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ABSTRACT

This paper studies professional forecasts on a micro level using three alternative data sets. The analysis is mainly based on the ECB Survey of Professional Forecasts for the euro area, but for comparison, Consensus Economics survey and the Survey of Professional Forecasts for the US are also investigated. We examine internal consistency of individual inflation and real GDP growth forecasts by estimating alternative specifications of the Phillips curve on a micro level. We also explore forecast uncertainty using two alternative measures, i.e. conventional standard deviation of individual point forecasts and the median values of individual forecasters' uncertainty based on subjective probability distributions of survey respondents. Our analysis indicates that individual forecasters deviate systematically from each other. Moreover, inflation uncertainty is closely related to the output growth uncertainty. In forming expectations, individual forecasters seem to behave according to the hybrid specification of the New Keynesian Phillips curve. The results also indicate that inflation uncertainty has a negative impact on economic activity by increasing inflation and lowering the price sensitiveness of aggregate supply.

Key words: Forecasting, Survey data, Phillips curve, Uncertainty

JEL Classification: C53, E37, E31

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1. Introduction

Expectations, which are crucial in price and wage formation and in the monetary policy transmission mechanism, have been widely analyzed using survey data (see Pesaran and Weale (2006) and Sinclair (2010) for basic references of survey-based studies). Since most of the studies have explored survey expectations on an aggregate level, we do not exactly know what happens behind the mean values of forecasts. If, for example, the mean value of inflation forecasts increases, we do not know whether all forecasters increase their expectations by the same amount or whether only low inflation forecasters generally become high-inflation forecasters. Since one expectations variable is typically analyzed at a time, internal consistency of individual expectations has not been analyzed intensively yet. Most of the survey data are in the form of repeated cross-sections rather than genuine panel data, which restricts the analysis of expectations uncertainty.

Typically, surveys publish only mean values of individual forecasts and corresponding conventional standard deviations as a measure of expectations disagreement. Disagreement measures dispersion (or consensus) across individual forecasters. However, it does not express confidence associated with each individual expectation. If, for example, forecasters assess that economic uncertainty has increased after an economic shock, they do not necessarily change their point estimates. On the other hand, point forecasts may indicate that inflation expectations are still firmly anchored, although public confidence in the likelihood that the inflation target will be achieved has reduced. Probability distributions of individual survey respondents are alternative measures of forecast uncertainty. They provide useful information about the probability of the future outcome being in the specific range. Increased macroeconomic volatility due to the economic and financial crisis has emphasized the need to analyze forecast uncertainty.

The ECB Survey of Professional Forecasters (ECB SPF) enables rich analysis of forecast uncertainty, which is based on probability distributions of individual respondents' expectations[1]. Contrary to many other surveys, the ECB SPF survey provides both *fixed event* and *fixed horizon* forecasts for different time horizons (terminology is from Dovern et al 2009). *Fixed event* forecast refers to a certain calendar year (for example, the next calendar year) and *fixed horizon* forecast to horizon a certain time period ahead (like four quarters ahead).

This paper studies individual professional forecasts in two economic areas using three alternative panel data sets. The analysis is mainly based on the ECB Survey of Professional Forecasts from 1999Q1 to 2012Q3, a period that includes both the pre-crisis years with relatively quite stable   inflation rates and the crisis years with negative inflation rates. For comparison, Consensus Economics survey (CF) and the Survey of Professional Forecasts for the US (US SPF) are also investigated. We first explore heterogeneity of individual forecasts and then estimate alternative specifications of the Phillips curve. We examine whether individual forecasters' views about future price and output developments are internally consistent. The need to use the lagged inflation term in the Phillips curve relationship and possible differences in the Phillips curve slopes are analyzed. Two alternative measures of forecast uncertainty are used: conventional standard deviation of point forecasts and the median value of individual forecasters' uncertainty based on probability distributions of survey respondents. The relationship between inflation and output uncertainty is examined. We also investigate the impact of inflation uncertainty on the Phillips curve relationship.

The results clearly indicate systematic differences across individual forecasts. We also provide evidence that on a micro level future price and real GDP growth expectations are positively related. Individual forecasters seem to form expectations according to the hybrid specification of the New Keynesian Phillips curve. Inflation uncertainty seems to be closely related to the output uncertainty. We find evidence that higher uncertainty tend to have a negative impact on economic activity.

2. Alternative data sets

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1 Kenny et al. (2012) provide some evidence of the usefulness of these data by showing that the distributional information helps to predict future inflation and output developments.

Since the beginning of 1999 the European Central Bank has conducted a quarterly Survey of Professional Forecasters (ECB SPF). In this survey the ECB asks a panel of approximately 75 forecasters their short- and long-term views of HICP inflation, real GDP growth and unemployment in the euro area. Respondents represent financial sector, non-financial research institutes and employer or employee organizations in the European Union (EU). Both *fixed event* forecasts and *fixed horizon* forecasts for different time horizons are surveyed. In addition to the point estimates, probabilities surrounding point estimates (i.e. density forecasts) for all variables and all horizons are published[2].

Mean expectations of inflation and real GDP growth one and two years ahead are displayed in Figure 1. Until mid-2008 forecasts were quite stable, but after that future prospects of price and output developments worsened sharply and also forecasting errors increased substantially. After 2009 expectations and expectations errors have, however, returned to more or less "normal levels". As shown in Figure 1, long term forecasts are typically more stable than short term forecasts.

For the sake of comparison, two surveys for the US are also analyzed: Consensus Forecasts survey provided by Consensus Economics (CF) and the Survey of Professional Forecasts provided by the Federal Reserve Bank of Philadelphia (US SPF). The CF survey, which has been conducted since 1989, publish forecasts for the US and many industrialized others countries every month. Respondents in this survey are public and private economic institutions in the all major economies. The US SPF is a quarterly survey, which began already in 1968Q4. It includes over 30 variables for different forecast horizons. Both surveys provide expectations on a micro level. Consensus Forecast provides only *fixed event* forecasts of several macroeconomic variables. The US SPF survey, instead, publishes both *fixed event* and *fixed horizon* forecasts.

In order to make alternative surveys comparable, we follow Gerlach (2007) and Dover et al (2009) and approximate *fixed horizon* forecasts as weighted averages of *fixed event* forecasts in the CF survey. Denote by $F[y_0,m,y_1(x)]$ the *fixed event* forecast of

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2 The ECB SPF survey is described in detail in Bowles et al (2007).

variable x for year y_1 made in month m of previous year, y_0 , and by $F[y_0,m,12(x)]$ the *fixed horizon*, twelve-month-ahead forecast made at the same time. We can then approximate the *fixed horizon* forecast for the next twelve months as the average of forecasts for the current and next calendar year weighted by their shares in the forecasting horizon:

$$F[\, y_0,m,12(x)] =((\, 12 - m\,)/12)^*\, F[\, y_0,m,y_0(x)] + (m/12)^*\, F[\, y_0,m,y_1(x)]. \quad (1)$$

For example, the July 2010 twelve-month-ahead forecast of inflation rate Δp $F[2010,7,12(\Delta p)]$ is approximated by the sum of $F[2010,7,2010(\Delta p)]$ and $F[2010,7,2011(\Delta p)]$ weighted by 5/12 and 7/12 respectively. Using formula (1) we construct expected inflation and real GDP growth series for the US in the CF survey.

