Maritta Paloviita – Matti Virén

Analysis of forecast errors in micro-level survey data

SUOMEN PANKKI
FINLANDS BANK
EUROJÄRJESTELMÄ
EUROSYSTEMET

Bank of Finland Research
Discussion Papers
8 • 2014

Maritta Paloviita and Matti Viren[1]

Analysis of forecast errors in micro-level survey data

Abstract

This paper studies forecasts errors at the micro level using two alternative survey data sets. The main focus is on inflation and real GDP growth forecasts in the ECB Survey of Professional Forecasters. For comparison, inflation forecasts in the US Survey of Professional Forecasters are also examined. Our analysis indicates that forecast errors are positively related to the subjective uncertainties based on probability distributions, but not to disagreement (standard deviation of point forecasts). We also show that forecast errors, which are rather persistent, are related to forecast revisions. Revisions of expectations generally lead to larger forecast errors. Subjective uncertainty measures, which are available at the time of forecasting, are useful in assessing future forecast errors.

Key words: Forecasting, Survey data, Expectations

JEL Classification: C53, E37, E31

---

[1] Maritta Paloviita is a research economist at the Bank of Finland and Matti Viren a scientific advisor at the Bank of Finland and professor of economics at University of Turku. Emails: maritta.paloviita@bof.fi and matti.viren@bof.fi. Antti Komonen and Sami Oinonen have kindly derived the data and Mika Kortelainen has provided useful comments. The opinions expressed in this paper do not necessary reflect those of the Bank of Finland or Eurosystem.

1. Introduction

Expectations clearly impact on all types of economic behavior. Current economic decisions are affected not only by expected future outcomes but also by the uncertainty surrounding those expectations. This was long ago pointed out by e.g. Friedman and Ball (cf. Hartmann and Herwartz 2012) and more recently by Bloom (2009). It is obvious that increasing forecasting uncertainty leads to wider differences in expectations across individual forecasters. It also leads to wider confidence intervals for the expected values of forecast variables. Forecast uncertainty may vary substantially across economic agents due to differences in available information. Needless to say, economic uncertainty is highly relevant for the monetary policy: if monetary policy is credible, inflation uncertainty is low and inflation expectations are firmly anchored.

Expectations have been widely analyzed using survey data (see Pesaran and Weale 2006 and Sinclair 2010 and references therein). Typically, the analysis is based on aggregated data (mean or median values of point forecasts), and disagreement (standard deviation of point forecasts) is commonly used as a measure of forecast uncertainty. Since disagreement captures only the dispersion across individual forecasts, it is not necessarily a good proxy for forecast uncertainty. Subjective probability distributions can be used to construct more useful proxies for individual forecast uncertainty. This issue is analyzed in several papers, e.g. in Rich and Tracy (2010) and Rich et al. (2012). Contrary to most other surveys, the ECB Survey of Professional Forecasters (ECB SPF) and the US Survey of Professional Forecasters (US SPF) provide micro level subjective probability distributions for different variables and time horizons, which facilitate comparisons between the two uncertainty measures. Using micro data from the ECB SPF and the US SPF, we are able to track quantitative survey responses of individual forecasters over time and analyze forecast errors at the micro level.

This paper studies forecast errors at the micro level using these two quarterly survey data sets. Our analysis is mainly based on short term HICP inflation and real GDP growth expectations from the ECB SPF, where point forecasts and subjective forecast uncertainties are directly comparable. For comparison, the GDP price index -based inflation expectations in the US SPF are also examined. The basic idea is to analyze whether subjective uncertainty measures, which are available in real time (at the time of forecasting), are useful for assessing subsequent forecast errors. We look at how the forecast errors of individual forecasters depend on forecast uncertainty and how the errors are related to forecast revisions[2]. We also analyze how inflation and output growth forecasts (and the respective forecast errors) are related to each other (e.g., whether survey participants make large forecast errors in both variables at the same time). In considering forecast updating, we are mainly interested in seeing how persistent the forecasts and forecast errors are. We proceed by scrutinizing the frequency of forecast revisions and the autocorrelation structure of forecasts (forecast errors). Given this information we examine the impact of persistence in individual expectations on forecast performance. The main finding of the study is that subjective forecast uncertainty seems to predict future forecasts errors.

The paper proceeds as follows. The data are described in the section 2. The results are presented in section 3, and section 4 concludes.

2. The two survey data sets

The European Central Bank has conducted the ECB SPF since 1999Q1[3]. In this survey the ECB asks professional forecasters in the European Union (EU) about their short and long term views of HICP inflation, real GDP growth and unemployment in the euro area. We analyze one year ahead inflation and output growth forecasts from 1999Q1to 2013Q3. When examining forecast uncertainty, the ECB asks survey respondents to report the probability distribution divided into pre-determined intervals (bins) for forecast variables. The ECB SPF data have some specific advantages for analysis of forecast uncertainty, since point forecasts and probability distributions are directly comparable due to the use of the same variable definitions and rolling forecast horizons[4]. Since the start of the survey, a total of 113 forecasters have participated the ECB SPF, but in the empirical study we can use only 95 cross-section units. The average number of survey responses has been 46.

The ECB SPF has been analyzed is some recent studies. Bowles et al. (2010) examined growth and unemployment forecasts in the ECB SPF. They provide evidence that forecast errors are very persistent and disagreement is not a good proxy for overall macroeconomic

---

[2] This analysis comes close to Clements (2013) who uses US SPF data to analyze the relationship between so-called ax ante and ex post forecast uncertainty, where the latter is derived by comparing point predictions to outcomes.

[3] Data source: http://www.ecb.europa.eu/stats/prices/indic/forecast/html/index.en.htm. The ECB SPF is described in detail in Bowles et al. (2007).

[4] The ECB SPF also provides point forecasts and corresponding probability distributions for fixed calendar years.

uncertainty. They also argue that individual forecasters underestimate the overall level of macroeconomic uncertainty. Conflitti (2011) has also considered several measures of uncertainty and disagreement at both aggregate and individual level by approximating the histogram by a piecewise linear function. She emphasizes that individual probability information is needed for analyzing uncertainty. Kenny et al. (2012) have shown that the distributional information in the ECB SPF helps to predict future inflation and output developments. Using micro level survey data from the ECB SPF, Andrade and Le Bihan (2013) analyzed forecast updating. They have also analyzed the empirical performance of alternative inattention models. Rich et al. (2012) used the ECB SPF data to study forecast uncertainty, forecast dispersion and forecast accuracy. They argue that forecast uncertainty is countercyclical and that disagreement is not a valid proxy for uncertainty.

