Sentiment in foreign exchange markets:

Hidden fundamentals by the back door or just noise?

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Abstract:

Foreign exchange markets have to deal next to hard facts with lots of expectations and emotions. One of the major puzzles in international finance remains the “exchange rate disconnect puzzle”. Analyzing sentiment in foreign exchange markets, it appears in fact that sentiment contains some forward looking information. Particularly due to the unknown economic relevance of sentiment in foreign exchange markets so far, we <u>first</u> analyze the relationship between fundamentals and sentiment in order to reveal underlying forces of the latter; <u>second</u> we accomplish our analysis by concentrating on popular expectation concepts and considering threshold effects. <u>Third</u>, we evaluate sentiment by testing on accuracy and on forward looking elements of subsequent exchange rate returns.

JEL classification: G14, F31

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1 Introduction

It is well known that exchange rates are judged by facts on the ground, like economical news, central bank interventions and political interferences, but are also driven by expectations and emotions. Looking back on the "disconnect puzzle" as one of the main puzzles in international finance, the link between exchange rates and explanatory variables are – most positively spoken – still unclear (see Sarno, 2005). Hence, alternative theories (in respect to traditional fundamental theories) are developed to analyze the influence of market moods or sentiment on financial prices such as exchange rates.

We examine sentiment on foreign exchange markets for two reasons. On the one hand we analyze the relations of sentiment with exchange rate fundamentals, in order to reveal the underlying (fundamental) forces to which sentiment is exposed. On the other hand, we examine, whether sentiment contains some valuable information in respect of subsequent exchange rate returns. Our results are the following: First, applying a threshold vector error-model we pinpoint, that sentiment is rather long-term anchored and related to mean-reversion depending on the fundamental discrepancy between exchange rates and PPP-rates. We interpret this as a form of "wishful thinking" (see Ito, 1990), such that forecasters belief too much in mean reversion. Second, sentiment is influenced by bond rates, but in different directions depending on the time-horizon. Third, running long-run regressions in connection with bootstraps technique, sentiment contains valuable information in respect of very long-term returns of exchange rates. We see this finding in line with Kilian and Taylor (2003), who show the predictability of exchange rates not sooner than two to three years upon the PPP-concept in an ESTAR model.

Turning towards related theories of market moods and sentiment, most notably the noise trader approach sets ground by starting with DeLong et al. (1990) where prices are driven away from fundamentals as a result to interactions between noise traders and sophisticated investors. At the same time an alternative approach arose from Shiller (1990), where the reasons for exuberance in financial prices are caused by switching investor attention on popular models, as a consequence of uncertainty of the true models, describing the markets. To attend explicitly to market moods, Barberis, Shleifer and Vishny (1998) created a model of investor sentiment. Here the empirical phenomenon of short-run underreaction and long-run overreaction in financial markets are given a theoretical fundament, justifying via psychological means of conservatism and representativeness.

Eyeing on exchange rate markets, Frydman and Goldberg (2003) apply oneself in contrast to certain irrationalities of agents in respect to the issue of a world of imperfect knowledge. Hence, non-fundamental factors like technical trading rules influence individual decision processes and can cause long swings in market prices. Furthermore, they show upon the concept of conservatism, that agents change their models only slowly during uncertain situations. Bacchetta and van Wincoop (2004) follow a similar intuition. They show that uncertainty of true parameter to known fundamentals could result in disconnections between fundamentals and exchange rates, as heterogeneous agents (fundamentalists vs. non-fundamentalists) try to discover the true parameters out of the interactions with each other and would cause major imbalances. In contrast to the former, DeGrauwe and Grimaldi (2006) do not imply investor's rationality with never ending expectations loops. Here fundamentalists and chartists use simple trading rules, which are regularly checked in respect of profitability. The authors are able to replicate major empirical puzzles related to exchange rates via simulations.

The empirical research of exchange rate expectation leads back to 20 years (see Dominguez, 1986, Frankel and Froot, 1987a, 1990 and Ito, 1990). Whereas in the beginning mainly consensus data was available, questions such as the degree of market rationality and the specific way how expectations were formed, found priority. Later on, with the broader availability of individual data, the focus shifted to different forms of expectations heterogeneity. Amongst others, analysis of individual forecasting performance arose and tracks of individual expectations were formed. With the increasing popularity of market microstructure issues, the focus changed again, this time towards the influence of variables like market volume or market volatility on expectations and the other way round.[1]

Whilst empirical analysis of sentiment on equity markets show indeed some influence from sentiment on financial prices (see Qiu and Welch, 2004, Brown and Cliff, 2005, Baker and Wurgler, 2005), analogous evidence for exchange rate markets is missing so far. Hence, analyzing as to whether sentiment of foreign exchange markets contain some valuable information, we analyze the Euro/US-Dollar (and Deutsche Mark/US-Dollar respectively) from December 1991 until August 2005.