In order to assess the empirical relevance of formula (1), we compared the original *fixed horizon* (four quarters ahead) forecasts in the ECB SPF survey to the corresponding forecasts based on formula (1), i.e. on weighted averages of *fixed event* forecasts for the current and next calendar years. Figure 2 illustrates the relationship between the two series and Table 1 provides a test for the equality of two series. It is a bit disturbing to see that original *fixed horizon* data seem to differ quite a lot from the constructed series. The deviation is particularly large with inflation while with output growth the difference is more moderate. Still, in both cases equality of the two series is clearly rejected (Table 1). Comparison of the series provides evidence that forecasters do indeed have some nontrivial path of future inflation and output growth in their mind when they form expectations. Therefore, in empirical studies, expectations based on weighted averages should be interpret with caution.

3. Empirical evidence

In this section we explore internal consistency of survey expectations on a micro level. More precisely, we investigate individual forecasters' trade-off between inflation and real activity. In practice this means estimating the Phillips curve. Phillips curves have been estimated extensively, but it has not been subject to micro-level analysis in the euro area. Fendel et al (2011) have used individual Consensus Forecast data to explore the Phillips curve relationship in G7 countries and Tillmann

(2010) has studied the relevance of the Phillips curve using US individual FOMC forecasts. Individual FOMC forecasts have also been used to examine the Taylor rule in the monetary policy (Fendel and Rülke (2012)).

First, we scrutinize cross-plots of individual inflation and real GDP growth forecasts in the ECB SPF survey. One year and two years ahead relationships are displayed in Figure 3. Both figures indicate that individual forecasters have quite heterogeneous views about future trade-off between inflation and output. Views about the Phillips curve seem to be even more divergent in the case of shorter forecast horizon Even so, the two variables are positively related with both forecast horizons.

Next, we examine heterogeneity of individual forecasts in the ECB SPF survey in more detail. For that purpose, we test the importance of cross-section fixed effects and period fixed effects in the panel regression $\Delta p^e_{it,X} = c + c_i + c_t + u_{it}$,, where $\Delta p^e_{it,X}$ denotes inflation expectations of forecaster i for period X, assessed in period t. Alternative dependent variables are considered: forecasts for fixed calendar years (t+0, t+1, t+2 or t+L, which refers to long term expectations). Also fixed horizon forecasts are investigated: four quarters ahead t+4 and eight quarters ahead t+8. In all cases, we test the hypothesis according to which both the cross section fixed effects and period fixed effects are the same across forecasters (see the F test statistics in table 2). We also test the restriction that the relationship between inflation and output growth forecast is the same for all forecasters (see Chi-squared test statistics in table 2). All test statistics indicate the rejection of the null hypotheses of equal coefficients. Only, in the case of current period values (first row) the significance level comes close to the 0.001 level indicating that the differences between individual coefficients are not of the magnitude of several light-years. Otherwise, the differences between individual forecasts are large and persistent.

Next, we explore how the survey respondents' views' about future price and output developments are related to each other in the ECB SPF survey (see table 3). First, using alternative fixed event and fixed horizon forecasts, we explore whether inflation and output growth expectations are positively correlated. Then, we estimate alternative specifications of the Phillips curve relationship. For comparison, we estimate Phillips curves also for the US using the CF survey (see table 4). In this case expectations variables are constructed using formula (1).

The first six rows in table 3 indicate that inflation and output growth expectations are indeed positively correlated. Only if we consider the long run (five year) expectations, the relationship seems to vanish. Thus, forecasters seem to believe that in the future rising prices are related to increasing real activity. The finding is consistent with the basic features of the data (see Figure 3)[3].

The rest of the rows in Table 3 display estimation results for the (New Keynesian) Phillips curve. For that purpose, we use relationship (2) as the estimating equation. In estimation, we use the survey values to see whether the expected values reflect this basic relationship in the same way as the actual data (see, e.g., Kortelainen et al 2011).

$$\Delta p^e_{it,T} = \alpha\Delta p^e_{it-1,T} + \beta\Delta p^e_{it,T+1} + \gamma\Delta y^e_{it,T} + \sum Seas_t + u_{it} \qquad (2)$$

where $\Delta y^e_{it,T}$ denotes the expected growth rate of output for the current calendar year expected in period t by forecaster i. T denotes the period that is subject to the forecast. "$Seas_i$" with i =1,2,…,12 (or i = 1,2,3,4) denotes a seasonal dummy for month or quarter i. The equation has also been estimated using fixed 4 quarters ahead expectations.[4] Equation (2) was estimated using both the ECB SPF and Consensus Forecast data.

As for the Phillips curve, we find that conventional hybrid specification performs strikingly well: the coefficients are correctly signed and of reasonable magnitude. This is usually not the case when the rational expectations model is estimated by the GMM using lagged values of inflation and output as instruments.[5] The sum of

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3 With the long time-horizon data we have a degrees of freedom problem (see Table 2) so that the results are not fully comparable with the shorter-time horizon data.

4 We have no monthly data on actual GDP growth which is needed in estimation of the Phillips curve. Hence, we have to use some sort of "real time" proxy for current output. That is done by computing a 12-month moving average of expectations for current-year output growth (the results are reported as equation 5 in Table 4).

5 With the ECB SPF data we have some sort of seasonality problem due to the fact that the current values of inflation and output growth are expressed in terms current calendar year, not with fixed time horizon.

coefficients of future and past inflation comes quite close to one in Hybrid specification. The coefficients represent a not-so-new 50-50 split in weights between past and future inflation.

Estimation results with the Consensus Forecast data (with much longer sample period) in Table 4 confirm that inflation and output forecasts are indeed positively correlated although allowing for both cross-section and period time effects produces rather low t-ratios for the respective coefficients. When the cross-section fixed effects are eliminated, the t-values increase substantially (being 3.42 in the case of equation 1 (first row) and 7.41 in the case of equation 2 in Table 4). This finding is consistent with evidence on Dutch households (see Christensen et al (2006)), although the relationship seems to be much stronger in the Dutch data. Recent cross-country evidence with Consensus Economics micro data on professional economists (Fendel et al 2011) also point to same direction. The interesting point of this study is strong support to nonlinear form of the Phillips curve.

If inflation expectations only partially reflect output growth expectations we should consider other sources of differences in inflation expectations. The most obvious explanation is a difference in the parameters of the Phillips curve. Thus, we estimate equation (2) with equal slopes for all forecasters and, alternatively, allowing for different (forecaster-specific) slopes. The corresponding test results of the hypothesis of equal coefficients for all forecasters are reported on the two last lines in Table 4. We see that the null hypothesis of equal coefficients is rejected so that the slopes are indeed different (although only "marginally" in the hybrid specification), suggesting that the "forecasting model" may indeed also produce differences in inflation forecasts. Thus, differences in inflation forecasts may not simply reflect differences in optimism versus pessimism.

Finally, note that the estimates of the Phillips curve (columns 3, 4 and 5 in Table 4) generally make sense – to some extent the results make more sense that those obtained by using actual data as to imposing the REH orthogonality conditions via the GMM estimator, see e.g. Adam and Padula 2011). Thus, again the coefficient of output is positive and the coefficients for both the forward and backward-looking inflation terms are of reasonable magnitude and the coefficients can be estimated quite precisely. All this confirms that the use of survey data is indeed useful in recovering the basic relationships from empirical observations.