Average point forecasts and corresponding confidence intervals (=2*standard deviations) for euro area inflation and real GDP growth are displayed in Figure 1, which clearly shows that survey responses are quite heterogeneous. In both cases, the confidence limits around the mean have varied over time and since mid-2008 have increased substantially. Figure 2 reports the share of forecasters who do not revise their forecasts from the previous quarter. The shares have varied between 0 and 0.348 for output growth and 0.049 and 0.388 for inflation with the respective means being 0.108 and 0.181, suggesting that output growth is revised slightly more frequently. In the middle of the financial crisis all the forecasters changed their views of future output growth in several of the periods. In the case of inflation, the lowest shares (close to zero) were observed in 2009Q1 and 2009Q2.

For comparison, we also analyze short term inflation forecasts in the US SPF[5]. This survey, which is nowadays provided by the Federal Reserve Bank of Philadelphia, has been conducted since 1968Q4. Since micro level survey responses are not fully comparable before and after 1992Q1 in the US SPF, we consider here the period 1992Q1-2013Q3[6]. During this period, the average number of survey responses was 34 (total number of cross-section units is 160). In the US SPF all forecasters report the probability that the annual over annual average percent change in inflation (GDP price index) falls in a particular range. Sill (2012) reviews alternative uncertainty measures in the US SPF. Matched point and density forecasts in the

[5] Data source: http://www.phil.frb.org/research-and-data/real-time-center/survey-of-professional-forecasters/. See Croushore (1992) for an overview of the US SPF.
[6] Not all individual forecasters could be identified for periods prior to 1992Q1, because some forecaster IDs were reused when the survey panel was changed.

US SPF are used by Rich and Tracy (2010) to analyze the relationship among expected inflation, disagreement and uncertainty[7].

Disagreement (standard deviation of point forecasts) corresponds here to dispersion of individual views. Disagreement does not affect subjective uncertainty, which is measured by averaging the standard deviations from individual probability distributions. Subjective uncertainty is available at the time of forecasting. Subjective uncertainties, especially their levels and variation, are not directly comparable in the ECB SPF and US SPF for various reasons. Here we analyze subjective uncertainties in the ECB SPF for rolling forecast horizons, whereas for the US SPF the forecast horizon differs for each quarter in a calendar year.

The two surveys also differ because of differing widths of pre-determined bins in the probability distributions. In the ECB SPF the interval width for inflation forecasts is 0.5 percentage point (for example, 1.0 to 1.4% and 1.5 to 1.9%), whereas in the US SPF the corresponding widths are one percentage point (1.0 to 1.9% and 2.0 to 2.9%)[8]. Therefore, the number of non-zero probabilities is typically higher in the ECB SPF responses compared to that in the US SPF. This means that euro area measures of subjective uncertainty are more detailed than those for the United States[9].

Changing the number of intervals also affects our measure on subjective uncertainty. Only for the US SPF has the number of inflation intervals remained unchanged (10 intervals) in our data set. In contrast, in the ECB SPF, the numbers were unchanged (with only minor exceptions) up to mid-2008, but thereafter more intervals were temporarily added to both the inflation and real GDP growth probability distributions. Since the beginning of 2010 the intervals have been almost the same as in the pre-crisis period[10]. For the ECB SPF individual

---

[7] Other surveys have also been recently analyzed at the micro level. Using a micro data set from the Bank of England Survey of External Forecasters, Boero et al. (2008) examined forecast uncertainty and disagreement. Dräger and Lamla (2012) studied updating of individual inflation expectations. Their study is based on Michigan Household Consumer Survey. Patton and Timmermann (2010) analyzed forecast dispersion using micro level Consensus Economics survey data.

[8] Wider intervals in the US SPF can be explained by the longer history of the survey: US inflation was clearly higher and more volatile in the early years of the survey compared to recent history.

[9] If for example, the euro area forecaster provides a point forecast of 1.5 per cent and 50-50 per cent probabilities for inflation being between 1.0-1.4 and 1.5-1.9 per cent, the number of bins is 2. In the US SPF the same assessment produce only one non-zero bin: 100 per cent probability for inflation being between 1.0-1.9 per cent.

[10] Due to the deep recession, many negative intervals were added for real GDP growth after mid-2008. Inflation views were very mixed at that time. Therefore, both negative and positive intervals were added for inflation. This change in intervals affects the uncertainty measures, but there is no obvious way of dealing with the problem.

uncertainties are constructed using the number of intervals in the questionnaire (zero probabilities also are included), whereas in the US SPF formula only non-zero bins are included.

Figure 3 presents the average numbers of non-zero probability intervals (bins) the forecasters have provided to the data collectors. Due to changing forecast horizons in annual-average over annual-average series, moving averages are reported for the US. Figure 3 shows that the average number of non-zero bins has been consistently higher in the ECB SPF (as noted before, this is due to narrower intervals in the euro area probability distributions). On the other hand, the shift in level in the ECB SPF series after mid-2008 is partly due to additional intervals in the ECB questionnaire. For the US, the number of non-zero bins has been changed much, not even during the financial crisis.

Figures 4 and 5 show disagreements and corresponding subjective uncertainties for inflation and real GDP growth in the ECB SPF. In both cases the two variables seem not to be very closely related. Both disagreement measures peaked in the middle of the crisis, which reflects a strong polarization of forecasters' views. The impact of the crisis on disagreement as to output growth was only temporary (although a smaller peak was also observed in the beginning of 2012), but for inflation, the degree of disagreement has stayed steady on a higher level compared 2006 and 2007. We observe that the average levels of subjective uncertainty for both variables have been quite similar. Before 2008 both subjective uncertainty measures decreased moderately, but the crisis seems to have turned the trends upwards. In neither case has the subjective uncertainty yet returned to the pre-crisis level.

Figure 6 shows the median nominal forecast errors for inflation and output growth in the ECB SPF. In the pre-crisis period, euro area inflation was consistently higher than forecasted. For both variables, huge forecast errors occurred in 2008 due to the crisis. Figure 7 illustrates how nominal forecast errors of euro area inflation and output growth are related. There seems to be a clear positive relationship between the two variables, reflecting the fact that inflation and output growth expectations largely follow a Phillips curve relationship[11].

Finally, we report two alternative measures for inflation forecast uncertainty in the US SPF (see Figure 8). Since the standard deviations of point forecasts and subjective uncertainty based on probability distributions are not directly comparable in the US SPF data,

[11] The same result is also reported in Frenkel et al. (2011).

disagreement is proxied here by the standard deviation of expected means constructed from individual probability distributions[12]. Figure 8 shows that disagreement on future price developments increased notably in the middle of the crisis. It also indicates that US inflation uncertainty has decreased somewhat recently (see Clements 2013 for a more detailed analysis of the US data). By contrast, decreasing euro area uncertainty cannot be observed in Figure 5.