The paper is structured as follows: In section two we introduce the data, upon which we base our analysis. Section three contains analysis of the determinants of exchange rate sentiment within a linear and nonlinear setting. In section four we perform accuracy tests and examine the predictive value of sentiment regarding subsequent exchange rate returns. Section five summarizes our main findings.

2 Dataset

Our analysis is based upon a sample of monthly data. The period which we cover ranges from December 1991 to August 2005 and adds up to a total of 165 observations. We use US-Dollar/Euro and US-Dollar/Deutsche Mark rates from the Deutsche Bundesbank. Moreover, six months Libor and ten years bond rates and equity index data are taken up by EcoWin, whereas monthly price index, trade balance and production data are picked up by the International Financial Statistics (IFS).

The sentiment data is generated upon aggregated individual six months exchange rate forecasts of the US-Dollar/Euro (respectively the US-Dollar/Deutsche Mark) by the ZEW Financial Market Survey. The majority of participants on this survey is working in the financial sector (approximately 75%); while analysts again represent the main fraction. In comparison to other surveys the average participation of approx. 300 participants is relative large and its composition is similar to other surveys, inter alia Consensus London.[2] By means of a unique questionnaire, ZEW participants were asked to choose of three categories fundamental, technical and flow

[1] For a broad overview of exchange rate expectations research, see MacDonald (2000).

[2] This survey is driven since Dec. 1991 (for a detailed description, see Menkhoff et al., 2006).

analysis according to their primarily information set being used in doing exchange rate analysis.[1] The outcome of this questionnaire show in reference to the “Finanzmarkt” participants, that approx. 60 percent of exchange rate analysis is based upon fundamentals, followed by 30 percent technical instruments and ten percent order flow. We will pick up this point at a later stage.

Focusing on the question how to generate sentiment data, we follow the method used in Brown and Cliff (2005). They have chosen a bull-bear spread, which is a common sentiment measure in financial media.

$$\text{Sentiment} = \text{Up} - \text{Down} \tag{1}$$

“Up” contains the relative amount of participants, who forecast a stronger US-Dollar vis-à-vis the Euro and contrarily “Down”. Both numbers are relatively measured to the amount of participants, who quoted this particular forecast. Since the ZEW follows the same principle when publishing their monthly survey results, we judge this method as being appropriate for our purpose.

3 Fitting sentiment

In this chapter we will examine the determinants of the sentiment, particularly considering popular fundamentals of exchange rates. By this means, we will first analyze the relations between sentiment and core fundamentals and afterwards combining these findings with common terms of expectations formation. The reason why we think that this analysis is of interest, prove to be twofold. First, we would generally like to know the underlying forces of the sentiment. Second, before examining potential forecast ability of the sentiment, we have to uncover its determinants in order to control for indirect effects from the sentiment to subsequent exchange rates.

The first approach is based upon the analysis of the sentiment in the broader setup; hence we include popular exchange rate fundamentals here. However, in our second approach we will consider nonlinear relations, where we concentrate on common means in the expectations literature that are justified in our former analysis.

[1] See ZEW Financial Market Report (2004) for a more information of this questionnaire.

3.1 A cointegrated vector error-correction model

We run our first analysis using a vector autoregressive model in error correction form, which is formulated in terms of differences:

$$\Delta x_t = \Pi \cdot x_{t-1} + \Gamma_1 \cdot \Delta x_{t-1} + \ldots + \Gamma_{k-1} \cdot \Delta x_{t-k+1} + \varepsilon_t \qquad (2)$$

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

Vector X_t contains the endogenous variables sentiment (sen), Euro/US-Dollar rate (fex), differences of inflation (inf) and of bond rates (bon) between the Euro-area and the US. Since the variables in X_t seem to be at least highly persistent or maximum integrated of order one – their corresponding differences show all stationary properties without linear trends – we restrict the constants of the model, μ, to the cointegration space.[1] Selecting the lag-length of the VAR, we rely on likelihood ratio tests, which show a lag one being sufficient. However we neither allow dummy nor seasonality effects.

In Table 1 we picture the results of residual tests in order to check the quality of the model specification. Multivariate LM-tests neither show autocorrelation up to the fourth order, nor first or second order autoregressive heteroskedasticity. On the other hand the residuals do not seem to follow a normal distribution very much, but since the asymptotic results are robust to heteroskedasticity and non-normality, this should not contradict subsequent inference results seriously as long as the residuals are i.i.d. (see Johansen, 2005). Identifying the rank of the cointegrated VAR model we run trace tests, see therefore the results in Table 2. It figures out, that our model underlies one long-term relation, since a higher-order LR-test could not reject the null hypothesis of one less existing unit root in the data.

