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## What Drives Heterogeneity in Foreign Exchange Rate Expectations: Deep Insights from a New Survey

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Georg Stadtmann**

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# What drives heterogeneity in foreign exchange rate expectations: Deep insights from a new survey

by Christian Dreger and Georg Stadtmann<sup>1</sup>

**Abstract.** Foreign exchange rate expectations play a central role in virtually all monetary models for the open economy. Therefore, it is extremely important to gain empirical insights into the expectations formation process. In this paper, we use a unique disaggregated data set to model the expectations of the Yen/USD exchange rate of about 50 leading foreign exchange rate professionals. The survey includes not only forecasts of the exchange rate, but also for macroeconomic fundamentals, like GDP growth, inflation, and interest rates. Different expectations of fundamentals might lead to different views of exchange rate dynamics. Using panel models, we are able to confirm the heterogeneity of exchange rate expectations often detected by former authors. More important, we provide strong evidence regarding the likely source of heterogeneity. In line with forward looking models for the exchange rate, expected fundamentals have a substantial impact on exchange rate expectations, thereby challenging the backward looking evidence of previous studies. However, the heterogeneity in the expectations of macroeconomic fundamentals is not sufficient to explain the heterogeneity in exchange rate expectations.

JEL: F31, F37, C23

Keywords: Exchange rate expectations, heterogeneity of expectations, expected fundamentals

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## 1 Introduction

Foreign exchange rate expectations play a central role in virtually all monetary models for the open economy. Therefore, it is extremely important to gain empirical insights on how exchange rate expectations are actually formed. In order to understand the behaviour of forecasters in foreign exchange markets, researchers have turned to examine the properties of survey based expectations.

One key advantage of survey data is that it facilitates the analysis of asset price expectations. Auxiliary assumptions concerning the expectation generating process are not required, and the dilemma of testing a joint hypothesis is avoided. Hence, knowledge of the expectation generating process relieves the falsification of exchange rate models. We contribute to the literature by using the Wall Street Journal (WSJ) database which is a disaggregated dataset of individual professionals for the Yen/USD exchange rate. As a distinct feature to other data sets, the survey is not limited to exchange rate expectations but covers also forecasts for a number of macroeconomic fundamentals, such as GDP growth, inflation and interest rates. Thus insights into the sources of heterogeneity in exchange rate expectations can be provided.

As a stylised fact emerging from the previous literature, exchange rate expectations differ across market participants. See Frankel and Froot (1987), Ito (1990), Tagaki (1991), MacDonald and Marsh (1996), Elliot and Ito (1999), and Bénassy-Quéré, Larribeau and MacDonald (2003), among others. Hence, the usual assumption of rational agents forming homogeneous expectations is not consistent with the survey data. Heterogeneity might occur due to several reasons. Both chartist and fundamentalist methods are employed by the agents in the expectation formation process, see Frankel and Froot (1990), Allen and Taylor (1990) and Cheung and Wong (2000). Forecasts of foreign exchange traders seem to rely on technical instruments in the short run, but more on macroeconomic fundamentals over longer time horizons. Evans and Lyons (2004) developed a theoretical model to identify the origins of dispersed information, as well as the technology by which information is subsequently aggregated and impounded. Heterogeneity of forecasters imply the use of different models (*model heterogeneity*) or different coefficients within the same model (*coefficient heterogeneity*), see Bénassy-Quéré, Larribeau and MacDonald (2003).

Modern approaches such as the news model have recently emphasized the importance of expected macroeconomic fundamentals in the determination of asset prices (Mussa, 1982, Ehrmann and Fratzscher, 2004). In these models the current exchange rate is a function of the expected path of economic fundamentals. To the extent that agents have different views about the future evolution of fundamentals, exchange rate expectations vary between forecasters. This proposition is investigated by means of the WSJ poll. Using a panel setting with individual fixed effects, expectations of fundamentals are shown to have a strong impact on exchange rate expectations. The goodness-of-fit statistics tremendously increase, if expected fundamental variables are embedded in the regression framework. Specifically, hybrid models are proposed, where forward and backward looking elements are allowed to enter. Therefore, exchange rate expectations partially deviate, because forecasters have different views about the course of macroeconomic variables.