3. Analysis of forecast errors

Our empirical analyses were done mainly in a micro data panel setting. We estimated the following model for absolute forecast errors of inflation:

$$|\pi_{t+4} - \pi^{e}_{it,t+4}| = \alpha_0 + \alpha_1\sigma_{\pi it,t+4} + \alpha_2 D_{\pi it} + \alpha_3|\pi_{t+3} - \pi^{e}_{it-1,t+3}| + u_{it}, \qquad (1)$$

where π denotes four-quarter inflation and i the individual forecaster. The inflation forecast is made in period t, and t+4 is the period to which the forecast refers. Thus, the term $\pi^{e}_{it,t+4}$ is the inflation forecast made by individual i in period t for period t+4 and π_{t+4} is the corresponding realized rate of inflation. The term $\sigma_{\pi it,t+4}$ refers to the subjective uncertainty forecaster i experiences as to future inflation in real time (standard deviation constructed from individual probability distribution). The term D is the revision indicator (showing whether or not the forecast value is revised from the previous period) and u is the error term.

It is worth noting that there is always a lag between the date when the survey is conducted and the last available observation of the forecast variable at that time. Inflation is observed with a one-month delay and real GDP growth with a two-quarter delay. The observation lag is taken into account in constructing forecast errors. However, it is omitted from equation (1) in order to keep the notation simple[13]. In essence, we get two values for each inflation and output growth forecast: the point forecast and the expected mean from the probability distributions. On the average, these values are practically the same in the ECB SPF data (see Figure 4 in Paloviita and Viren 2013), whereas for the US data there are some differences (see Clements 2010). For the euro area we considered both point forecasts and expected means in our empirical analysis – in qualitative terms the results are the same for these two sets of data but closer scrutiny reveals some nontrivial differences (compare the results for equations 5 and 6 in Table 1 with the results for the other equations). In our analysis we dealt

[12] Due to changing forecast horizons in annual-average over annual-average series, we report here the moving averages.
[13] The observation lags are taken into account in a similar way in Andrade and Le Bihan (2013).

mainly with absolute forecast errors, but some comparative analyses were also done for nominal forecast errors. In some panel estimations fixed cross-section effects were used. We also tested the impact of disagreement between forecasters on forecast errors. In this case we used aggregated data (mean values over individual forecasters). Equation (1) was applied to the euro area and US forecast errors for inflation. It was also applied to the euro area forecast errors of real GDP growth[14].

4. Empirical results

In this section we provide a summary of the empirical findings. The main results for the euro area are presented in Table 1 and for the US in Table 2. In Table 3, we report results for forecast errors. To indicate the persistence of forecast errors, we display a short summary of the autocorrelations functions and some estimates of the frequency of forecast revisions. The main findings can be summarized as follows:

1. Absolute forecast errors are related to subjective forecast uncertainty: forecasters who – at the time of forecasting - are less confident in their point forecasts make larger forecast errors (see the coefficients of the standard deviations σ_g and σ_π in Tables 1 and 2). By contrast, such a relationship does not seem to exist between absolute forecast errors and the disagreement measure. In fact, the relationship seems to be negative rather than positive (see equations 9 and 10 in Table 1)! Our results indicate that forecast uncertainty in a sense predicts future forecast errors. Therefore, real time subjective uncertainty measures are useful in assessing the accuracy of point forecasts (we can make assessments of the width of the confidence limits of point forecasts). One should not, however, generalize this result simply by saying that less confident forecasters are making larger forecast errors on average, because the result reflects both cross-section and time series variation in both variables. If one computes the cross-section correlation coefficients between forecast errors and the subjective uncertainty measure, the values are positive but rather low (0.023 for inflation and 0.109 for output growth, neither being statistically significant) suggesting that on an individual basis subjective uncertainty is not so important that one should infer that confident forecasters are making clearly “better forecasts”[15]. On the other hand, the relationship between average

[14] Actual inflation data is available to 2013Q3 for the euro area and to 2013Q2 for the US. Euro area output growth history has been published up to 2013Q2.
[15] This outcome is consistent with Clements’ (2013) findings.

values (averaged over forecasters) is also rather weak. The coefficients of correlation are 0.08 for output growth and 0.09 for inflation. Thus, the decomposition of the panel estimation result does not provide a clear-cut interpretation of the source of the positive relationship between subjective uncertainty and forecast errors.

2. Absolute forecast errors seem to be persistent: lagged forecast errors explain more than 30 per cent of current period errors. In Tables 1 and 2 the coefficients for the lagged forecast errors are large and significant. The autocorrelation functions for forecast errors (reported in Table 3) confirm that result, although we notice that the autocorrelations die out quite quickly. Table 3 also shows how often the forecast values for period t and t-i are the same (forecast is not revised). These data suggest that roughly 10 per cent of subsequent values are the same (no revision). However, when the time horizon (lag) becomes longer, the share of unchanged forecasts diminishes, although surprisingly slowly[16]. The share of forecasters who do not change either the output growth or inflation forecast appears to be very small (about 2.5 per cent) for the first lag and practically zero for longer time lags.

3. Forecast errors are related to the way forecasts are revised: larger errors are detected where forecasts are revised. This is apparent on the basis of Figures 1 and 2, and is confirmed by the findings in columns 5-8 in Table 1.

4. Forecast errors are related to each other. The correlation between inflation and output growth forecast errors (absolute errors) is 0.33 (0.32). Inflation and output growth (subjective) uncertainties are more strongly correlated: the correlation between disagreement measures is 0.72 and between subjective uncertainty measures 0.80. By contrast, for both variables, correlation between disagreement measure and subjective uncertainty measure is rather small (less than 0.2). It is interesting that absolute forecast errors are also related to nominal errors (see e.g. equations 17 and 18 in Table 1). Thus, absolute forecast errors of inflation seem to increase when output growth exceeds the forecast value. In other words, positive real GDP growth shocks (unexpectedly high values of output growth) generate larger inflation errors than do negative GDP growth shocks.

5. Results for the euro area and the United States are very similar, at least in the sense that in both cases (inflation) forecast errors are positively related to subjective uncertainty.

[16] Forecast revisions are based on the formula $g^e_t - g^e_{t-i}$. If for example, output growth forecasts are 3.0, 3.5 and 3.0 in three subsequent periods, the formula indicates that there is no forecast revision between the first and last period, which is actually not the case.

Moreover, and forecast errors are quite persistent. The empirical findings are quite similar in the ECB SPF and US SPF, although the results are not directly comparable due to differences in sample periods, forecast horizons and structures of probability distributions. Nominal forecast errors in the US SPF data seem to be more persistent than in the ECB SPF data, but with absolute forecast errors only minor differences between the two surveys can be detected.