4. Analysis of forecast uncertainty

Finally, turn to analysis of forecast uncertainty and disagreement. The recent financial crisis clearly highlighted the fact that mean values of survey forecasts do not necessary reveal all relevant information about forecasters' expectations. An analysis of forecast uncertainty may also provide useful information of the market participants' behavior. Forecast uncertainty and disagreement in the ECB SPF survey has been analyzed in some recent studies, but not from the point of view of internal consistency of different variables (see for example Bowles et al (2010) and Conflitti (2011)). Uncertainty and disagreement in the Bank of England Survey of External Forecasters has been widely analyzed in Boero et al (2008).

The ECB SPF survey includes both individual point estimates and individual probability distributions (basically for all forecast horizons). In Figure 4 we compare average of individual point forecasts with corresponding expectations based on subjective probability distributions. Both inflation and real GDP growth forecasts for four quarters ahead are displayed. Figure 4 indicates that the alternative forecast series are closely related up to the point being identical. That may reflect the way in which the forecasts are constructed (maybe, the point forecast is made first and then the distribution of values is computed around this value). Of course, at the level of individual values, some rather large discrepancies do exist but when the data are aggregated these values cannot be discerned (see e.g. Engelberg et al (2009) for further evidence this correspondence).

Individual forecast uncertainty is investigated using two alternative measures, i.e. (1) the median values of individual forecasters' subjective uncertainty that is measured by second moment of the distribution of forecast values and (2) conventional standard deviation of point forecasts that indicates disagreement between individual forecasters. Figure 5 represents these two measures for both inflation and output growth expectations four quarters ahead in the ECB SPF survey. Individual uncertainties and corresponding expected values are compared in Figure 6.

The relationship between these measures is scrutinized in Table 5. From this table, we can see that that there is quite close relationship between inflation and output growth forecast uncertainties. Thus, the explanatory power of a simple regression model for inflation uncertainty is above 0.6. The data for individual forecast uncertainty (computed from the distribution of individual responses) is not very informative in terms of different events while the disagreement series seem to be much more sensitive to economic crises, in particular to the financial crisis in 2007-2009. This is particularly true for the output growth where the level of uncertainty appear to be more than five times higher than normally in the middle of the crisis in 2008/2009[6].

Signs of increasing uncertainty during and after the crisis period may have different explanations. We can speculate, for example, that strategic forecasting potentially explains forecast values in the crisis years (forecasters may have wanted to cover also less probable outcomes). On the other hand, when even the sign of future price developments was widely debated (inflation or deflation) at that time, increasing inflation uncertainty seems to be reasonable. Also, growth prospects were very difficult to assess in real time in the middle of the crisis, partly due to huge data revisions. It is better to interpret recent survey information with caution. When looking at only point estimates and dispersion of inflation expectations, we should perhaps not hasten to conclude that the survey data indicate that inflation expectations have been firmly anchored during and after the crisis.[7]

To get some more insight of the nature of the change in subjective uncertainty we use the ECB SPF data to compare average probability distributions of individual forecasters for inflation expectations (computed four quarters ahead). We explore two just periods during the crisis: 2008Q3 and 2009Q3 (see Figure 7). A comparison

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[6] This finding is consistent with Döpke and Fritsche (2006), who have analyzed forecast dispersion of German professional forecasts for 1970-2004. They find that forecast dispersion varies over time and is particularly high before and during recessions.

[7] Typically, long-term forecast uncertainty is interpreted using standard deviation. Unfortunately, the sample size with long-term forecasts is so small that it is really hard to make proper statistical analysis.

indicates that distributions are indeed clearly different in the two periods. However, they are largely different due to the difference in the mean. A level shift in inflation expectations from 2008Q3 to 2009Q3 can be easily discerned but the change in the dispersion is not equally obvious. Between the two periods the median of variances computed from individual PDFs decreased from 12.2 to 9.6 but it is a bit difficult to see that some genuine change in uncertainty (measured in this way) would indeed have taken place.

The recent crisis revealed also other possible caveats in the surveys. Individual forecasters may react to increasing uncertainty by adopting completely different distribution (with more skewness and kurtosis). Thus we should not only focus on the standard deviation. On the other hand, the crisis may have changed survey response rates (less survey responses are received altogether and/or the distribution is described less accurately). In the US SPF, the distribution of forecasts is particularly crude, since in terms of inflation, the average number of entries per respondent is only 3.5. In the ECB SPF things are somewhat better. With inflation, there has been 4.7 entries and with output growth 5.1 entries on an average. Time-variation in the response rate in the US SPF survey is also reported in Figure 9. This variation seems to be rather random although some small increase in the response rate (average number of data points reported for the distribution) could be discerned. Altogether, the US data seem less informative than the ECB data. The disagreement measure works more or less in the same way as in the ECB data showing marked increase in inflation uncertainty in the middle of financial crisis but the subjective uncertainty measures (computed from the reported distributions) show very little sensitivity with respect to economic developments. On the basis is this evidence one might prefer the disagreement measure (standard deviation of individual point forecasts) as a more informative uncertainty indicator for forecast uncertainty. At least, the US data (Figure 8) points to this direction.

In fact, examination of survey response patterns and survey response rates suggests that one cannot necessarily scrutinize the higher-order moments of the distributions in order to analyze forecast uncertainty. Even the standard deviations may be on relatively shaky ground. The interpretation problem is aggravated by the fact that the questionnaires have been changed over time. The recent change in 2008/2009 where more “bad” alternatives were added to the questionnaire is particularly problematic from the point of assessing the impact of financial crisis on uncertainty[8].

Finally, we also try to utilize the data on individual inflation uncertainty in the Phillips curve relationship along the lines of old paper by Levi and Makin (1980). They argue that the slope of the Phillips curve ought to depend on the level of inflation uncertainty. Levi and Makin (1980) found evidence of this effect and here we test the hypothesis with the (more powerful) individual forecasters’ panel data. The results, which are displayed on the last row of Table 3, clearly indicate that forecast uncertainty tends to change the slope of the Phillips curve. The curve both shifts upwards and the slope also becomes (marginally) steeper. In other way round, looking at the supply response to unanticipated inflation, the results suggests – in accordance to Friedman’s Nobel lecture (1977) - that higher uncertainty tends to suppress output[9]. Thus, uncertainty is not a trivial thing in terms of economic importance. Although we have dealt with inflation uncertainty it is worthwhile to remember that inflation and output growth uncertainties are highly correlated (the coefficient of correlation being about 0.8). Thus the result for inflation uncertainty may also reflect effect more general economic uncertainty. That may affect not only the slope of the Phillips curve but other relevant behavioral relationships as well.

5. Concluding remarks

This paper has examined individual inflation and real GDP growth expectations using three alternative panel data sets. The analyses have produced several interesting results. First of all, the results show that individual forecasters seem to deviate systematically from each other. Even so, the forecasters seem to produce values that are largely consistent with basic principles of economics: inflation and output growth expectations are positively correlated and, moreover, consistent with the hybrid

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[8] Scrutiny of the distribution of individual distributions suggests, however, that the new questionnaires did not awfully much affect the reported distributions in the sense that many forecasters would have wanted to produce more gloomy forecasts prior to 2007 but would have been prevented in doing so because of missing values on the scale. This can be seen by scrutinizing the three-dimensional graph(s) in Figure 10.