The remainder of this paper is as follows. In section 2, stylized facts of the formation process of exchange rate expectations are reviewed, starting from the rational expectations assumption. Section 3 describes the survey data used in this study. Empirical results on the expectations generating process are presented in section 4. Section 5 concludes.

## 2 Expectations generating processes

In order to understand the behaviour of agents in the foreign exchange market, the properties of survey based expectations need to be explored. The rational expectations assumption

$$(1) \quad S_{t+1} - S_t = \alpha + \beta(E_t S_{t+1} - S_t) + u_{t+1}$$

provides the benchmark model. Here  $S$  is the natural logarithm of the exchange rate, expressed as units of foreign currency per unit of domestic currency,  $u$  is the error term,  $E$  is the expectations operator, and  $t$  denotes time. Because of the integration properties of exchange rates, the equation is stated in terms of changes rather than in terms of levels.

Rationality implies that the prediction error fluctuates randomly around 0. This hypothesis can be restated in terms of the unbiasedness and orthogonality condition. If forecasts are unbiased, the parameter values  $\alpha=0$  and  $\beta=1$  are implied. Hence, the mean prediction error is 0. Furthermore, if the errors are generated by a pure white noise process, i.e. if they are uncorrelated, homoscedastic in a conditional and unconditional sense and normal, they are also orthogonal to any other additional information available at the time when the forecast is made, since a white noise process cannot be predicted in a systematic manner.<sup>2</sup>

Previous empirical studies have soundly rejected the rationality assumption, as survey expectations are both biased and non-orthogonal. This has led some researchers to concentrate on non-rational expectations generating schemes, which are supported from an empirical point of view. As a first striking feature, expectations seem to be substantially backward looking, as the expected innovation in the exchange rate depend on actual and past trends of the exchange rate, i.e. lagged exchange rate fluctuations. For example, the equation

$$(2) \quad E_t S_{t+1} - S_t = \delta + \gamma(S_t - S_{t-1}) + u_t$$

defines extrapolative expectations. MacDonald and Torrance (1988) and Cavaglia, Verschoor and Wolff (1993) have detected bandwagon effects in the expectation formation process, implying that actual trends will prevail in the future ( $\gamma>0$ ). However, there is also evidence for mean reverting, see for example Bénassy-Quéré, Larribeau and MacDonald (2003). Here, a recent change in the exchange rate cause forecasters to expect a reverse movement in the future ( $\gamma<0$ ). While bandwagon effects seem to be important in the short run, expectations tend to be more stabilizing over longer forecasting horizons. It is worth to mention that the finding of extrapolative expectations can be justified by distinct arguments. Learning processes may lead to an influence of lagged exchange rate fluctuations. In addition, the existence of an equilibrium exchange rate could account for mean reverting behaviour.

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<sup>2</sup> It should be noted that the errors from rational expectations are autocorrelated by a MA( $h-1$ ) structure, if the forecast horizon  $h$  is longer than 1 period. This does not apply to our analysis since the forecasting horizon and frequency are both 6-month.



The other striking feature of survey expectations points to their heterogeneity, see MacDonald and Marsh (1996), Elliott and Ito (1999), Prat and Uctum (2000) and Bénassy-Quéré, Larribeau and MacDonald (2003). Thus, the mean or median cannot be used as a sufficient surrogate for individual forecasts. Heterogeneity can result when information is differently weighted, because it is not covered in the individual information sets or less relevant in models which individuals actually prefer. In terms of the backward looking rules, past exchange rates are differently weighted across the agents to arrive at individual forecasts.

However, this interpretation is not really convincing. Forward looking models such as the news model of asset price determination have emphasized the importance of expected macroeconomic fundamentals for the determination of the current exchange rates as well as for the exchange rate expectations. As Frenkel (1981) and Mussa (1982) have shown, the current exchange rate is a function of current fundamentals as well as the whole expected path of these fundamentals. Hence, the news approach stresses the importance of forward looking variables in the determination of exchange rate expectations. As these variables are not included in model (2), the backward looking evidence might be biased. Furthermore, the right hand side variables used to examine survey expectations exhibit no individual specific variation, as past exchange rates are identical for all agents. Only fixed effects or individual slope parameters are considered to explain the heterogeneity.