5. Conclusions

Using micro level survey data from the ECB SPF and US SPF, this paper studies the link between forecast uncertainty and subsequent forecast errors. Forecast uncertainty is measured using two alternative proxies: disagreement (standard deviation of point forecasts) and subjective uncertainties based on probability distributions. Overall, our analyses confirm the findings by Bowles et al. (2010), Conflitti (2011) and Rich et al. (2012), who argue that subjective uncertainty is a better proxy for forecast uncertainty than disagreement.

We provide new evidence that there are some similar features in forecast errors and subjective uncertainties of different forecast variables. We also find that subjective measures of forecast uncertainty contain relevant information about individual forecasters' confidence in real time. Thus, subjective uncertainty is useful in assessing the accuracy of point forecasts. Increasing uncertainty at the time of forecasting seems to anticipate increasing forecast errors. Therefore, increasing forecast uncertainty should show up in larger confidence intervals for mean predictions. Such a finding would obviously be of some importance from the point of view of Brainard uncertainty and the choice of policy instruments under uncertainty (cf. Brainard 1967 and Dennis 2005).

Thus far, we know relatively little of the sources of forecast uncertainty: are the sources in the data, data revisions, economic policies or political issues, to mention the most obvious candidates. Of course, it may be that these changes reflect irrational patterns – perhaps some herding behavior. The big issue is whether uncertainty can be somehow affected by economic policies. Clearly, more analysis of survey data is required.

References

Andrade, P. and Le Bihan, H. (2013) Inattentive professional forecasters, *Journal of Monetary Economics, 60(8), 967-982.*

Bloom, N. (2009) The Impact of Uncertainty Shocks. *Econometrica* 77, 623-685.

Boero, G., Smith, J. and Wallis, K. F. (2008) Uncertainty and Disaggreement in Economic Prediction: The Bank of England Survey of External Forecasters, *The Economic Journal*, 118 (July), 1107-1127.

Bowles, C., Friz, R., Genre, V., Kenny, G., Meyler, A. and Rautanen, T. (2007) The ECB Survey of Prefessional Forecasters: A Review after Eight Years‟ Experience, *ECB Occasional Paper* 58.

Bowles, C., Friz, R., Genre, V., Kenny, G., Meyler, A. and Rautanen, T. (2010) An Evaluation of the Growth and Unemployment Forecasts in the ECB Survey of Professional Forecasters, *OECD Journal: Journal of Business Cycle Measurement and Analysis*, Vol. 2.

Brainard, W. (1967) Uncertainty and the Effectiveness of Monetary Policy. *American Economic Review* 57(2), 411-425.

Clements, M. P. (2010) Explanations of the inconsistencies in survey respondents' forecasts, *European Economic Review* 54, 536-549.

Clements, M. P. (2013) Forecast Uncertainty – Ex Ante and Ex Post: US Inflation and Output Growth, Forthcoming in *Journal of Business & Economic Statistics.*

Conflitti, C. (2011) Measuring Uncertainty and Disaggreement in the European Survey of Professional Forecasters, *OECD Journal: Journal of Business Cycle Measurement and Analysis*, Vol. 2.

Croushore, D. (1992) Introducing the Survey of Professional Forecasters, *Federal Bank of Philadelphia Business Review* (November/December), 3-13.

Dennis, R. (2005) Uncertainty and Monetary Policy. *FRBSF Economic Letter*, 2005-33,

Dräger, L. and Lamla, M. J. (2012) Updating inflation expectations: Evidence from micro-data, *Economics Letters* 117, 807-810.

Frenkel, M., Lis, E. M. and Rülke, J.-C. (2011) Has the economic crisis of 2007-2009 changed the expectation formation process in the Euro area? *Economic Modelling* 28, 1808-1814.

Hartmann, M. and Herwartz, H. (2012) Causal relations between inflation and inflation uncertainty – Cross-sectional evidende in favour of the Friedman-Ball hypothesis, *Economics Letters, 115, 144-147*.

Kenny, G., Kostka, T. and Masera, F. (2012) How informative are the subjective density forecasts of macroeconomists? *ECB Working Paper*, 1446.

Paloviita, M. and Viren, M. (2013), What's behind the survey values? An analysis of individual forecasters' behavior Forthcoming in *Journal of Business Cycle Measurement and Analysis.*

Patton, A. J. and Timmermann A. (2010) Why do forecasters disagree? Lessons from the term structure of cross-sectional dispersion, *Journal of Monetary Economics* 57, 803-820.

Pesaran, M. H. and Weale, M. (2006), Survey Expectations, Chapter 14 in *Handbook in Economic Forecasting*, ed. Elliot, G, ed. Granger, C. W. J and ed. Timmermann, A., Elsevier.

Rich, R. and Tracy, J. (2010) The Relationships among Expected Inflation, Disagreement, and Uncertainty: Evidence from Matched Point and Density Forecasts, *The Review of Economics and Statistics, 92(1), 200-207.*

Rich, R., Song, J. and Tracy, J. (2012) The Measurement and Behavior of Uncertainty: Evidence from the ECB Survey of Professional Forecasters, *Federal Reserve Bank of New York Staff Reports 588.*

Sill, K. (2012) Measuring Economic Uncertainty Using the Survey of Professional Forecasters. Business Review of Philadelphia FED, Q4/2012, 16-27.

Sinclair, P. (2010) Inflation Expectations ed. Peter J. N. Sinclair, Routledge *International Studies in Money and Banking, London.*

Table 1 Estimates with the ECB SPF data

	1	2	3	4	5	6	7	8	9	10
	$\|g-g^e\|$	**$\|\pi-\pi^e\|$**	**$\|g-g^e\|$**	**$\|\pi-\pi^e\|$**	**$\|g-g^{ex}\|$**	**$\|\pi-\pi^{ex}\|$**	**$\|g-g^e\|$**	**$\|\pi-\pi^e\|$**	**$\|g-g^e\|$**	**$\|\pi-\pi^e\|$**
constant	1.100	.636	1.050	.629	.910	.551	.899	.599	1.483	.702
	(23.02)	(24.11)	(15.12)	(17.40	(10.83)	(13.46)	(9.66)	(16.03)	(3.34)	(2.00)
σ_g	.205		.308		.199		.140			
	(2.36)		(1.29)		(2.12)		(1.46)			
σ_π		.111		.125		.120		.089		
		(2.21)		(1.74)		(2.21)		(2.81)		
g^e disagreement									-2.227	
									(2.81)	
π^e disagreement										-.1.118
										(1.34)
$D(g^e \neq 0)$					.079		.298			
					(2.31)		(3.88)			
$D(\pi^e \neq 0)$						.079		.061		
						(2.41)		(2.01)		
D(g=0)									-3.401	
									(2.48)	
$D(\pi=0)$										-.610
										(0.80)
lagged dep.var.									.781	.603
									(5.86)	(6.22)
Fixed effects	no	no	FE	FE	no	no	no	no	single series	single series
R^2	0.002	0.003	0.050	0.065	0.004	0.005	0.008	0.003	0.611	0.353
SEE	1.162	0.540	1.175	0.533	1.147	0.541	1.135	0.541	0.733	0.419
DW	0.59	0.87	0.62	0.93	0.57	0.84	0.60	0.83	1.44	1.84