Table 3 presents the results of the vector error-correction model. Regarding the long-term relation and setting the sentiment's beta-coefficient to one, it turns out, that all variables have influence on the sentiment. The relative inflation and bond rate affect the sentiment positively, which we associate with underlying inflation expecta-

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[1] We did not find clear evidence of stationarity using the Augmented Dickey Fuller test as well as the Phillips-Perron test.

tions. The exchange rate stands in a negatively relation to the sentiment and points to mean-reversion behavior, which corresponds well with former research on expectations data and the idea of the validity of purchasing power parity (in the following PPP) in the long run. Turning to the short-term dynamics now, we see that next to the sentiment only bond rates show statistically significant error correction. Then again, the magnitudes of corresponding alpha-coefficients seem rather small; consequently the economical significance should be put into question. Furthermore, pulling up the short-term coefficients from lagged sentiment dynamics, we have to confess, that sentiment has no impact in the short-run on any of the other variables. Sentiment is in the short-run positively affected by itself and by the relative bond rate. Further, we find a negative influence on sentiment from the Euro/US-Dollar, contrary to the steady-state relation. Putting the contrarian relations between sentiment and bond rates together, it seems that another type of uncovered interest parity upon bond rates retains for the sentiment in the long-run. In lieu of the short-run dynamics, higher interests are followed by expected currency appreciations. However, while the sentiment shows some kind of extrapolative behavior in the short-run, mean-reversion dominates the long-run relation with the exchange rate.

So far, our results seem to match prior findings from the analysis of long-term expectations in such that our sentiment is subject to mean-reversion as well. Additionally, interest rates influence the sentiment in two different ways, depending on the time-relation. Hence, because the economical significance of our findings seems to be questioned, we will tighten these results in the next chapter, where we analyze the relation between the sentiment, a term of exchange rate mean-reversion and the bond difference. Considering the latest findings in research of PPP, it shows that this theory holds - if of any - the long-term, especially if deviations from PPP are big (see inter alia Kilian and Taylor, 2003). Moreover and as already mentioned in chapter two, the majority of the survey participants underlying our sentiment use fundamental information in doing exchange rate analysis. Additionally the positive influence of bond rates and inflation in long-run point to the importance of inflation expectations, hence the introduction of a regressive expectation term seems to be reasonable.[1]

[1] For details of our proceeding according to the regressive term, follow the notes of Table 4.

3.2 A threshold cointegrated VAR model

Following up our last findings, we now focus our analysis on the possibility of threshold effects. So far our results indicate the existence of one long-term relation upon sentiment. However, the error-corrections don't appeal to be economically strong. A reason for this weak evidence could be connected to non-linearity in the data due to apparent regimes. Specifically to our analysis, we would expect error-correction depending on the magnitude of fundamental disequilibrium. We have to be aware, that if more than one long-term relation exists, the results would not be reliable. Nevertheless the linear analysis did not show any sign of another valid cointegration relation. In the detected relation, sentiment error-corrects statistically stronger than any other variable. Since the detected cointegration relation show inter alia strong mean reversion, we presume that the power of the long-term forces underlying the sentiment depends on misbalances in respect to either PPP positively. In this spirit we can draw subsequent analysis on an observable threshold variable and choose a threshold model accordingly. We see our following analysis very close in line to Taylor and Peel (2003), Kilian and Taylor (2003) and Sarno and Valente (2006), who use threshold models to analyze mean reversion in exchange rates. Whereas Taylor and Peel define exchange rate equilibriums upon a monetary model, Kilian and Taylor use the PPP concept and so do Sarno and Valente. What all these elaborations have in common is that exchange rates show mean reversion towards fundamentals in an extreme regime, where deviations from equilibrium are rather big. However, in the other regime exchange rates prove to be close to corresponding fundamentals; hence they show random walk behaviour. However, to model the regimes depending on the magnitudes of exchange rate exuberance, the former two set an (exponential) smooth threshold autoregressive model (ESTAR), whereas Sarno and Valente built their analysis upon a Markov switching vector error-correction model (MS-VECM).