To make progress, a testing procedure for the heterogeneity of expectations is required. Whether or not expectations are heterogeneous across individuals can be investigated using a test proposed by Ito (1990), see also Elliott/Ito (1999). The test equation is given by

$$(3) \quad E_{i,t}S_{t+1} - E_{A,t}S_{t+1} = \theta_i + u_{i,t}$$

where  $i$  denotes the individual and  $A$  the cross section average of forecasts, respectively. If the fixed effect  $\theta_i$  is not equal to 0, the individual forecast differs from the consensus, thereby indicating heterogeneity. If the error term has white noise properties, is homoscedastic and not correlated across the forecasters in the survey, heterogeneity will be sufficiently captured by the fixed effects. As an alternative to this approach, differences

across individuals might not materialize in a constant, but rather fluctuate in a random way. In that case, a random effects specification could be more appropriate, where the variances of the errors differ across forecasters. While individual effects can be tested against a pooled regression model, where heterogeneity in the coefficients does not exist, the decision between fixed and random effects is based on a Hausman test, see Woolridge (2003) for a discussion.

Note that the same approach can be utilized to uncover the likely sources of heterogeneity in exchange rate expectations. Specifically, the right hand side of the equation might contain additional variables. In the extended framework, individual constants should not deviate significantly from 0. Then, heterogeneity would be solely caused by the new regressors.

### **3 WSJ survey data set**

The forecasters considered in the analysis have participated in the WSJ poll, which is conducted on a semi-annual base. Most of the participants are economists and do not affect exchange rate trading directly. See Cho and Hersch (1998) for a detailed description of the data set. Initially, the survey focused on interest rate predictions for the short and long term end of the maturity spectrum. As a consequence, the literature that has used of the WSJ data set is focused on the short and long term interest rate forecasts, see Greer (2003), Cho and Hersch (1998), Kolb and Stekler (1996) and Eisenbeis, Waggoner and Zha (2002).

Starting in 1989, the 6-month Yen/USD prediction has been added to the poll. In addition, forecasts for GDP growth and CPI inflation are reported since then. Only American forecasters participate in the WSJ survey, i.e. the Japanese view is not reported. This limitation is not very crucial, as MacDonald and Marsh (1996) did not detect informational asymmetries between forecasters of different financial centers. But, expected relative fundamentals, i.e. predictions for US inflation and GDP growth relative to those of Japan cannot be constructed, as the information is limited to the US.

The empirical analysis is based on the semi-annual surveys from January 1989 to January 2005 (33 observations). Overall 130 economists have joined in the exchange rate

survey during this period. Since only a minority provided their forecasts in all polls, the original data has an unbalanced panel structure. Figure 1 shows how often forecasters have attended the surveys. For example, 13 economists participated in just one poll and 3 participated in all polls. In order to derive reliable results, the analysis is limited to forecasters who have participated at least in 15 polls. By applying this constraint, the results can be based on the information of 49 forecasters. It is evident, however, that the panel data set is still unbalanced because of missing observations.

*-Figure 1 about here-*

In line with the previous literature, the gaps in the data are replaced by the mean expectations over the participating individuals (MacDonald and Marsh, 1996, Benassy-Quéré, Larribeau and MacDonald, 2003). Note that this strategy biases the results in favour of homogeneity, implying that a finding of heterogeneity would be even more convincing. Tests for heterogeneity of exchange rate expectations utilize a balanced data set of totally 1.617 observations.

#### **4 Empirical results**

In order to establish some basic features of the WSJ data set, the first step is to examine the rational expectations assumption, see equation (1). Results obtained from a pooled regression model for the semiannual (one period) forecasting horizon are exhibited in Table 1.

*-Table 1 about here-*

Both the unbiasedness and orthogonality condition are evaluated. The constant differs significantly from 0, while the slope parameter differs from 1. Furthermore, the forecast errors resulting from this equation are not generated by white noise processes. For example, if the relationship is extended by the lagged forecast errors, they turn out to be

highly significant. Therefore, the orthogonality condition is also rejected. In sum, forecasts in the WSJ poll appear to be non-rational.

*-Table 2 about here-*

Expectations in the WSJ survey also have substantial backward looking properties, see Table 2. The extrapolative model is estimated as a pooled regression, where the expected change in the exchange rate is explained by the contemporaneous and lagged changes of the exchange rate. A richer lag structure is embedded in the initial specification, but only the contemporaneous change of the exchange rate turned out to be significant. Moreover, it enters with a negative sign, thereby indicating a stabilizing element in exchange rate expectations. If the exchange rate increased by 10% within the last 6-months, forecasters expect on average a decrease of the exchange rate of about 1.5% for the next 6 months. No bandwagon effects are detected in the WSJ survey, possibly due to the relative long forecasting horizon of half a year.