Superscript *e* denotes point forecast and *ex* expected means computed from probability distributions. Numbers inside parentheses are corrected t-values. *FE* denotes fixed cross-section effects. "*Single series*" refers to the mean value of individual forecasters' expectations. All estimates are OLS estimates. Inflation is measured using the harmonized index of consumer prices. The number of observations is 2468.

Table 1 continued

	11 $g-g^e$	12 $\lvert g-g^e \rvert$	13 $\lvert g-g^e \rvert$	14 $\pi-\pi^e$	15 $\lvert \pi-\pi^e \rvert$	16 $\lvert \pi-\pi^e \rvert$	17 $\lvert \pi-\pi^e \rvert$	18 $\lvert \pi-\pi^e \rvert$	19 $\lvert \pi-\pi^e \rvert$
constant	-.410	.530	.498	.410	.410	.415	.505	.508	.309
	(4.52)	(9.22)	(6.59)	(12.88)	(15.21)	(11.18)	(18.29)	(13.76)	(7.65)
σ_g	-.605	.100	.172						
	(3.84)	(1.21)	(1.41)						
σ_π				.057	.082	.085	.043	.030	-.086
				(0.94)	(1.81)	(1.24)	(0.95)	(0.49)	(1.26)
$\lvert g-g^e \rvert$					.197	.191	.111	.105	.101
					(17.64)	(16.49)	(10.27)	(9.42)	(9.17)
$\lvert \pi-\pi^e \rvert$		.914	.906						
		(11.86)	(11.55)						
$g-g^e$				.269			.095	.096	.041
				(23.80)			(13.90)	(13.74	(5.95)
$\pi-\pi^e$	1.172								
	(22.89)								
lagged dep.var.									.426
									(15.69)
Fixed effects	no	no	FE	no	no	FE	no	FE	FE
R^2	0.356	0.183	0.217	0.311	0.181	0.230	0.231	0.279	0.420
SEE	1.354	1.053	1.105	0.660	0.491	0.485	0.476	0.496	0.423
DW	0.43	0.71	0.73	0.57	0.98	1.05	1.03	1.09	1.72

Table 2 Estimates with the US SPF data

	1	2	3	4	5	6
	$\|\pi-\pi^e\|$	$\|\pi-\pi^e\|$	$\|\pi-\pi^e\|$	$\|\pi-\pi^e\|$	$\|\pi-\pi^e\|$	$\|\pi-\pi^e\|$
constant	.588	.689	.699	.345	.386	.269
	(18.11)	(17.77)	(16.81)	(18.97)	(20.70)	(1.93)
σ_π	.187	.060	.174			
	(4.50)	(1.30)	(4.27)			
g			-.028			
			(3.91)			
π^e						-.102
disagreement						(0.374)
$\|\pi-\pi^e\|_{-1}$				.520	.464	.676
				(1932)	(17.52)	(8.07)
Fixed effects	no	FE	no	no	no	single series
R^2	0.011	0.128	0.021	0.262	0.314	0.456
SEE	0.552	0.533	0.550	0.473	0.470	0.318
DW	0.98	1.10	0.99	1.98	2.02	1.49

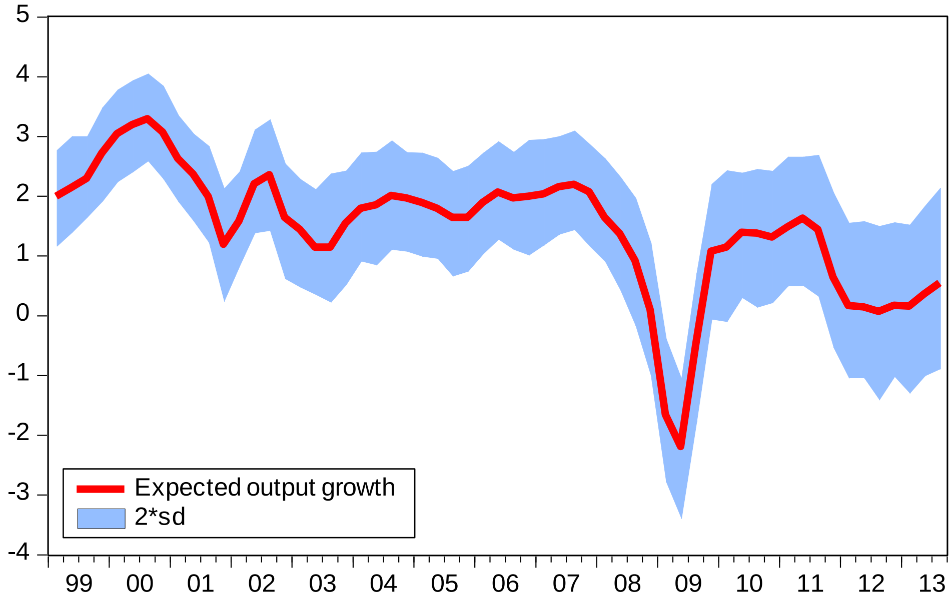
Notation is the same as in Table 1. US inflation is measured by the GDP price index and the number of observations is 2951.

Table 3 Persistence of point forecasts

	1	2	3	4	5	6	7	8	9
dep var →	**$g-g^e$**	$\|g-g^e\|$	**$\pi-\pi^e$**	$\|\pi-\pi^e\|$	**$\pi-\pi^e_{US}$**	**$\|\pi-\pi^e\|_{US}$**	**$\Delta_i g^e=0$**	**$\Delta_i\pi^e=0$**	$\Delta_i g^e$&
lag i↓									**$\Delta_i\pi^e=0$**
1	.674	.566	.574	.426	.886	.672	10.90	12.40	2.74
2	.398	.222	.264	.213	.719	.246	5.51	12.36	0.65
3	.166	.050	.012	.102	.549	-.069	4.96	10.49	0.80
4	-.021	-. 038	-.205	.042	.374	-.176	4.63	10.69	0.64
data	**acf**	**acf**	**acf**	**acf**	**acf**	**acf**	**share**	**share**	**share**

acf denotes autocorrelation coefficient for (nominal or absolute) forecast error with different time lags i. The *shares* are percentage shares of unchanged forecasts (no revisions) for different lag lengths i. The data are for the ECB SPF except for columns 6 and 7, where the US SPF data are used.