[9] From the point of view of the Lucas’s (1973) supply curve, increased aggregate inflation uncertainty directly affects the supply curve coefficient and thus the price sensitiveness of supply. See e.g. Bloom (2009) for empirical evidence of effect.

specification of the New Keynesian Phillips curve. Also the respective uncertainties seem to be positively related. We find evidence that inflation uncertainty is important element in the Phillips curve relationship and increased uncertainty suppresses economic activity. Since the beginning of the crisis inflation uncertainty in the euro area has been at a high level compared to the earlier years. If uncertainty remains at this high level also in the future, it may restrain real GDP growth substantially. As for future analyses, it would be useful to explore the distributional features of the micro data sets more extensively (e.g., the higher order moments). One might also benefit from (revisions of) the “real-time data. Finally, more general treatment of overall economic uncertainty could be useful.

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Table 1 Comparison of actual and constructed forecast data in the ECB SPF survey

Test of equality of the ECB SPF time series

$\Delta p^{e}_{it,4}$ = .702 +.548$\Delta p^{e}_{it,4g}$ t1 = 28.35, t2 = 43.38, R2 = 0.542, SEE = 0.263, DW = 1.14

$\Delta g^{e}_{it,4}$ = .289 + .856$\Delta g^{e}_{it,4g}$ t1 = 9.44, t2 = 57.39, R2 = 0-838, SEE = 0.434, DW = 1.14

$\Delta p^{e}_{it,4}$ denotes the original inflation forecast four quarters ahead in the survey and $\Delta p^{e}_{it,4g}$ the corresponding four-quarter forecast from the fixed event (current and next calendar year) forecasts computed based on formula in (1).

Table 2 Testing the importance of fixed effects in the ECB SPF survey

Dependent variable	degrees of freedom	F	$\chi 2$
Fixed event forecasts			
Δp^{e}_{t+0}	99,2880	2.71	152
Δp^{e}_{t+1}	98,2806	6.09	264
Δp^{e}_{t+2}	93,1034	4.35	258
Δp^{e}_{t+L}	97,1993	10.93	812
Fixed horizon forecasts			
Δp^{e}_{t+4}	96,2551	5.95	270
Δp^{e}_{t+8}	96,2771	6.44	422

Table 3 Relationship between inflation and output growth forecasts in the ECB SPF data

Dep v.	const	Δy^e_t	Δp^e_{t+1}	$s1*\Delta^e p_{t+1}$	$s2*\Delta^e p_{t+1}$	$s3*\Delta^e p_{t+1}$	$s4*\Delta^e p_{t+1}$	$\Delta^e p_{t-1}$	$\delta\Delta p_t$	R2/SEE
Fixed horizon forecasts										
Δp^e_{t+4}	1.581	.086								0.058
	(89.31)	(10.401)								0.373
Δp^e_{t+8}	1.741	.028								0.003
	(60.39)	(2.23)								0.291
Fixed event forecasts										
Δp^e_t	1.644	.208								0.242
	(126.54)	(37.88)								0.565
Δp^e_{t+1}	1.619	.084								0.031
	(64.18)	(7.29)								0.356
Δp^e_{t+2}	1.701	.060								0.012
	(36.66)	(2.87)								0.269
Δp^e_{t+L}	2.098	-.086								0.019
	(47.05)	(4.17)								0.233
Phillips curve estimates										
Δp^e_t		.108	1.003							0.508
		(16.84)	(127.11)							0.457
Δp^e_t		.111		.893	.989	1.046	1.050			0.541
		(17.40)		(93.02)	(93.18)	(99.29)	(87.78)			0.442
Δp^e_t		.111		.364	.511	.551	.485	.485		0.694
		(17.32)		(17.42)	(25.72)	(26.17)	(22.91)	(22.54)		0.348
Δp^e_t		.152		.858						0.506
		(11.36)		(55.18)						0.329
Δp^e_t		.088			1.010					0.482
		(5.59)			(60.00)					0.429
Δp^e_t		.103				1.071				0.618
		(8.69)				(77.85)				0.456
Δp^e_t		.119					1.045			0.465
		(9.67)					(67.64)			0.528
Δp^e_t		.130		.268	.411	.450	.401	.524	.183	0.682
		(17.32)		(11.07)	(18.13)	(18.63)	(15.91)	(21.73)	(5.32)	0.352

Numbers inside parentheses are corrected t-ratios. Δp_{t+4} denotes expected inflation for the subsequent four quarters and Δp_{t+1} the corresponding measure for the next calendar year. Δp_{t+L} denotes the long-run inflation expectations. The growth rate of output, Δy^e_t is defined accordingly. In the Phillips curve, the dependent variable Δp^e_t is expected rate of inflation for the current period. In a sense, it is the micro-level real-time equivalent of actual inflation. $\delta\Delta p$ is the standard deviation of individual forecasts. All equations have been estimated by OLS, the simple equations on rows 1-6 also include cross-section fixed effects. s1-s4 denote seasonal dummies. Equations on rows 10-13 are estimated with the first, second, third and fourth quarter data only. The last row represents an uncertainty-augmented hybrid Phillips curve.

Table 4 CF panel data estimates of inflation-output growth equations

	1	2	3	4	5	6
Constant	2.617 (57.12)	2.601 (65.16)				1.597 (16.09)
$\Delta y^{e}_{t,T}$	.032 (1.74)		.149 (12.71)	.053 (7.63)	.062 (11.73)	.430 (10.91)
$\Delta y^{e}_{t,T+1}$		.038 (2.25)				
$\Delta p^{e}_{t,T+1}$			.855 (51.08)	.138 (8.86)	.258 (23.66)	
$\Delta p^{e}_{t-1,T}$				.851 (63.51)		
Δp_{t-1}					.696 (68.47)	
fixed cross section terms	x	x				x
seasonal dummies			x	x		
dependent variable	$\Delta p^{e}_{t,T}$	$\Delta p^{e}_{t,T+1}$	$\Delta p^{e}_{t,T}$	$\Delta p^{e}_{t,T}$	$\Delta p^{e}_{t,T}$	$\Delta y^{e}_{t,T+1}$
SEE	0.222	0.366	0.835	0.389	0.445	0.400
R^2	0.963	0.828	0.464	0.828	0.858	0.792
χ^2 test statistic for equality of individual cross-section coefficients	784.4 (0.00)	2495 (0.00)	599.17[a] (0.00)	130.08[a] (0.001)	166.60[a] (0.00)	1200 (0.00)

Notation is the same as in Table 2. Superscript denotes the case where the alternative is a model with forecaster-specific coefficients of the output growth variable. For equation 5, expectations are expressed as 12 month fixed time horizon and actual past inflation is assumed to be known to all forecasters. No time-effects are used with the Phillips curves.

