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# Analysis of aggregated inflation expectations based on the ECB SPF survey



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## Analysis of aggregated inflation expectations based on the ECB SPF survey

### Abstract

This paper examines aggregated inflation expectations based on the ECB Survey of Professional Forecasters (ECB SPF). We analyse possible impacts of changing panel composition on short and long term point forecasts and forecast uncertainties using approach, which is based on a set of sub-panels of fixed composition. Our results indicate that the unbalanced panel data do not cause systematic distortions to aggregated survey information. However, micro level analysis of expectations would also be useful, especially in times of wide disagreement across forecasters and high levels of inflation uncertainty.

Key words: Survey data, Expectations, Changing panel composition

JEL Classification: C53, E37, E31

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## 1 Introduction

Survey information has been widely used in empirical analysis of inflation expectations (see Pesaran and Weale 2006 and Sinclair 2010 and references therein). Analysis of the central tendency of expectations (mean or median) is usually based on unbalanced panel data. Typically, the panel composition changes over time, since not all forecasters will participate in the survey regularly and they do not necessarily reply to all survey questions.<sup>3</sup> If expectations are very heterogeneous and sample size is relatively small, it is possible that changes in aggregated forecasts will partly reflect changes in panel composition. The impact of outliers on mean expectations may also be non-negligible.

Since the start of 1999 the European Central Bank has conducted a quarterly Survey of Professional Forecasters (ECB SPF). Participants in this survey are experts in financial or non-financial institutions in the European Union. In addition to economic analysis and empirical research, the ECB SPF survey plays a central role in the euro area monetary policy. The survey summarizes professional forecasters' views about euro area inflation, real GDP growth and unemployment in many different forecast horizons. Also information related to forecast uncertainty is reported. The survey results are regularly reported in the ECB Monthly Bulletin.<sup>4</sup>

This paper analyses inflation expectations based on the ECB Survey of Professional Forecasters (ECB SPF). We examine aggregated point forecasts and forecast uncertainties that are based on subjective probability distributions. The focus of the analysis is on possible impacts of changing panel composition on aggregated expectations. Following the Engelberg et al. (2011) approach, which is based on a set of sub-panels of fixed composition, we investigate aggregated forecasts revisions. We also construct lower and upper bounds around aggregated forecast revisions. Engelberg et al. (2011) have examined the US SPF survey data, but to our knowledge their approach has not been applied to the ECB SPF survey before.<sup>5</sup> For comparison, we also consider aggregated expectations based on balanced panel data.

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<sup>3</sup> In some surveys there is a rotating panel design (in every survey round some forecasters are being re-surveyed and the others are participating for the first time).

<sup>4</sup> See e.g. "Fifteen years of the ECB Survey of Professional Forecasters" in the ECB Monthly Bulletin in January 2014 and "Results of the ECB Survey of Professional Forecasters for the fourth quarter of 2013" in the ECB Monthly Bulletin in November 2013.

<sup>5</sup> Before Engelberg et al. (2011), Stark (2004) paid attention to changing panel composition in the US SPF survey.

Our analyses indicate that the unbalanced panel data does not cause systematic distortions to aggregated survey information. Even during the financial crisis and in the case of long term expectations (with relatively few survey responses), aggregates based on the unbalanced panel data are reasonable proxies of professional expectations. However, micro level analysis of expectations would also be useful, especially in times of wide disagreement across forecasters and high levels of inflation uncertainty.

The paper proceeds as follows. The ECB SPF and the history of aggregated inflation expectations are summarised in section 2. Empirical analyses are reported in section 3, and conclusions are drawn in section 4.

## **2 The ECB Survey of Professional Forecasters**

Since the beginning of 1999, the ECB has conducted the Survey of Professional Forecasters (ECB SPF) on a quarterly basis.<sup>6</sup> The ECB SPF provides micro level point forecasts of HICP inflation, which is defined as the year-on-year percentage change in the Harmonised Index of Consumer Prices (HICP). Six different forecast horizons are surveyed. The ECB SPF also includes corresponding subjective probability distributions, which indicate how individual experts assess the probability of the future inflation outcome being within the pre-determined ranges (bins).<sup>7,8</sup> Disagreement (standard deviation of point forecasts) reflects dispersion of inflation views, and standard deviations of subjective probability distributions measure micro level confidence associated with individual expectations at the time i.e. individual uncertainty.