The specific model, on which we built up our analysis, stems from Hansen and Seo (2002) and features the integration of cointegration analysis. In contrast to similar methods (for instance Balke and Fomby, 1997), the model's estimates and tests are multivariate. The short-term and cointegration coefficients as well as the threshold are jointly estimated via maximum likelihood based upon a specific grid search algorithm.[1] In contrast to Hansen and Seo we handle a three-regime model. To hold the model tractable, we assume symmetric thresholds, which enable us to concentrate on a system with two regimes. Consequently, the threshold variable, *z*, has to be measured in absolute terms and determines together with the threshold, γ, the current regime. We allow also constants in the cointegration space but not in the short-term dynamics, as we did in the previous analysis. Our model arises as follows:

$$\Delta x_t = \begin{cases} \mathbf{\Pi}^{(1)} \cdot x_{t-1} + \mathbf{\Gamma}_1^{(1)} \cdot \Delta x_{t-1} + \cdots + \mathbf{\Gamma}_k^{(1)} \cdot \Delta x_{t-k} + \varepsilon_t & \text{if} \quad z \le \gamma \\ \mathbf{\Pi}^{(2)} \cdot x_{t-1} + \mathbf{\Gamma}_1^{(2)} \cdot \Delta x_{t-1} + \cdots + \mathbf{\Gamma}_k^{(2)} \cdot \Delta x_{t-k} + \varepsilon_t & \text{if} \quad z > \gamma \end{cases} \tag{3}$$

$$\text{with } \varepsilon_t \sim N_p(0, \Sigma) \qquad \text{and } \; t = 1, \ldots, T \tag{4}$$

Since the parameterization of the threshold model is yet unknown, we have to rely on the linear model in our null hypothesis. Nevertheless the asymptotic distribution of the appropriate LM test, in order to check the validity of the threshold model, figures out to be intractable again. To run inference analysis anyhow, Hansen and Seo suggest two alternative LM-tests via bootstrap techniques, which in contrast provide asymptotical distributions. The fixed regressor bootstrap, upon which we will base our threshold test, fixes in contrast to conventional bootstrap technique next to estimated coefficients and corresponding residuals under the null hypothesis, the model variable series as well as estimated error-corrections. Modifying the residuals by adding i.i.d.-innovations of a standard normal distribution, one regress them on the model variables – once for the whole sample and another time for the split samples upon the threshold. Using the latter coefficient matrixes and modified residuals from the former unseparated regression make possible to calculate Eicker-White covariance matrix estimators. This in turn enables to calculate a LM-like statistic. Repeating these steps numerous times, delivers a simulated distribution of the test statistic and hence appropriate critical values finally. The alternative procedure is closer to standard bootstrapping. Here residuals are presumed being i.i.d., but without tak-

[1] Confidence intervals for the cointegration parameters (β) are evenly spaced around their linear estimates and the grid search examines all combinations of β and threshold (γ), which meet the minimum fraction for a regime (trimming parameter).

ing control of potential violations like heteroskedasticity, which has been revealed in our previous analysis.[1]

According to our linear estimation in the previous subchapter, we assume one lag in the VAR-setting. Depending upon the threshold value all coefficients are allowed to differ. We set the trimming parameter rather conservative at 0.20 due to our small sample size. Setting the grid sizes for the cointegration coefficients to 100 and to 300 for the threshold variable, we run 1000 bootstraps. Furthermore we choose the Eicker-White covariance matrix to correct potential heteroskedasticity in the residuals. Special attention arises from the choice of the threshold variable. In contrast to Hansen and Seo we do not focus to choose the error-correction variable as the threshold variable, but rather the regressive term in absolute values.

However, the estimations differ depending on the implemented threshold variable. Choosing the error-corrections as the threshold, resulting estimations become odd. Particularly, the error-corrections in the sentiment do not differ between the regimes and the existence of a nonlinear threshold model is strongly rejected.[2] In contrast the results with the regressive term as the threshold variable turn out being very much in line with our prior belief. The results are shown in Table 4. We denote a threshold of approx. 0.16. This constitutes the first regime, if the exchange rate is close to the PPP-rate in a band of 20 percent. Hence, the second regime holds, if the exchange rate is above the band, being far away from PPP. Therefore we define the first regime as the “tranquil” regime, whereas the second represent the “extreme” regime. As assumed, error-correction in the sentiment increases, when leaving the tranquil regime and turning into the extreme regime (from 0.06 to 0.24). Additionally, being in the tranquil regime, sentiment is influenced positively by interest rates in the short-term but vice versa in the extreme regime. Furthermore, short-term influence by the regressive term on the sentiment takes place in the extreme regime, which we assume being connected with existing trends in this regime.

All in all, it figures out, that expectations anticipate stronger mean reversion in situations, where fundamental discrepancy between exchange rates and PPP-rates

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[1] The fixed regressor bootstrap is robust to heteroskedasticity (see Hansen and Seo, 2002).

[2] To conserve space, we skip corresponding results.

are the biggest. Only in this regime we evaluate the long-term forces towards PPP underlying the sentiment being both statistically and economically significant.[1]

4 Forward-looking attributes of sentiment

Finally we examine the sentiment in respect to its ability to forecasting exchange rates. Since we figured out, that sentiment is better described by fundamentals in extreme circumstances and in case sentiment contains valuable forecasting information, it would be of high interest knowing in which time horizon.