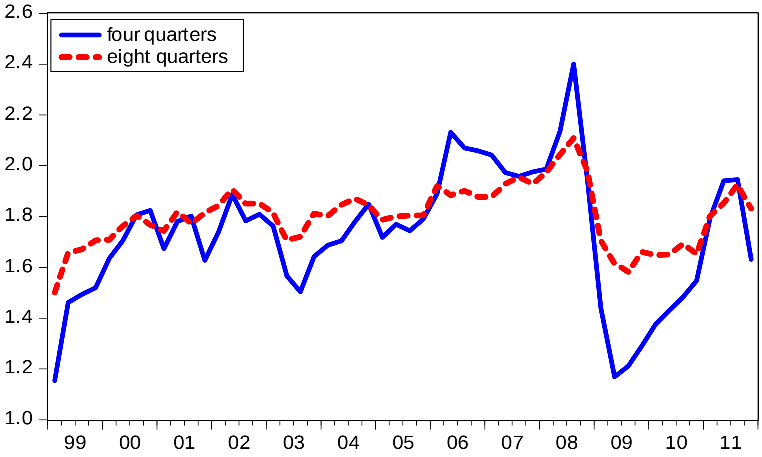
Table 5 Relationship between SPF-ECB uncertainty measures

	1	2	3	4
Constant	.150 (72.26)	.199 (20.34)	.131 (18.02)	.167 (9.45)
disagreement w.r.t. Δy_t	.366 (70.89)			
$\delta\Delta y_t$		.552 (28.00)	.684 (42.95)	.669 (38.76)
Δp_t				-.001 (0.05)
Δg_t				-.017 (5.10)
fixed cross section terms		x		
dependent variable	disagreement	$\delta\Delta p_t$	$\delta\Delta p_t$	$\delta\Delta p_t$
R^2	0.604	0.732	0.648	0.649
SEE	0.051	0.112	0.126	0.123

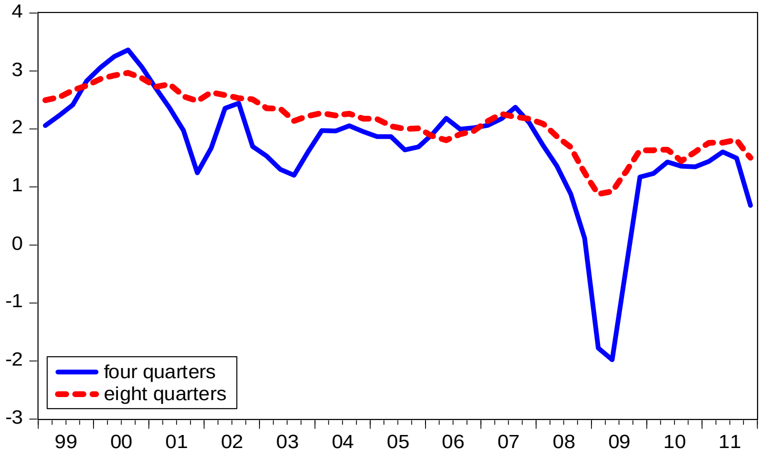
The dependent variable is inflation uncertainty, measured by disagreement (standard deviation of point estimates) or individual inflation uncertainty, $\delta\Delta p$ (average standard deviation of individual inflation forecasts based on subjective probability distributions). The term $\delta\Delta y$ refers to individual output growth uncertainty (average standard deviation of individual growth forecasts based on subjective probability distributions). Otherwise, the notation is the same as in Table 1.

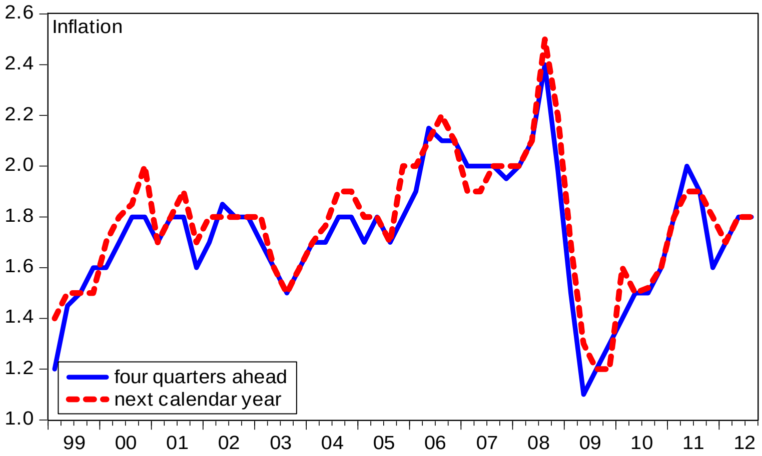
Figure 1 Forecasts of inflation and output growth for one and two years ahead (ECB SPF)

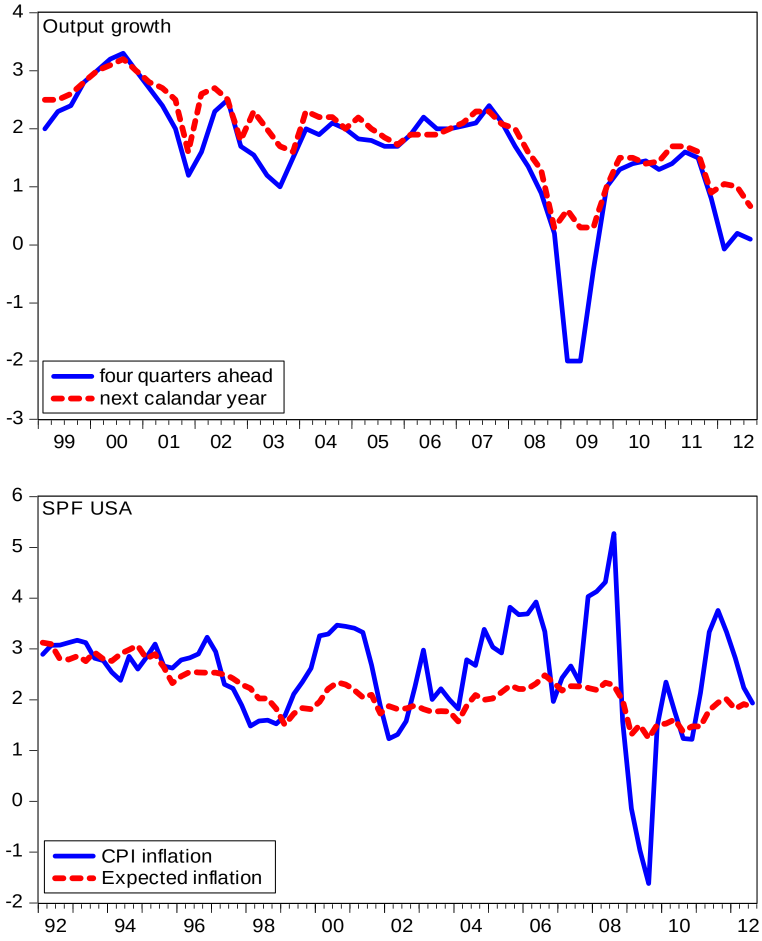
inflation ECB



output growth ECB







In all graphs, forecasts are dated according to the quarter of publications of the forecast.