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<sup>6</sup> Data source: <http://www.ecb.europa.eu/stats/prices/indic/forecast/html/index.en.html>. The ECB SPF is described in detail in Bowles et al. (2007). See <http://www.ecb.europa.eu/stats/pdf/spfquestionnaire.pdf?a9c65f6e4b965a8832693dcb0aebff66> for a survey questionnaire in January 2013 and [http://www.ecb.europa.eu/stats/prices/indic/forecast/shared/files/dataset\\_documentation\\_csv.pdf?76c07dc372dffabc3fec09d8cefbf682](http://www.ecb.europa.eu/stats/prices/indic/forecast/shared/files/dataset_documentation_csv.pdf?76c07dc372dffabc3fec09d8cefbf682) for a description of the ECB SPF data set.

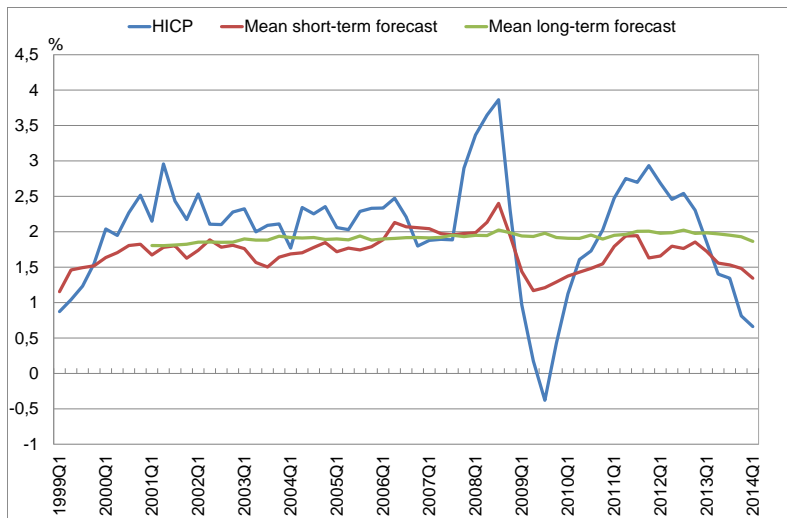
<sup>7</sup> The ECB SPF survey also includes real GDP growth and unemployment rate forecasts. Fixed event forecasts refer to a certain calendar year (for example, the current or next calendar year) and fixed horizon forecast to a certain time period (for example, four quarters ahead). The ECB SPF also reports individual forecast assumptions: ECB's interest rate (main refinancing operations), Brent crude oil prices in US dollars, USD/EUR exchange rate and labour costs (annual rate of change in whole-economy compensation per employee). The probability distributions are open-ended on both sides.

<sup>8</sup> We can construct the average expected mean based on probability distributions. First we calculate the expected mean for each forecaster and then calculate the average across all forecasters. It has been shown that in the ECB SPF the mean inflation forecasts and the corresponding average expected means based on probability distributions are virtually identical (see Paloviita and Virén 2014a).

The ECB SPF panel data have been analysed on the micro level in many recent studies. For example, Bowles et al. (2010) find that the ECB SPF forecast errors are very persistent and that disagreement is not a good proxy for macroeconomic uncertainty. Conflitti (2012) argues that uncertainty and disagreement are higher for GDP and unemployment than for inflation. Using evaluation predictive densities Kenny et al. (2014) find clear evidence that forecasters are overconfident and that they neglect risks (some forecasters assign a zero probability to many frequent events). According to Rich et al. (2012) forecast uncertainty is countercyclical and uncertainty and levels of inflation and output growth are related. Tsenova (2012) shows that euro area long term inflation expectations are well-anchored, but many individual forecasts are considerably below trend inflation. Andrade and Le Bihan (2013) report that forecasters fail to systematically update their forecasts and they disagree when updating. Paloviita and Virén (2014a) show that individual forecasters' price and real GDP expectations are positively related but forecasters disagree systematically with each other. They also find that inflation and output uncertainties based on probability distributions are closely related at the micro level. According to Paloviita and Virén (2014b), inflation uncertainty has a negative impact on economic activity.