Figure 1 Average point forecasts for real GDP growth and inflation in the ECB SPF



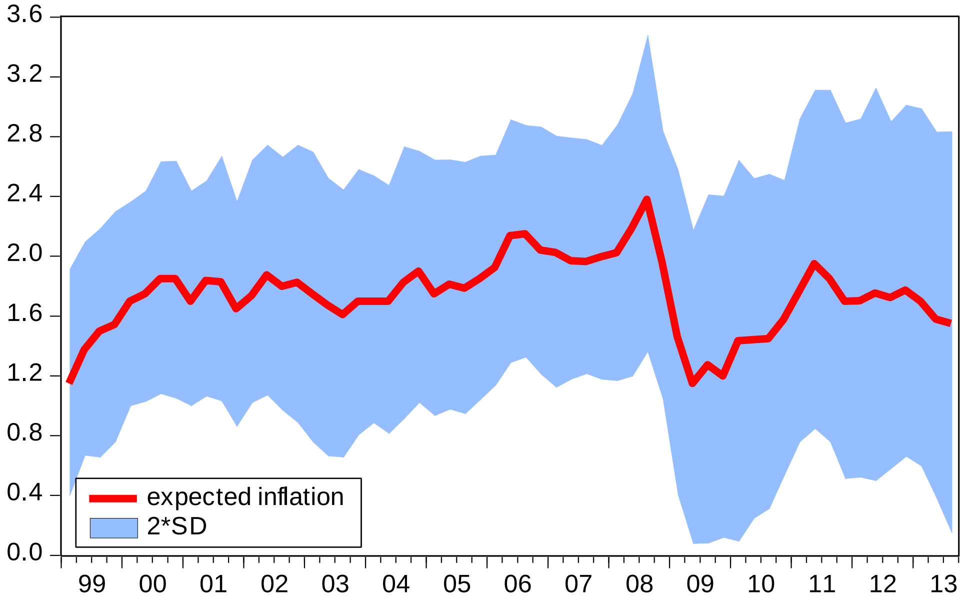
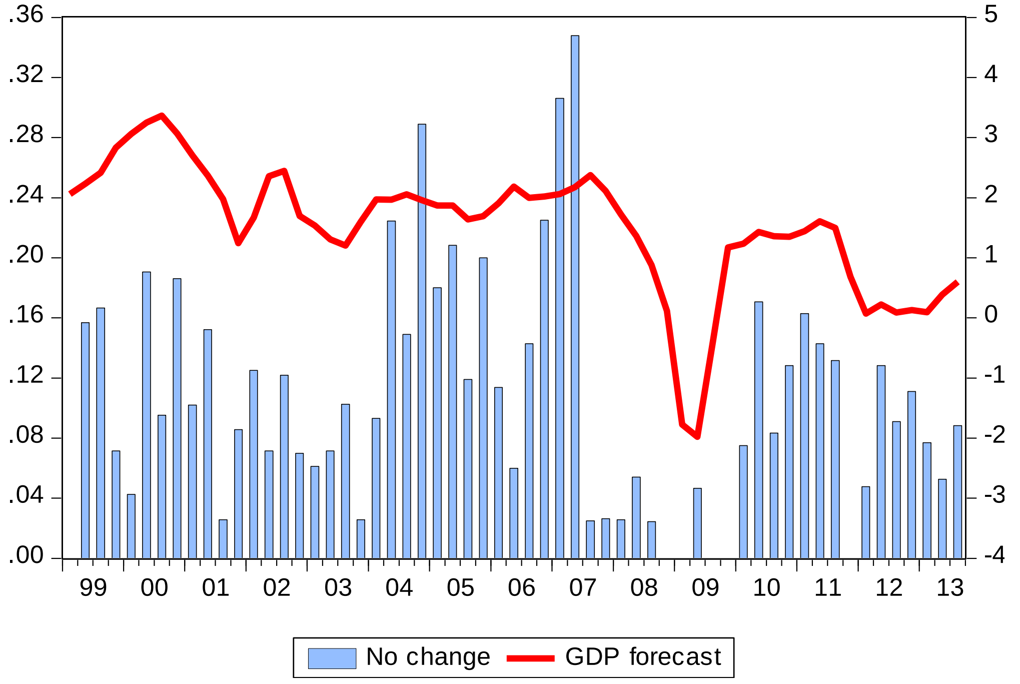


Figure 2. Shares of forecast revisions in the ECB SPF



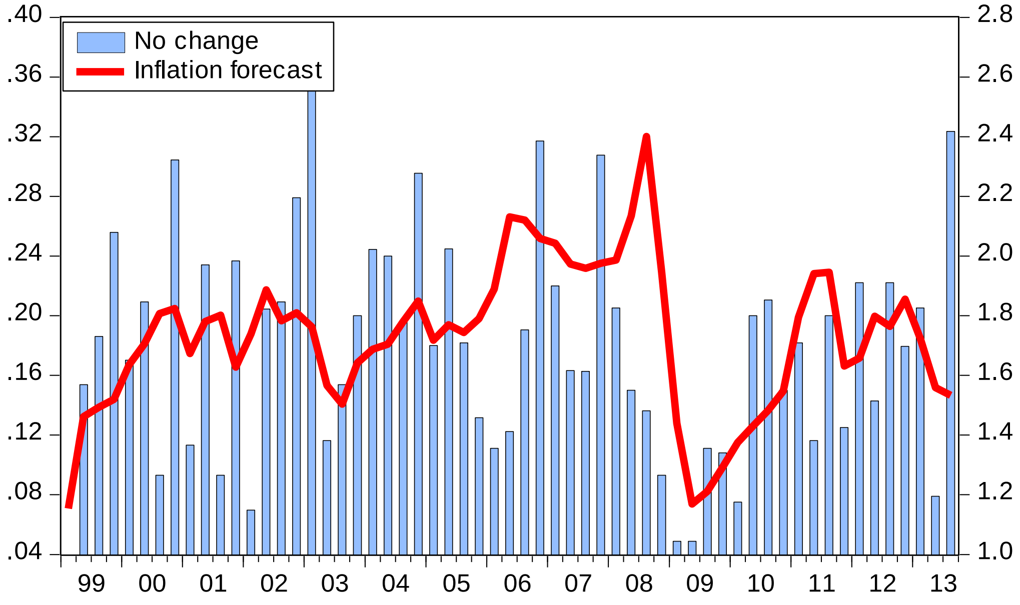
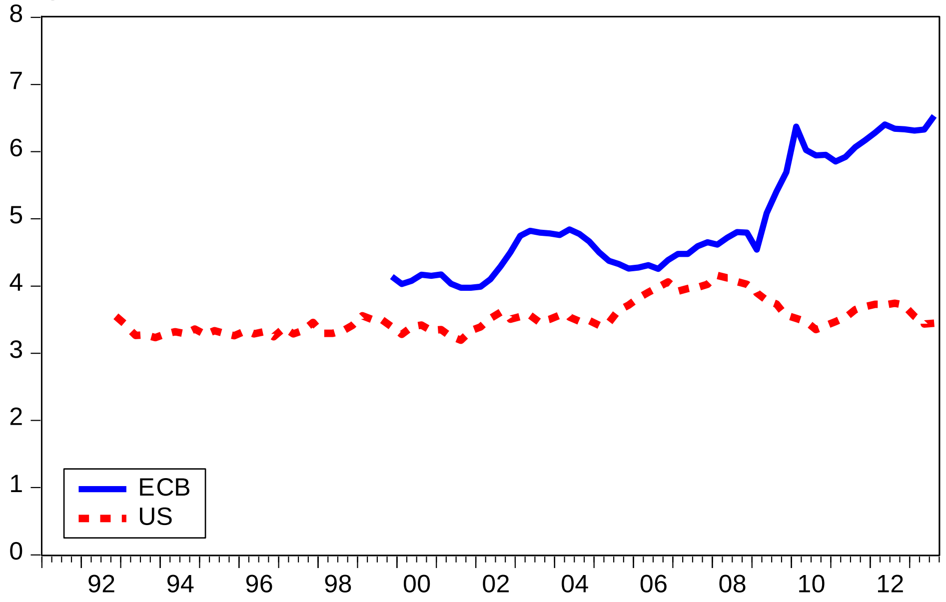