Figure 2 Relationship between survey forecasts four quarters ahead and corresponding approximations based on formula (1) (ECB SPF)

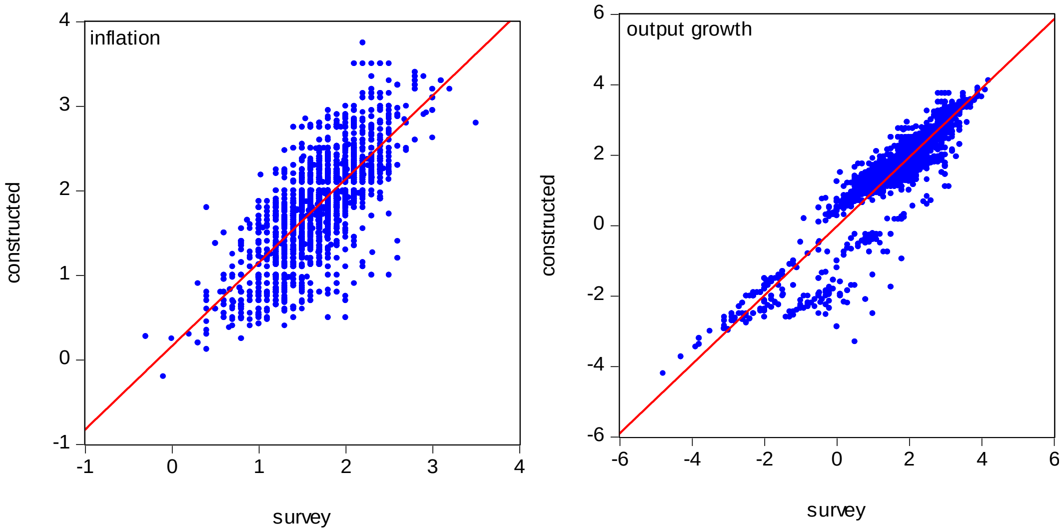


Figure 3 Relationship between inflation and output growth forecasts (ECB SPF)

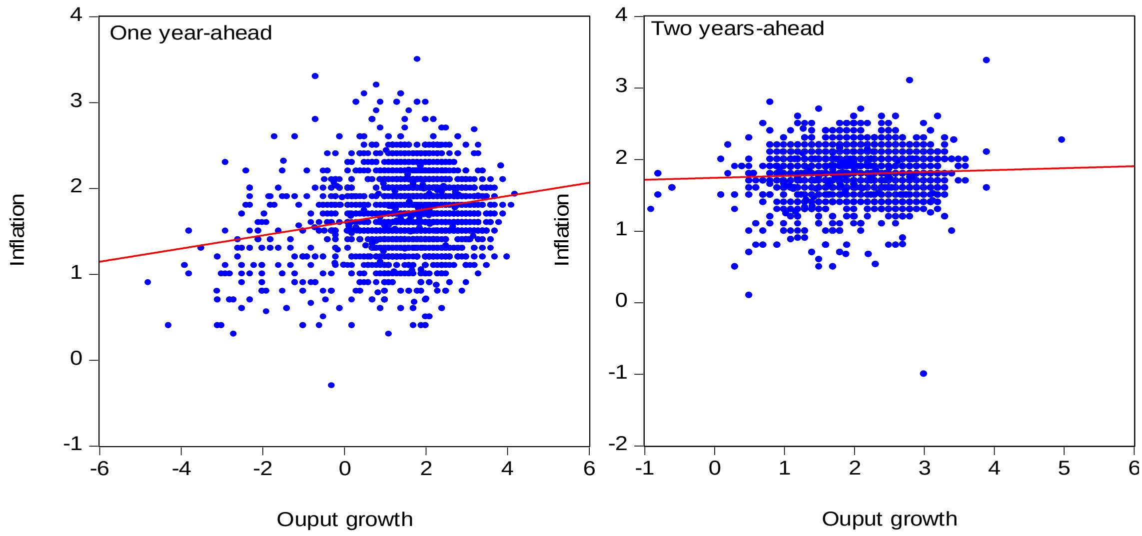


Figure 4 Comparison of mean values of individual point forecasts and expected values based on subjective probability distributions (ECB SPF)

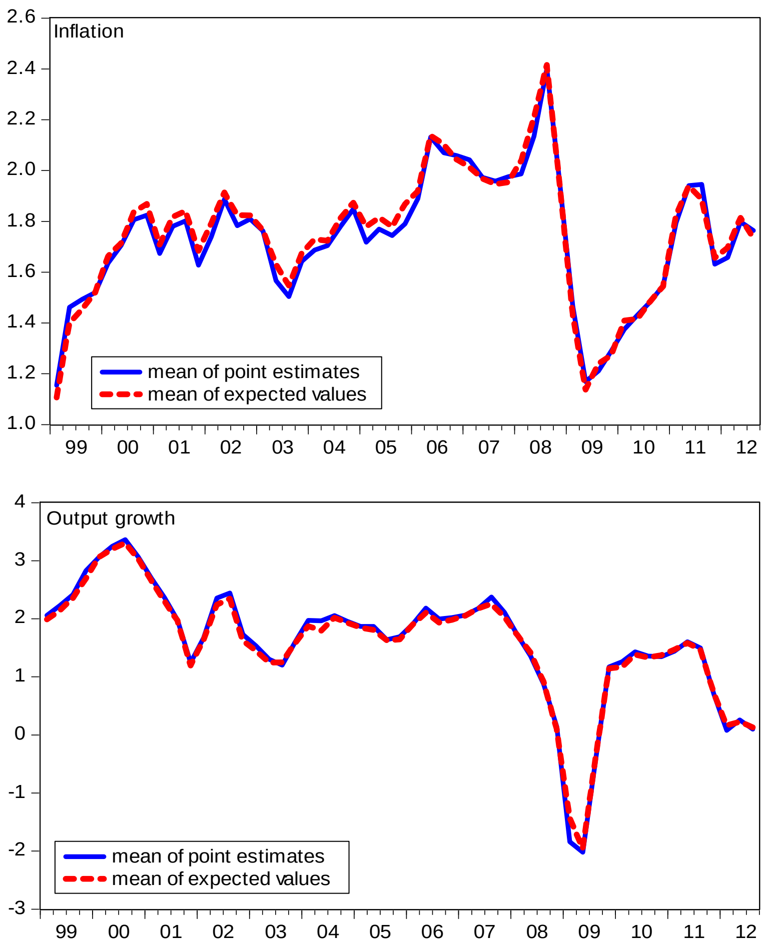
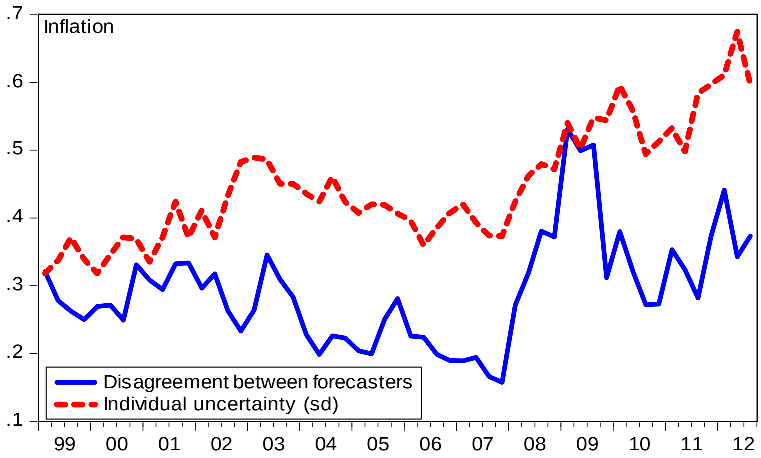
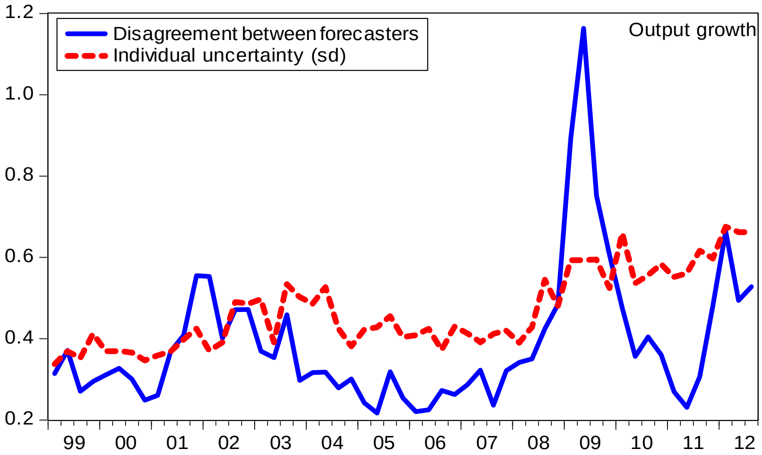