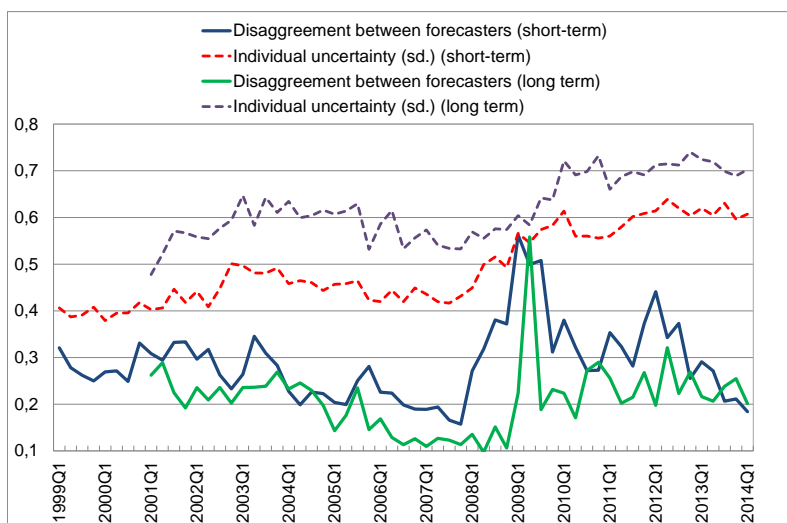
## **2.1 Evolution of aggregated expectations**

We analyse short and long term inflation expectations in 1999Q1-2014Q1. Short term expectations refer to rolling forecasts for one year ahead. Strictly speaking, it is a rolling forecast for the month one year ahead of the latest available inflation rate at the time when the survey is conducted. Long term expectations refer to inflation forecasts four calendar years ahead in the Q1 and Q2 rounds and five calendar years ahead in the Q3 and Q4 rounds. Figure 1 shows the inflation history and the average short term and long term expectations (dated according to publication of the survey). It clearly shows that since 2008 euro area inflation has been very volatile compared to earlier years. It also indicates that there has been more variation in the short term than long term expectations.



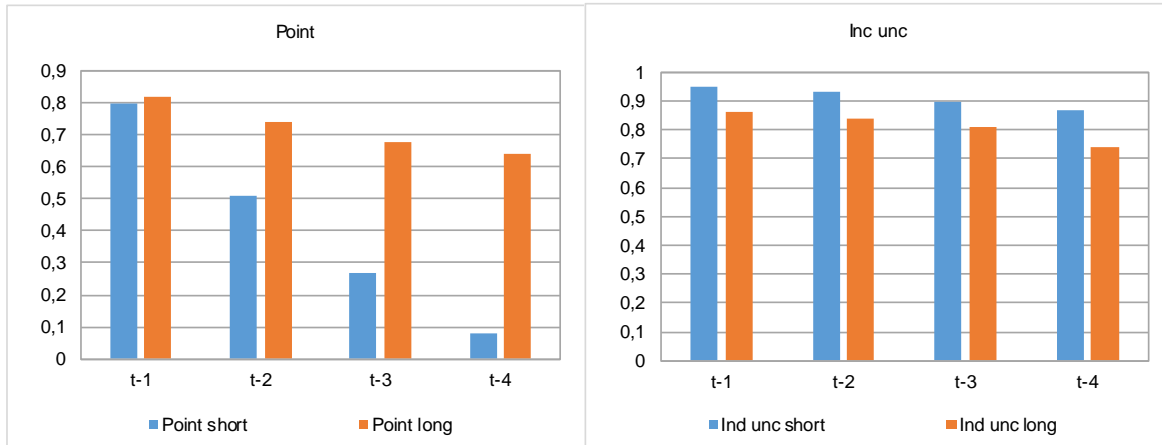
**Figure 1.** Inflation history and average short and long term inflation expectations

Figure 2 shows forecast disagreements and the average individual uncertainties for short and long term inflation expectations. It is clear that forecast dispersion increased temporarily to a very high level in 2009 (and also in 2012) compared to the pre-crisis years, but in both cases the increase in uncertainty has been more permanent since the onset of the financial crisis.