For this purpose we will pursue two approaches. First, we will look at some standard calculations, such as the mean error (ME) or the root mean square error (RMSE). Second, we will investigate the contribution of sentiment in explaining following average returns in Euro/US-Dollar. Doing so, we will use subsequent time periods from one month up to 60 months.

4.1 Accuracy of sentiment forecasts

To throw light on the forecasting property of the sentiment and respectively to provide some standard information for comparisons with other forecasts, we investigate common calculations in respect to the quality of the sentiment forecasts. As most of the standard analysis is based upon point forecasts, we have to transform the sentiment data. One appropriate possibility to accomplish is to quantify aggregated expectations via the Carlson and Parkin approach (1975). Applying this method we get point forecasts which enable us to run adequate accuracy tests.

Table 5 represents the corresponding results in congruency with the surveyed six months forecast horizon. Furthermore and for comparative purposes, calculations are run for forecasts upon the forward rate as well as the random walk. Obviously aggregated expectations perform worse than competing forecast series in all tests except for the hit rate. The mean error, mean absolute error and the root mean square error of the expectations are in all cases bigger than accordant numbers from the forward rate and the random walk. Direct comparisons between expectations as

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[1] Note that we do not deduce upon our analysis exchange rate behaviour towards PPP by itself.

well as forward rates with the random walk reveals, that the latter performs the best. However, consulting the hit rate, which displays the share of correct trend forecasts, shows undoubtedly advantages towards expectations. Trend forecasts upon expectations reveal a 55 percent hit rate, whereas forward rates prove correctness in only 30 percent of the cases.[1]

Even though we assume six months expectations, due to the design of the survey, the short-term orientation of financial markets indicates by itself that our sentiment underlies rather long-term considerations. Alternatively, if expectations are biased upon strong fundamental beliefs, which would be associated with a form of wishful thinking similar to Ito's findings (1990), forecasters anticipate too much mean reversion according to what fundamentals actually speak (1990).[2]

4.2 Sentiment in a long-horizon setting

In this chapter we build up long-term regressions to follow the idea of fairly long-term sentiment. We target the simulation-analysis of Brown and Cliff (2005) who investigate sentiment on US equity index using bootstrap technique.

$$r_t^k = \alpha^k + \Theta^{k\prime} \cdot \boldsymbol{z}_t + \beta^k \cdot S_t + \varepsilon_t^k \qquad (5)$$

We regress k-period average returns of the Euro/US-Dollar, r_t^k, on a vector of control variables, $\boldsymbol{z}_t$, in which we put change of differences in domestic vs. foreign short term interest rate, term structure, inflation rate, equity index, production index, trade balance and the sentiment, S_t. We consider a large set of additional regressors, since we are in need of control for potential explanatory variables of exchange rate returns as well as the sentiment. Given that we built up a rather long-term analysis, we concentrate on variables, which are known of having some explanatory power in the long run on exchange rates.

The difficulty we are confronted with is twofold. On the one hand, we have to overcome an overlapping problem (see Hansen and Hodrick, 1980). Since we calcu-

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[1] Remember the random walk forecasts no change; hence, the benchmark is set at 50 percent.

[2] See Menkhoff et al. (2006), who alternatively consider rational forecasters, since the market environment is too short-term orientated, given fundamental circumstances.

late average returns of sequential periods, we obtain a moving average process of the dimension of the specific period in the error term, ε_t^k. Basically one overcomes this issue using Newey-West standard errors, but due to our relatively small sample size, this correction has small power (see inter alia Hodrick, 1992). Another issue which must be taken into account arises from persistent behavior of some of the regressors, which constitute a potential source of bias in consecutive estimates even though corresponding regressors are preparatory (see Stambaugh, 1999). Following Brown and Cliff (2005), we run a bootstrap with 10,000 simulations in order to derive more accurate estimate results from simulated distributions, upon which our following inference analysis is based.

The outcomes, presented in Table 6, reveal an interesting pattern. In the short-run, we cannot detect any prediction ability of the sentiment. Not until approx. two and a half years, sentiment shows contribution in order to predict subsequent returns in the Euro/US-Dollar. Strikingly, from month 32 upwards, the corrected beta coefficient from the sentiment variable turns out being significant. Getting an idea about the magnitude of the influence on returns, we apply to a one standard deviation of the sentiment and calculate potential impacts on subsequent total Euro/US-Dollar returns. Glancing at two examples, the total impact of sentiment on following six month returns yields on average 0.08 percent, whereas corresponding impact on 36 months returns ads up to 15 percent.