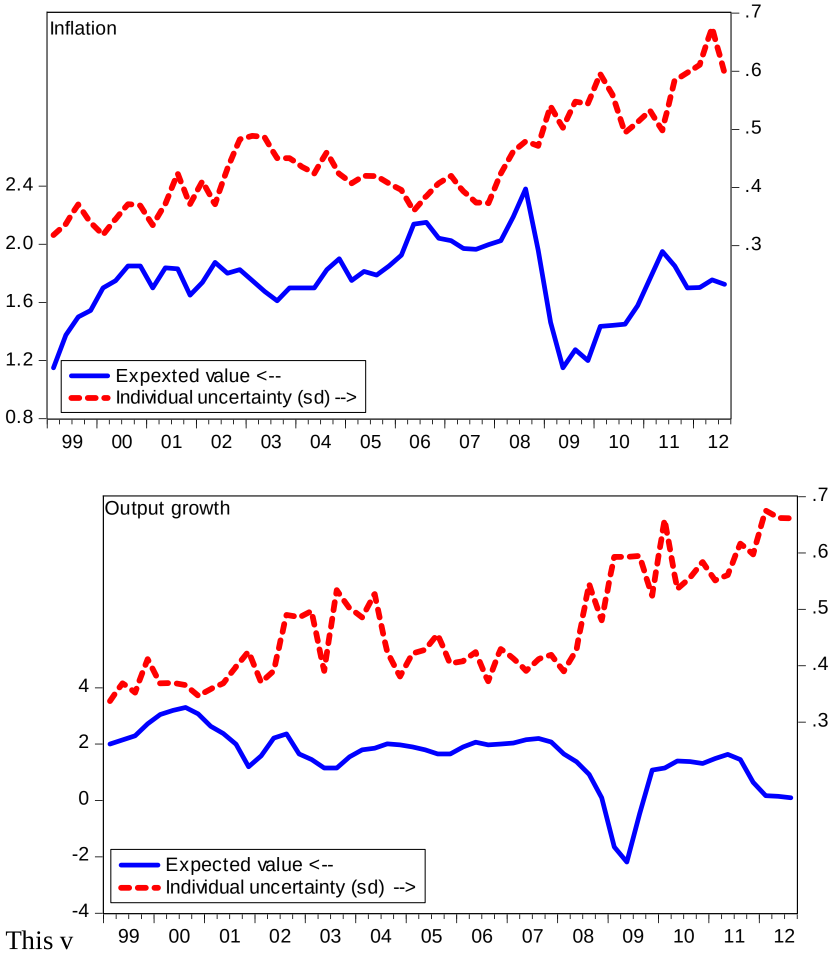
Figure 5 Comparison of forecast uncertainties (ECB SPF)





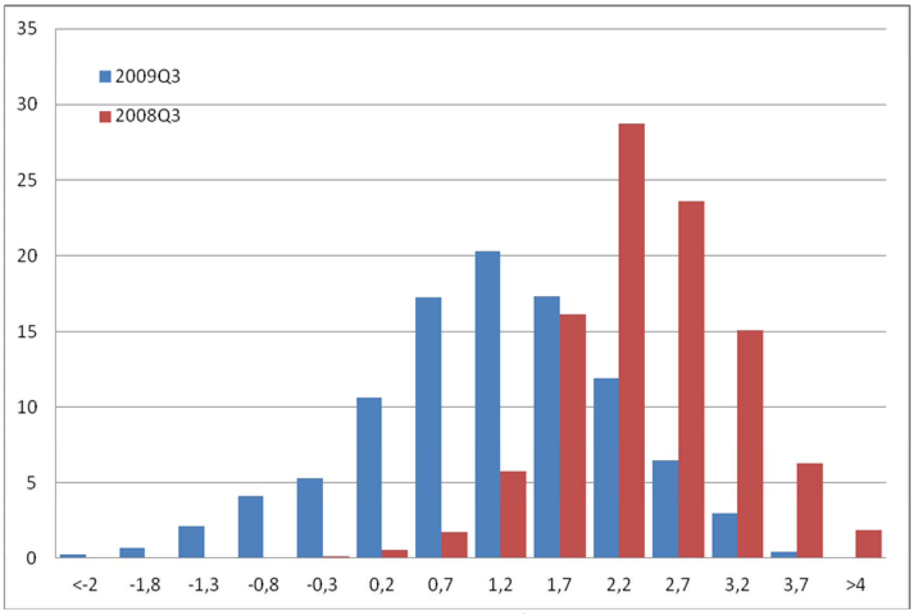
Uncertainty is measured by the standard deviation of point forecasts (disagreement) and the median of the standard deviation of individual forecasts (computed from the individual distributions). Forecast horizon is 4 quarters ahead. Also here, dating corresponds the publications of forecasts.

Figure 6 Expected values vs. individual uncertainty (ECB SPF)



This v
Values are respective medians

Figure 7 Average values of perceived probabilities of inflation expectations



Values at the x-axis represent the mean values of relevant intervals in questionnaire. The data are for ECB SPF.

Figure 8 Uncertainty and the form of the distribution in the US data (US SPF)