**Figure 2.** Short and long term forecast disagreement and average individual uncertainty

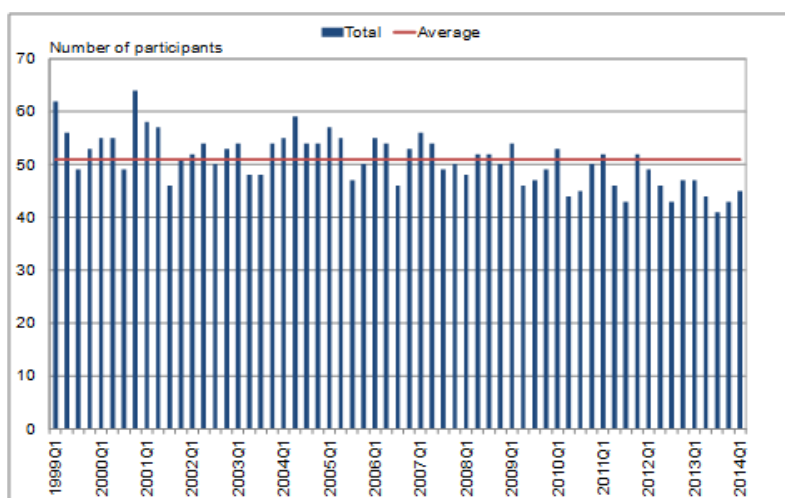
Next, we consider persistence of expectations by exploring how aggregated point forecasts and individual uncertainties relate to their own histories. In figure 3 we consider how the average short/long term point forecasts and individual uncertainties surveyed in the current period are correlated with their own lags surveyed in previous periods.



**Figure 3.** Correlation coefficients

It is quite clear that both short and long term point expectations in period  $t$  are highly correlated with expectations in period  $t-1$ , but only long term expectations are highly correlated with the other lags. Inflation uncertainties are very persistent. Comparison shows that in all cases serial correlations are somewhat higher for short term than long term inflation uncertainty.

Since 1999 total of 113 professional forecasters have participated in the ECB SPF. On average, 52 survey respondents have forecasted euro area inflation for the short term (Figure 4). The sample size is relatively small, but still larger than in many other corresponding surveys (around 40 in the US SPF and 20-30 in the Bank of England SPF). There has been some seasonal variation in survey participation, since the number of forecasters has been slightly lower in the third than in other quarters due to the holiday season. The crisis seems to have reduced the number of forecasters somewhat.



**Figure 4.** Number of forecasters (short-term inflation forecasts)

### 3 How does changing panel composition affect aggregated expectations?

Aggregated expectations presented in section 2 were constructed using all survey responses without paying any attention to changing panel composition. It is worth noting that the constantly changing panel composition means that changes in average forecasts based on the unbalanced panel data are potentially problematic. In order to measure the evolution of aggregated expectations properly, survey respondents must represent the whole forecaster population reliably in every survey period and non-responses must be completely random, i.e. statistically independent of forecasters' inflation views (forecasters join and leave the survey at random). If survey participants are not randomly picked from the forecaster population, there is a risk that changes in aggregated forecasts reflect partly changing panel composition. Due to the smaller number of survey responses, panel changes are potentially more problematic in the case of long term expectations in the ECB SPF.<sup>9</sup>

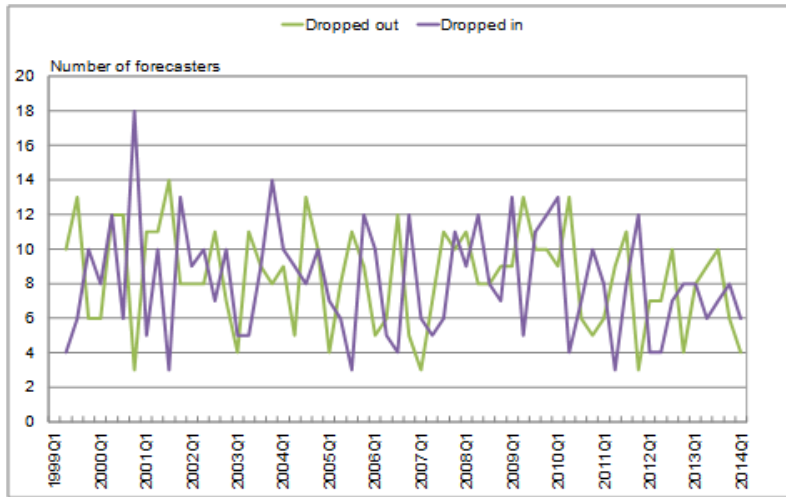
Figure 4 indicates that the number of survey participants has varied over time, but it is not informative with respect to changing panel composition. If the number of forecasters is unchanged between two quarters, it need not necessarily mean that exactly the same experts participate in the survey in both periods. This can be seen in Figure 5 where Dropped in -series refers to the number of forecasters who joined the survey and Dropped out –series to the number of forecasters who left the survey in each period compared to the previous period.<sup>10</sup> It is clear that there has been quite a lot of changes in panel composition over time (on average, 8 forecasters have joined and 8 forecasters left the survey). Therefore, we need to pay attention to possible impacts of changing panel composition on aggregated expectations.