The next step is to examine the homogeneity restriction for exchange rate expectations by equation (3). This refers to a test of the poolability condition. In particular, the deviations of the individual predictions from their arithmetic mean are regressed on a unique constant in the pooled model, and on individual constants in the fixed effects alternative. The residual sum of squares is 3.16 in the pooled model and drops down to 2.41 under the fixed effects specification. The significance of the decrease is confirmed by a *F*-test (*F*-statistic=10.27, *p*-value=0.000). Thus, exchange rate expectations are heterogeneous. This finding reinforces the results of previous studies, for example MacDonald and Marsh (1996) and Bénassy-Quéré, Larribeau and MacDonald (2003).

The information content of the expected macroeconomic fundamentals to explain revisions of exchange rate expectations is displayed in Table 3. Forward looking variables include predictions of nominal interest rates at the short and long end of the maturity spectrum, GDP growth and CPI inflation. The expected fundamentals refer to the US economy, but not to Japan. Specifications are shown for each of the fundamentals. All equations include the contemporaneous change of the actual exchange rate to capture backward looking behaviour. Furthermore, the models are estimated using random and

fixed effects. Although the Hausman test cannot reject the null hypothesis of random effects, both random and fixed effects models are reported for robustness issues. To estimate the component variances in the random effects specification, the Swamy and Arora technique is used, which is build upon the residuals from the within (fixed effect) and between (means) regression. The differences between the regression parameters obtained by a random and a fixed effects specification turned out to be largely neglectable.

*-Table 3 about here-*

Judgements regarding the likely development of macroeconomic fundamentals are able to explain a significant portion of the revisions of exchange rate expectations. The signs of the impacts are often in line with standard theories of exchange rate determination. Note that the exchange rate is expressed as Yen per US Dollar. Then, a rise in the expected US short or long term nominal interest rates (Models I and II) or US inflation (Model IV) leads agents to predict a depreciation of the US Dollar, according to the PPP and UIP condition. Especially, the estimated inflation parameter takes a value close to one. Hence, higher US inflation expectations cause an expected depreciation of the US Dollar of equal size. Furthermore, a stronger outlook for GDP growth will cause forecasters to predict an appreciation of the US Dollar, according to monetary models of exchange rate determination (Model III). It should be noted, that the coefficient of the backward looking part of the regression is almost stable and still significant throughout the different regressions. Thus, the impact of backward looking variables on exchange rate expectations is still detectable.

Finally, it is tested whether forward looking variables are also appropriate to explain the heterogeneity of exchange rate expectations. Here, the right hand side of the equation (3) is extended by the list of fundamentals of the various models. The pooled regression model is also strongly rejected in this case. As an example, the  $F$  statistic is 9.81 ( $p$ -value=0.000) in the model with inflation expectations (Model IV). Therefore, the heterogeneity in the expectations of macroeconomic fundamentals is not sufficient to explain the heterogeneity in exchange rate expectations. Limitations in the data set might

be responsible for this outcome, as the fundamentals are reported only for the US, but not for Japan.

## **5 Conclusion**

In this paper, we use a unique disaggregated data set to model the expectations of the Yen/USD exchange rate of about 50 leading foreign exchange rate professionals. As a novelty, the survey includes not only exchange rate projections, but also expectations of macroeconomic fundamentals, like GDP growth, inflation, and nominal interest rates. Using panel models, we are able to confirm the heterogeneity of exchange rate expectations often detected in previous studies. Furthermore, we provide strong evidence regarding the likely sources of heterogeneity. In line with forward looking models for the exchange rate, expectations of fundamentals have a substantial impact on exchange rate expectations, thereby extending the backward looking evidence obtained in a number of previous studies. However, the heterogeneity in expected macroeconomic fundamentals is not sufficient to explain the heterogeneity in exchange rate expectations.