Figure 3 Numbers of non-zero bins in ECB SPF and US SPF



The US series is constructed using four-quarter moving averages.

Figure 4 Comparison output growth uncertainty measures in the ECB SPF

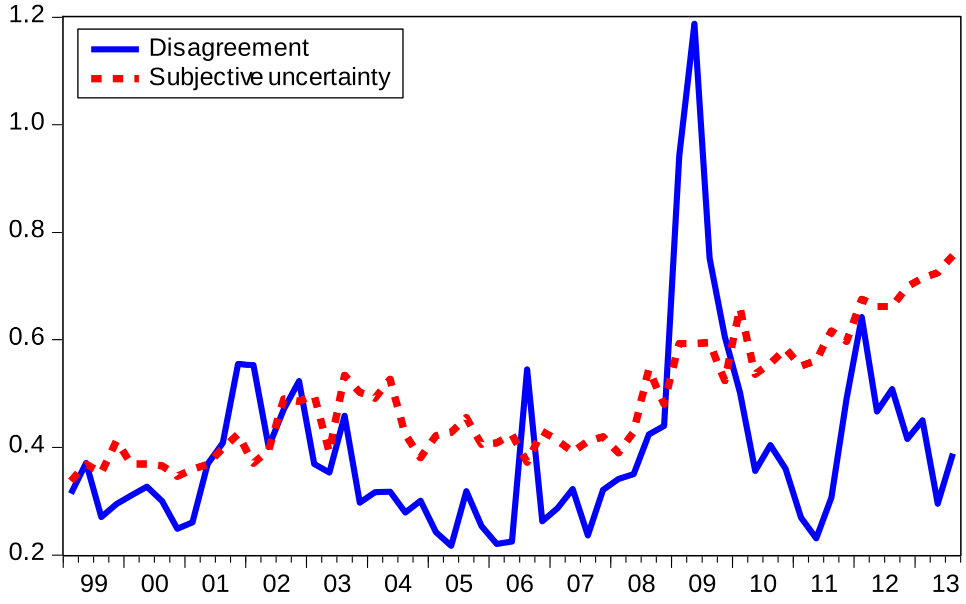


Figure 5 Comparison inflation uncertainty measures in the ECB SPF

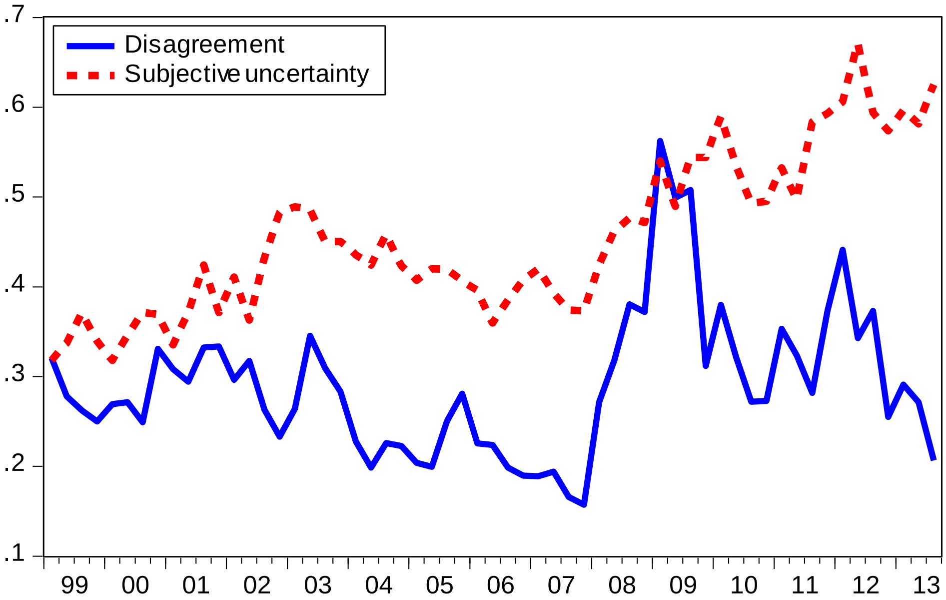


Figure 6 Nominal forecast errors for inflation and output growth in the ECB SPF

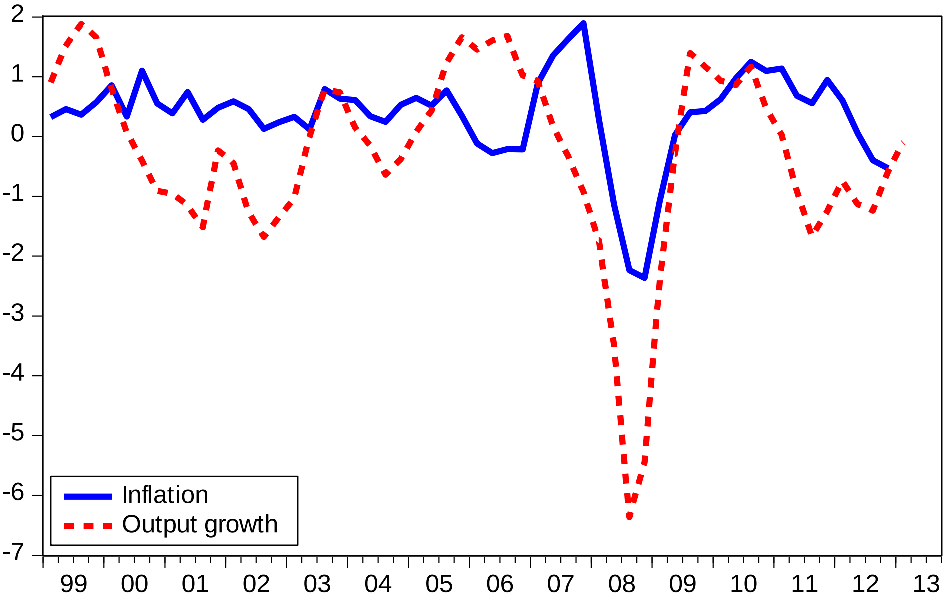


Figure 7 Relationship between nominal forecast errors for output growth and inflation in ECB SPF

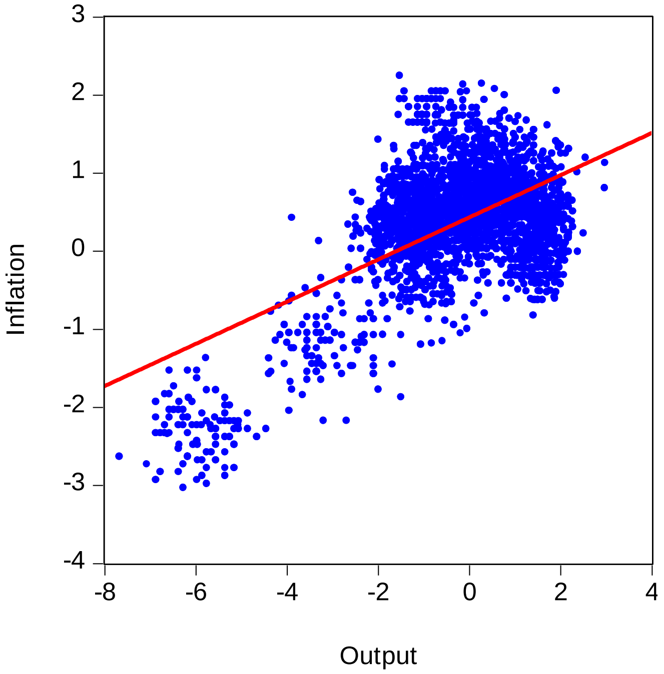
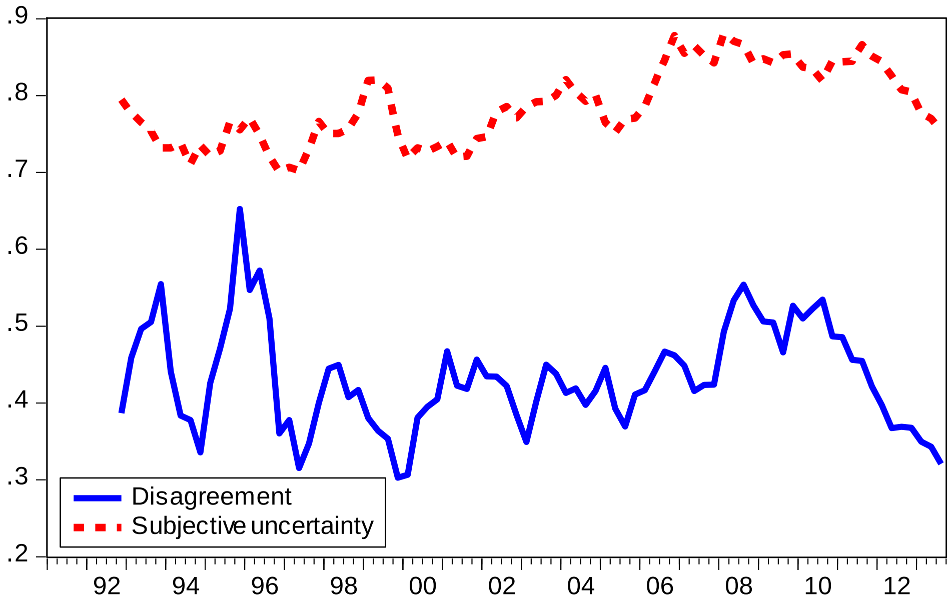


Figure 8 Comparison of inflation uncertainty measures in the US SPF



BANK OF FINLAND RESEARCH DISCUSSION PAPERS

ISSN 1456-6184, online

1/2014 Bill Francis – Iftekhar Hasan – Jong Chool Park – Qiang Wu **Gender differences in financial reporting decision-making: Evidence from accounting conservatism.** 2014. 58 p. ISBN 978-952-6699-63-9, online.

2/2014 Esa Jokivuolle – Jussi Keppo **Bankers' compensation: Sprint swimming in short bonus pools?** 2014. 40 p. ISBN 978-952-6699-64-6, online.