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<sup>9</sup> The ECB has recently paid attention to the impact of changing panel composition and large outliers on aggregated long term inflation expectations (see “Results of the ECB Survey of Professional Forecasters for the third quarter of 2014” in the ECB Monthly Bulletin in August 2014).

<sup>10</sup> Figure 4 illustrates changing panel composition in short term point forecasts.





**Figure 5.** Number of forecasters who join and leave the survey

In this paper we assess the impacts of changing panel composition on aggregated inflation forecasts in three different ways. First, we compare aggregated forecast revisions in two data sets: in the original unbalanced panel data set with changing panel composition and in a set of sub-panels of fixed composition. Then, we construct lower and upper bounds for aggregated forecast revisions which are defined on the basis of the smallest and largest micro level forecast revisions observed in the data. Finally, for comparison, we construct aggregated expectations using balanced panel data.

### 3.1 Aggregated forecast revisions

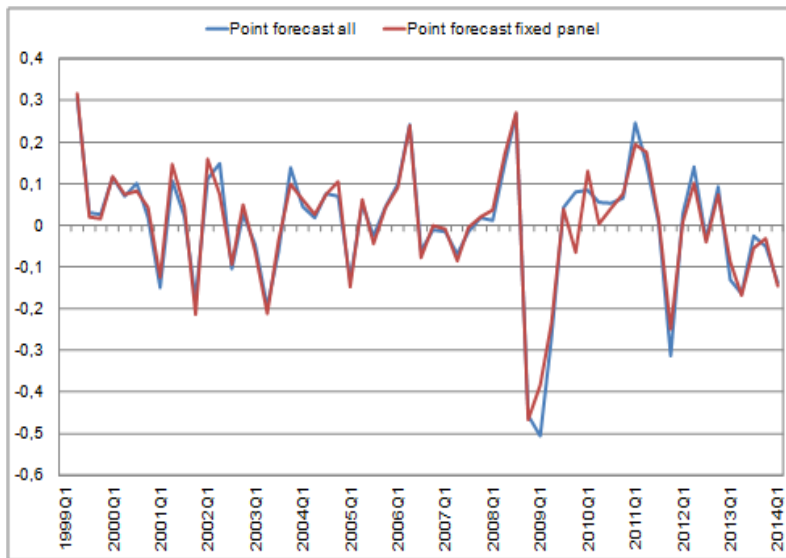
We follow the Engelberg et al. (2011) approach and compare average forecast revisions in two alternative data sets: in the original unbalanced panel data and in the set of separate sub-panels, each of which includes only two quarters (Q1-Q2, Q2-Q3, ...). In the case of the unbalanced panel data, the panel composition varies over time. In the other case, panel composition is fixed, since in every sub-panel only those forecasters who responded to the survey in both periods are considered. If average forecast revisions are not substantially different in the two data sets, we can assess that the averages based on all the survey responses are reliable with respect to changing panel composition.

Next, we present more formally the Engelberg et al. (2011) approach. Let the term  $N_t(1,1)$  denote the group of forecasters who respond to the survey in periods  $t$  and  $t+1$ . Forecasters, who respond to the survey only in period  $t$ , belong to group  $N_t(1,0)$  and forecasters, who participate in the survey only in period  $t+1$ , belong to group  $N_t(0,1)$ . We focus on the *union*

