the term structure of interest rates, *Journal of Economic Dynamics & Control*, 27: 2243-65.

Shiller, Robert J. (1990), Speculative prices and popular models, *Journal of Perspectives*, 4: 55-65.

Sims, Chris (2003), Implications of rational inattention, *Journal of Monetary Economics*, 50: 665-90.

Solnik, Bruno (1987), Using financial prices to test exchange rate models: a note, *Journal of Finance*, 42: 141-9.

Stambaugh, Robert F. (1999), Predictive regressions, *Journal of Financial Economics*, 54: 375-421.

Takagi, Shinji (1991), Exchange rate expectations: a survey of survey studies, *International Monetary Staff Papers*, 38: 156-83.

Tandon, Kishore and Thomas Ulrich (1987), International market response to announcement of U.S. macroeconomic data, *Journal of International Money and Finance*, 6: 71-83.

Taylor, Mark P. (1989), Expectations, risk and uncertainty in the foreign exchange market: some results based on survey data, *Manchester School*, 57: 142-53.

Taylor, Mark P. (1995), The economics of exchange rates, *Journal of Economic Literature*, 33: 13-47.

Taylor, Mark P., David Peel and Lucio Sarno (2001), Non-linear mean reversion in real exchange rates: toward a solution of the purchasing power parity puzzles, *International Economic Review*, 42: 1015-42.

Taylor, Mark P. and Lucio Sarno (1998), The behavior of real exchange rates during the post-Bretton Woods period, *Journal of International Economics*, 46: 281-312.

Taylor, Alan M. and Mark P. Taylor (2004), The purchasing power parity debate, *Journal of Economic Perspectives*, 18: 135-58.

Thornton, Daniel L. (1989), The effect of unanticipated money on the money and foreign exchange markets, *Journal of International Money and Finance*, 8: 573-87.

Valkanov, Rossen (2003), Long-horizon regressions: theoretical results and applications, *Journal of Financial Economics*, 68: 201-32.

Veronesi, Pietro (1999), Stock market overreaction to bad news in good times: a rational expectations equilibrium model, *Review of Financial Studies*, 12: 975-1007.

Wakita, Shigeru (1989), Are survey forecasts trusted? American trade account deficit and yen/dollar rate, *Economics Letters*, 29: 339-44.

Westerhoff, Frank H. (2003), Expectations driven distortions in the foreign exchange market, *Journal of Economic Behavior & Organization*, 51: 389-412.

Wieland, Cristian and Frank H. Westerhoff (2005), Exchange rate dynamics, central bank interventions and chaos control methods, *Journal of Economic Behavior & Organization*, 58: 117-32.

ZEW Centre for European Economic Research (2004), Financial Market Report, 13:2.