3/2014 Iftekhar Hasan – Chun-Keung (Stan) Hoi – Qiang Wu – Hao Zhang **Beauty is in the eye of the beholder: The effect of corporate tax avoidance on the cost of bank loans.** 2014. 67 p. ISBN 978-952-6699-65-3, online.

4/2014 Kaushik Mitra – Seppo Honkapohja **Targeting nominal GDP or prices: Guidance and expectation dynamics.** 2014. 47 p. ISBN 978-952-6699-66-0, online.

5/2014 Hendrik Hakenes – Iftekhar Hasan – Phil Molyneux – Ru Xie **Small banks and local economic development.** 2014. 49 p. ISBN 978-952-6699-69-1, online.

6/2014 Esa Jokivuolle – Jarmo Pesola – Matti Virén **What drives loan losses in Europe?** 2014. 27 p. ISBN 978-952-6699-70-7, online.

7/2014 Taneli Mäkinen – Björn Ohl **Information acquisition and learning from prices over the business cycle.** 2014. 38 p. ISBN 978-952-6699-71-4, online.

8/2014 Maritta Paloviita – Matti Virén **Analysis of forecast errors in micro-level survey data.** 2014. 20 p. ISBN 978-952-6699-74-5, online.

http://www.suomenpankki.fi/en • email: Research@bof.fi
ISBN 978-952-6699-74-5, ISSN 1456-6184, online