It seems that sentiment reveal valuable information in order to predict longer-term returns. This finding is in line with Kilian and Taylor (2003), whose exchange rate predictions from an ESTAR model based upon PPP did not start to value before two to three years. On the other hand our sentiment obviously does not serve well as a contrarian indicator in the short-run. Figure 1 merges these findings, where the hatched area is associated to the periods, in which the sentiment contains additional information in order to predict subsequent exchange rate returns on a minimum alpha-error of five percent.

5 Conclusions

Our results match prior research on exchange rate expectations, whereas a form of mean-reversion characterizes long-term expectations and therefore our sentiment. Additionally, interest rates influence the sentiment, but in two different ways depending on the time-relation. Nevertheless the sentiment contains stronger mean reversion in situations, where fundamental discrepancy between exchange rates and PPP-rates are the biggest. Only in this regime we evaluate the long-term forces towards PPP underlying the sentiment being both statistically and economically significant. Return to mind; the majority of the survey participants underlying our sentiment use fundamental information in doing exchange rate analysis. Note, that we do not deduce from our analysis exchange rate behaviour towards PPP by itself.

Considering the short-run focus of exchange rate markets, six months expectations horizon appears being rather long-term. Hence, the sentiment shows long-term anchorage. Alternatively, the sentiment is strongly biased towards (longer-term) fundamental concepts. This would be associated with a form of “wishful thinking” similar to Ito’s finding (1990) but in the way, that forecasters anticipate too much belief in mean reversion according to what the fundamentals speak.

Putting all this together, sentiment reveals some valuable information in respect of very long-term exchange rate returns. On the other hand it does not contain any valuable information concerning shorter-term exchange rate returns. This finding is in line with Kilian and Taylor (2003), where the exchange rate predictions of an ESTAR model based upon the PPP-concept do not start to value earlier than two to three years.

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6 Appendices

TABLE 1. Misspecification tests of the VEC-model.

Tests of autocorrelation					
	LM-test$^{(1)}$:	X^2 (16)	= 21.31	prob. value	= 0.17
	LM-test$^{(2)}$:	X^2 (16)	= 20.33	prob. value	= 0.21
	LM-test$^{(3)}$:	X^2 (16)	= 6.15	prob. value	= 0.99
	LM-test$^{(4)}$:	X^2 (16)	= 15.25	prob. value	= 0.51
Test of Normality					
	LM-test:	X^2 (8)	= 53.56	prob. value	= 0.00
Tests of ARCH					
	LM-test$^{(1)}$:	X^2 (100)	= 110.69	prob. value	= 0.22
	LM-test$^{(2)}$:	X^2 (200)	= 189.37	prob. value	= 0.69
	LM-test$^{(3)}$:	X^2 (300)	= 341.12	prob. value	= 0.05
	LM-test$^{(4)}$:	X^2 (400)	= 427.92	prob. value	= 0.16

Note:

The test of normality distribution of the residuals is strongly rejected, indicating that residuals are not normal distributed. Additionally the tests of ARCH-effects reveal some heteroskedasticity in the data. Univariate tests reveal that normality is rejected due to skewness in sentiment and relative inflation and excess kurtosis in the latter one. However, the asymptotic results upon the Gaussian likelihood seem to be robust to some types of deviations from Gaussian distribution of the residuals – heteroskedasticity and non-normality (see, Johansen, 2005).

TABLE 2. Cointegration rank determination of the VEC-model.

Trace tests	rank three	rank two	rank one	rank zero
Eigenvalue	0.02	0.04	0.09	0.22
LR-test	3.15	10.02	26.44	67.20
p-value	0.56	0.64	0.32	0.00
LR-test *	2.51	9.20	24.44	64.75
p-value *	0.68	0.72	0.44	0.00

Note:

The LR-tests and p-values marked with an asterisk are the Bartlett-corrected LR-tests and p-values because of small sample-size effects on the power of the rank determination.

TABLE 3. The VEC-model: Unrestricted estimation and tests of model-fit.