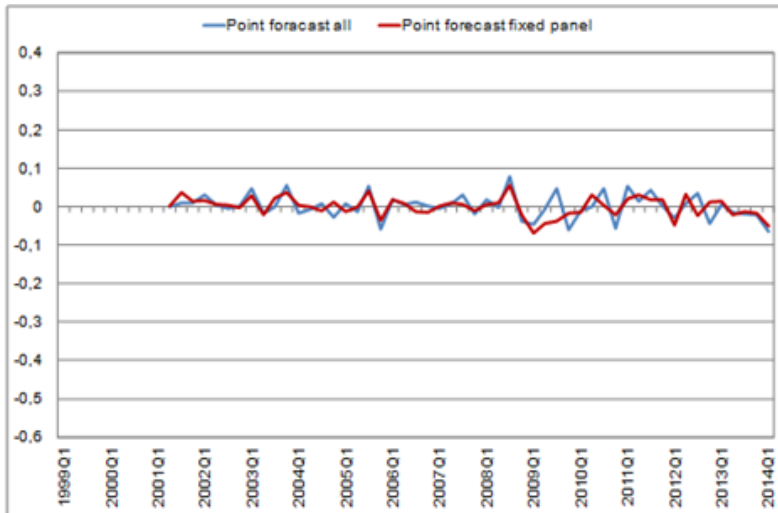
(U) of the forecasters, which is denoted by  $N_{tU} \equiv N_t(1,1) \cup N_t(1,0) \cup N_t(0,1)$ . The symbol  $\exp_{ti}$  refers to expected inflation of forecaster  $i$  in period  $t$ . The survey includes information about  $(\exp_{ti}, \exp_{(t+1)i})$  for  $N(1,1)$ ,  $\exp_{ti}$  for  $N(1,0)$  and  $\exp_{(t+1)i}$  for  $N(0,1)$ .

Here we want to compare average forecast revisions in the *intersection* group of forecasters and in the *composition* group of forecasters. In every sub-sample those experts who responded to the survey in both periods belong to the *intersection* group:  $N_{tI} \equiv N_t(1,1)$ . In this case, the average forecast revision has the form  $\Delta_{tI} \equiv \text{mean}(\exp_{(t+1)} | i \in N_{tI}) - \text{mean}(\exp_t | i \in N_{tI})$ . The *composition* group includes those forecasters who responded to the survey at least in one period in a certain sub-sample. In this case two distinct group of forecasters are compared (panel composition is not fixed) and the average forecast revision is defined as  $\Delta_{tC} \equiv \text{mean}[\exp_{(t+1)} | i \in N_{tI} \cup N(0,1)] - \text{mean}[\exp_t | i \in N_{tI} \cup N(1,0)]$ .

Comparison of the two methods is shown in Figures 6 and 7. Blue lines refer to aggregated forecast revisions based on all survey responses and the red lines to aggregated forecast revisions based on the Engelberg et al. (2011) approach.