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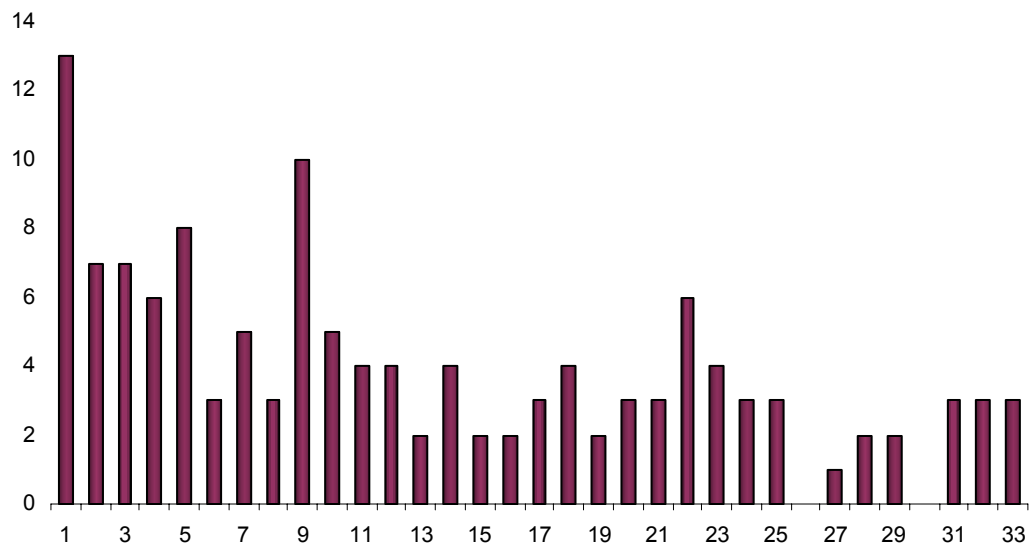
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Figure 1: Number of times a forecaster participated in the WSJ poll



Note: Number of attendances in the WSJ poll (horizontal axis) vs number of forecasters (vertical axis).

Table 1: Rational expectations hypothesis

## A Unbiasedness condition

	Coefficient	Standard error
Constant	-0.010*	0.001
$E_t S_{t+1} - S_t$	0.872*	0.013

## B Orthogonality condition

	Coefficient	Standard error
Constant	-0.012*	0.001
$E_t S_{t+1} - S_t$	0.915*	0.013
$u_{i,t}$	0.366*	0.024

Note: Sample period 1989.1-2005.1. Pooled regression. Semiannual change of exchange rate regressed on expected exchange rate change excluding (upper part) or including (lower part) the lagged forecast error. A '\*' denotes significance at least at the 0.05 level.

Table 2: Significance of backward looking models

	Coefficient	Standard error
Constant	0.008*	0.002
$S_t - S_{t-1}$	-0.153*	0.013

Note: Sample period 1989.1-2005.1. Pooled regression. Semiannual change of exchange rate expectations regressed on contemporaneous change of actual exchange rate. A '\*' denotes significance at least at the 0.05 level.

Table 3: Significance of expected economic fundamentals

## A Random effects specification

	I	II	III	IV
Constant	0.021* (0.004)	0.028* (0.006)	0.004 (0.004)	0.041* (0.004)
$S_t - S_{t-1}$	-0.139* (0.012)	-0.153* (0.012)	-0.151* (0.012)	-0.146* (0.012)
$STI_t$	-0.282* (0.061)			
$LTI_t$		-0.321* (0.086)		
$GY_t$			0.153 (0.094)	
$CPI_t$				-1.173* (0.130)

## B Fixed effects specification

	I	II	III	IV
Constant	0.021* (0.003)	0.026* (0.006)	0.004 (0.003)	0.039* (0.004)
$S_t - S_{t-1}$	-0.138* (0.012)	-0.153* (0.012)	-0.151* (0.012)	-0.147* (0.012)
$STI_t$	-0.285* (0.061)			
$LTI_t$		-0.285* (0.087)		
$GY_t$			0.173 (0.095)	
$CPI_t$				-1.090* (0.131)

Note: Sample period 1989.1-2005.1 Semi-annual change of exchange rate expectations regressed on contemporaneous change of actual exchange rate and expected macroeconomic fundamentals.  $STI$  ( $LTI$ )= short (long) term interest rate,  $GY$ =GDP growth,  $CPI$ =CPI inflation. Numbers in parentheses below the regression coefficients are standard errors. A '\*\*' denotes significance at least at the 0.05 level.