Cointegration equation:

	sen(-1)	inf(-1)	fex(-1)	bon(-1)	const.
β'	1.00	0.17	- 2.51	0.61	- 0.16
	[. NA]	[2.41]	[- 4.97]	[4.14]	[- 1.97]

Error correction equations:

	Δsen	Δinf	Δfex	Δbon
α	- 0.08	0.07	0.00	0.11
	[- 4.95]	[1.15]	[0.31]	[2.87]
Δsen(-1)	- 0.20	- 0.02	0.04	0.02
	[- 2.59]	[- 0.08]	[1.60]	[0.15]
Δinf(-1)	0.03	- 0.00	0.00	- 0.06
	[1.68]	[- 0.03]	[0.45]	[- 1.23]
Δfex(-1)	0.62	2.49	0.06	- 1.17
	[2.31]	[2.32]	[0.64]	[- 1.72]
Δbon(-1)	- 0.07	0.10	- 0.03	0.04
	[- 2.40]	[0.75]	[- 2.61]	[0.50]
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	541.73
Akaike IC	-6.38

Note:

This table shows the coefficients of the VEC-model. The sample contains 165 monthly observations from December 1991 to August 2005. The endogenous variables are sentiment (sen), relative inflation (year-to-year), Euro/US-Dollar rate and relative bond rate. Other variables were tested, amongst others the real production, trade balance and short interest rates, but couldn't really improve the estimation and are therefore abandoned. We do not report a likelihood-ratio-statistic for binding cointegration restrictions, since no coefficients are restricted. Furthermore, looking at the residual correlation matrix, indicates that between sentiment and Euro/US-Dollar simultaneous effects exist, which could be related to further extrapolative behavior of the sentiment in the short-term relation or alternatively, to short-term influence from sentiment on exchange rates.

TABLE 4. The threshold VEC-model: Estimation and tests of model-fit.

Cointegration Equation:

			sen(-1)	reg(-1)	bon(-1)	const.
γ	0.16	β'	1.0000	-1.66	0.41	0.02

Error Correction Equations:

		α	Δsen(-1)	Δreg(-1)	Δbon(-1)
regime 1	Δsen	- 0.06	- 0.16	- 0.27	- 0.09
		[- 3.13]	[- 1.61]	[- 0.57]	[- 2.42]
	Δreg	0.00	0.06	0.25	- 0.02
		[0.86]	[.286]	[2.63]	[- 2.02]
	Δbon	0.05	0.30	- 1.79	- 0.07
		[0.99]	[1.69]	[- 1.93]	[- 0.95]
regime 2	Δsen	- 0.25	- 0.13	1.40	- 0.06
		[- 4.97]	[- 1.13]	[2.54]	[- 1.41]
	Δreg	0.01	0.06	0.14	- 0.03
		[0.72]	[1.70]	[1.01]	[- 2.08]
	Δbon	0.49	- 0.52	- 1.60	0.03
		[3.66]	[- 2.13]	[- 1.17]	[0.23]

Fixed regressor p-value for threshold effect:	0.09
Wald p-value for equality of dynamic coefs:	0.05
Wald p-value for equality of ECM coefs:	0.00

Note:

This table shows the coefficients of the threshold VECM. The sentiment is set to one in the cointegration space. Neither are restrictions set in the cointegration space, nor in the short-term dynamics. The sample contains 165 monthly observations from December 1991 to August 2005. The endogenous variables are the sentiment (sen), the regressive term and the relative bond rate. The regressive term corresponds to the difference of current Euro/US-Dollar and the fundamental justified PPP rate. The latter is based upon long-term validity of 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. The first regime contains 64 percent of the observations, whereas the remaining 36 percent belong to the second regime. The estimation of the corresponding linear VEC-model without threshold effect reveals qualitatively the same results as in Table 3, with an error-correction of - 0.07.

TABLE 5. Tests of accuracy upon six months forecast horizon.

	ME	MAE	RMSE	Theil's U	Hit rate
Sentiment	-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	-	-

Note:

To derive aggregate point expectations we use the quantification method of Carlson and Parkin (1975), which requires three specific assumptions. We assume that the subjective probability distributions, concerning the forecast realizations, are normally distributed. However, the use of the normal distribution for the corresponding means of the individual probability distributions can be justified upon the Central Limit Theorem. Moreover we set a symmetric scaling factor of three percent according to a specific questionnaire, which displays the threshold from which the forecasters perceive noticeable changes in the exchange rate. Nevertheless results upon other thresholds around three percent didn't differ qualitatively. Random walk forecasts are calculated on current exchange rates, respectively no change forecast. Asterisks refer to the level of significance: *: ten per cent, **: five per cent, ***: one per cent.

ME shows the mean error based on US-Dollar/Euro forecasts and realized exchange rates.

MAE shows corresponding absolute mean error.

RMSE shows corresponding root mean square error. Differences between forecast series were examined upon Theil's U.

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

Hit rate shows the share of right direction forecasts. Trend predictability is tested upon χ^2-tests.

TABLE 6. Outcomes of long-horizon regressions.