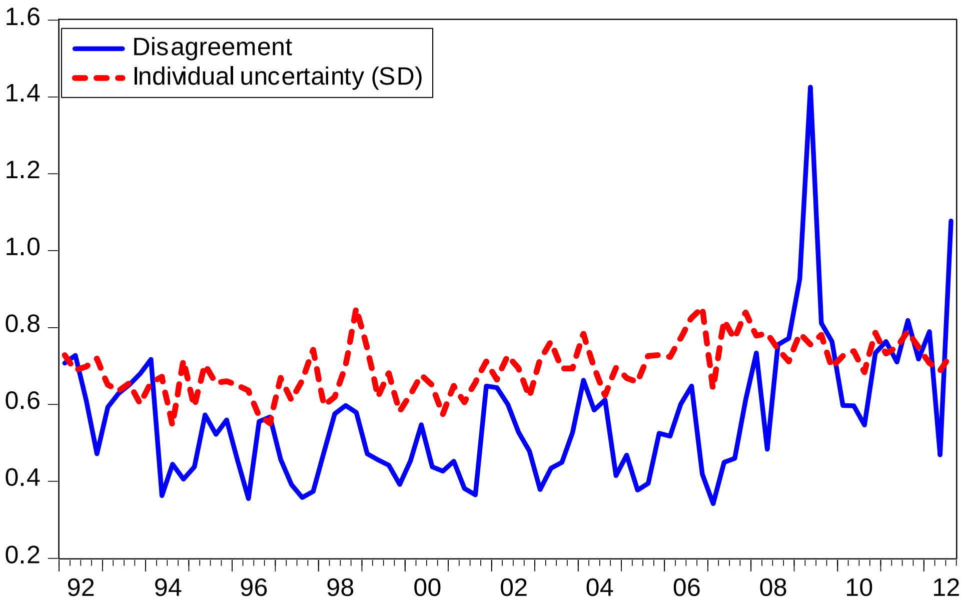
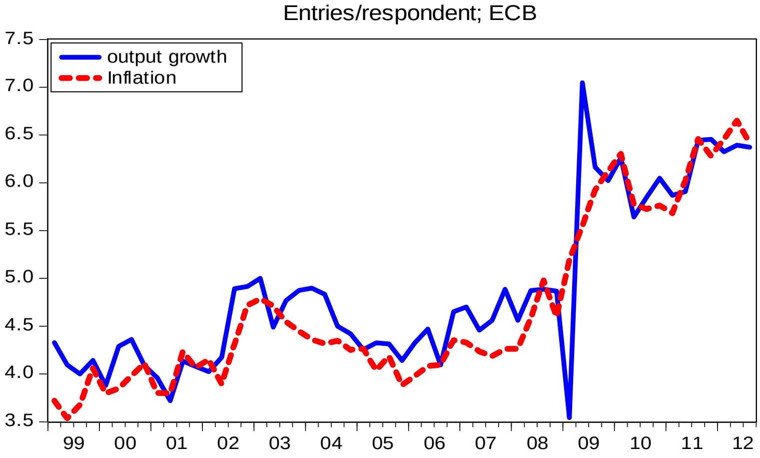
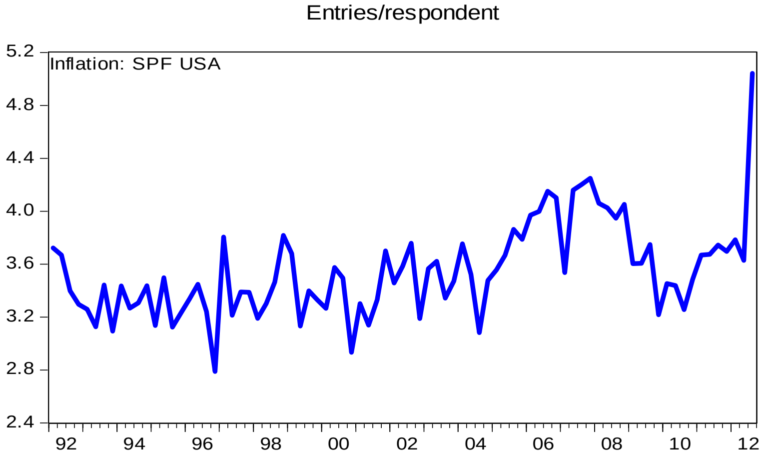


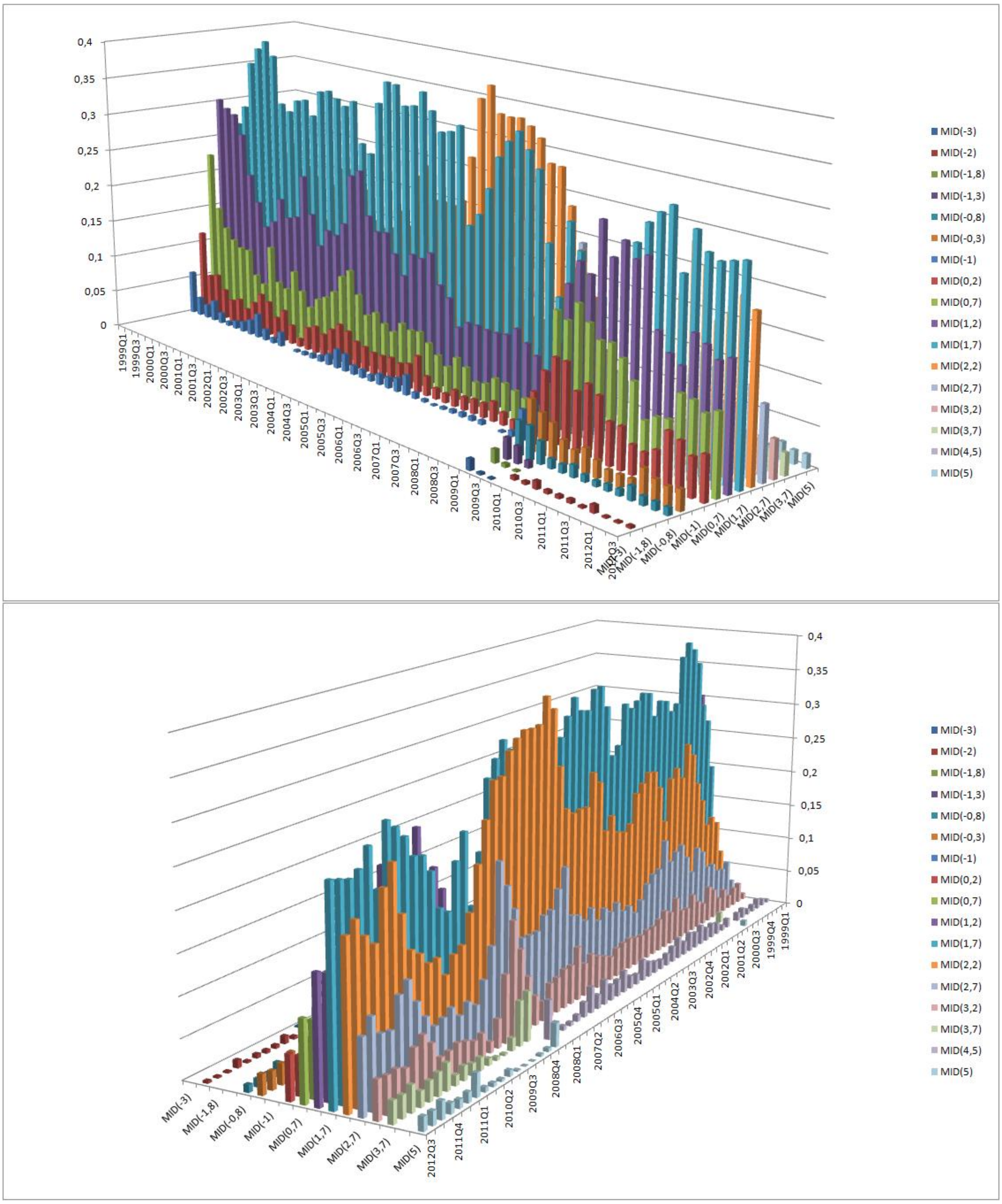
Figure 9 Changes in the response rates





The series "entries/respondent" are derived by dividing the number of entries (=categories in the distribution with nonzero values) by the number of forecasters.

Figure 10 Average values of reported distributions for inflation in the SPF-ECB micro data



The upper (lower) graph illustrates the left-hand (right-hand) side of the distribution of the reported values for expected inflation.

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