	1month	6months	12months	18months	24months	30months	36months
β	.0021	.0002	.0014	.0037	.0054	.0074	.0086
$\beta^{(adj.)}$	.0011	.0003	.0007	.0031	.0050	.0071	.0084
$Prob.^{(adj.)}$	.3512	.2258	.2063	.1738	.1460	.0742	.0147
Impact	.0005	.0008	.0041	.0279	.0597	.1064	.1500

Note:

All regressions are estimated with Newey-West standard-errors in which the lag-lengths depend on the number of return periods. The vector of control variables, z_t, contain changes of differences in domestic vs. foreign short term interest rate, term structure, inflation rate, equity index, production index and relative trade balance.

The simulation procedure takes place as follows: First, long-term regressions of the exchange rate returns on the control variables are run using Newey-West standard deviations. Second, we estimate a VAR-model including one month return and control set, whereas the beta coefficient of the sentiment in the return equation is set to zero. Arising residuals are stored. Third, using the latter 10' bootstraps are accomplished in order to generate recursively new time series, with which fourth one runs estimations analogous in the first step. Fifth, simulated t-values are calculated pulling up sentiment beta coefficients, correcting them by subtracting the mean beta from the bootstraps and dividing by the corresponding mean standard deviation. Sixth, setting up resulting distributions enables to calculate probabilities for the original sentiment betas, which needs to be corrected beforehand.

Beta shows the original estimates of the sentiment coefficients.

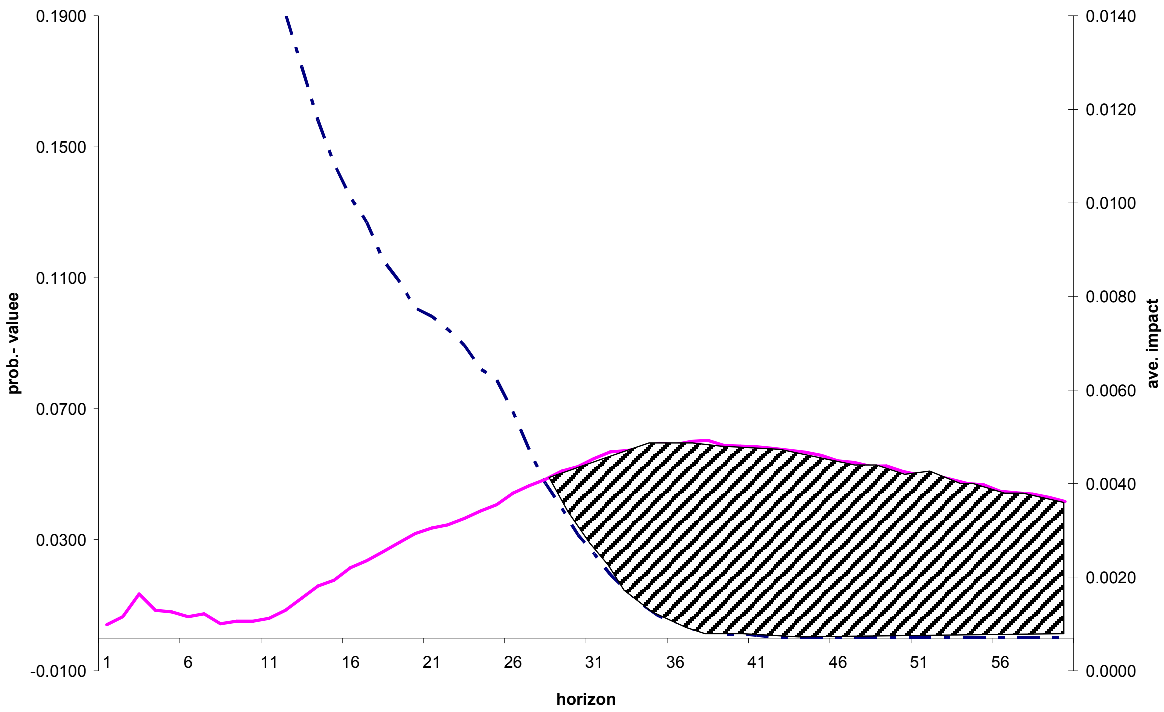
$Beta^{(adj.)}$ shows the adjusted estimates of the sentiment coefficients from the simulation results

$Prob.^{(adj.)}$ shows the probability for the null hypothesis that the corresponding parameter is zero.

Impact shows the impact of a standard deviation sentiment change on the total return in percent.

Corresponding results for longer horizons show, that round about the 36^{th} month, the average impact from sentiment is the greatest (see therefore Figure 1).

FIGURE 1. Influence of sentiment on future Euro/US-Dollar changes.



Note:

This figure shows the simulated probability values for adjusted beta coefficients of the sentiment (left scaled) and related average impacts on monthly Euro/US-Dollar returns (right scaled). The latter are calculated using a standard deviation change in the sentiment. However, the hatched area corresponds to the time horizons, in which the significance of the sentiment coefficient is five percent or lower.