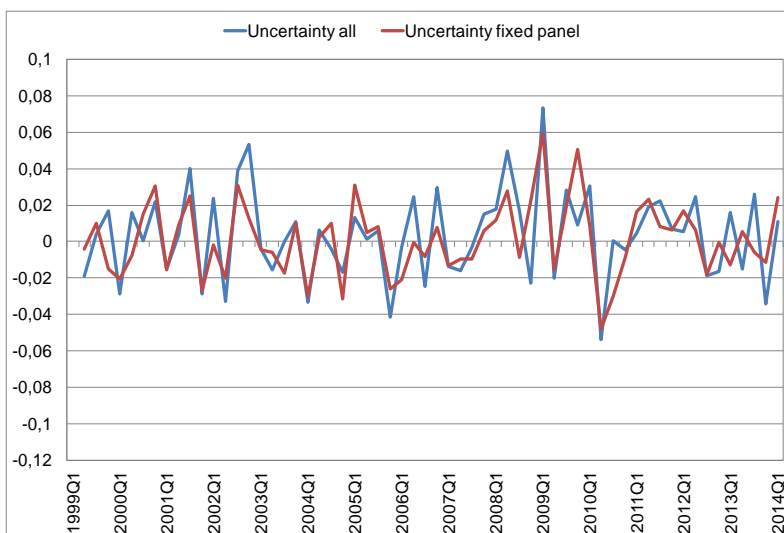


**Figure 6.** Aggregated forecast revisions for short-term inflation

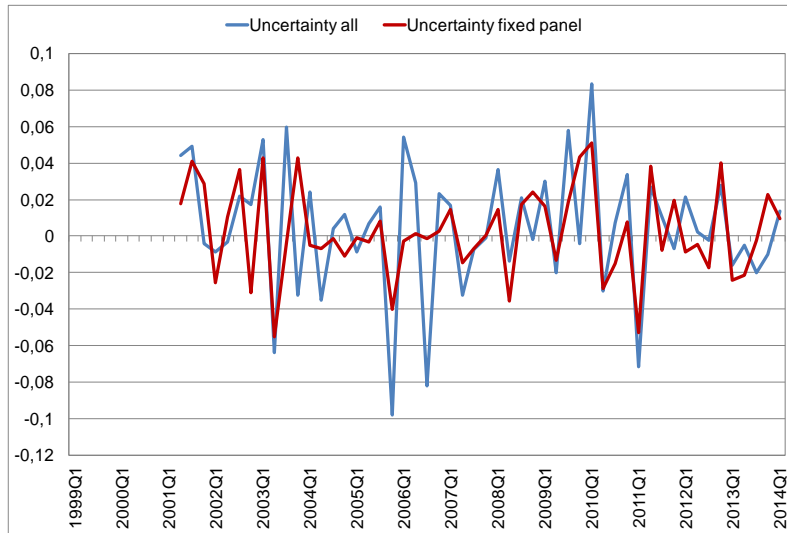


**Figure 7.** Aggregated forecast revisions for long term inflation

According to figures 6 and 7 the alternative methods provide very similar pictures of aggregated forecast revisions over time. Since the difference between the two lines is minor, we provide evidence that the original unbalanced ECB SPF panel data are reliable with respect to changing panel composition. Even during the financial crisis and in the case of long term expectations (with relatively few survey responses) the differences between the series are very small. Also revisions in aggregated inflation uncertainties look very similar, although in the case of long term uncertainty, the unbalanced data seem to be somewhat more volatile (figures 8 and 9).



**Figure 8.** Changes in aggregated short-term inflation uncertainty



**Figure 9.** Changes in aggregated long term inflation uncertainty

All in all, figures 6 – 9 suggest that the unbalanced panel data does not seem to cause any appreciable effects on aggregated forecast revisions. Although forecasters entry and exit the ECB SPF survey quite frequently and extensively, it does not seem to cause systematic distortions to aggregated forecast revisions.

### 3.2 Bounds for aggregated expectations

In this section, we assess the relevance of aggregated information in an alternative manner. Again, we follow Engelberg et al. (2011) and define lower and upper bounds around aggregated forecast revisions by assuming that the unobserved individual forecast changes must lie in some range. Lower and upper bounds for this range are defined on the basis of the smallest and largest micro level forecast revisions observed in the data. Again, the analysis is based on a set of sub-panels consisting of just two periods. In every sub-panel we consider those forecasters who belong to group  $N_i(1,1)$ ,  $N_i(1,0)$  or  $N_i(0,1)$ . The idea is to fill in missing observations for groups  $N_i(1,0)$  and  $N_i(0,1)$  by defining them limits (ranges) on the basis of the most extreme forecast revisions observed for group  $N_i(1,1)$ . In other words, we assume that the unobserved forecast changes for groups  $N_i(1,0)$  and  $N_i(0,1)$  are relatively no larger than the largest observed forecast change for group  $N_i(1,1)$ . We also assume that these changes are never relatively smaller than the smallest observed forecast change for group  $N_i(1,1)$ .

We denote the *union* (U) of the forecasters by  $N_{tU} \equiv N_t(1,1) \cup N_t(1,0) \cup N_t(0,1)$  and the term  $\Delta_{tU} \equiv \text{mean}(\text{exp}_{t+1} | i \in N_{tU}) - \text{mean}(\text{exp}_t | i \in N_{tU})$  refers to the average forecast revision for this

group. The terms  $K_{tL}$  and  $K_{tU}$  refer to the lower and upper bounds of the unobserved forecast revisions between periods  $t$  and  $t+1$ . For group  $N(1,0)$  the bounds can be expressed as

$$\exp_{ti} + K_{tL} \leq \exp_{(t+1)i} \leq \exp_{ti} + K_{tU} \quad (1)$$

and for group  $N(0,1)$  the corresponding formula is

$$\exp_{(t+1)i} - K_{tU} \leq \exp_{ti} \leq \exp_{(t+1)i} - K_{tL} . \quad (2)$$

Lower and upper bounds are defined as follows:

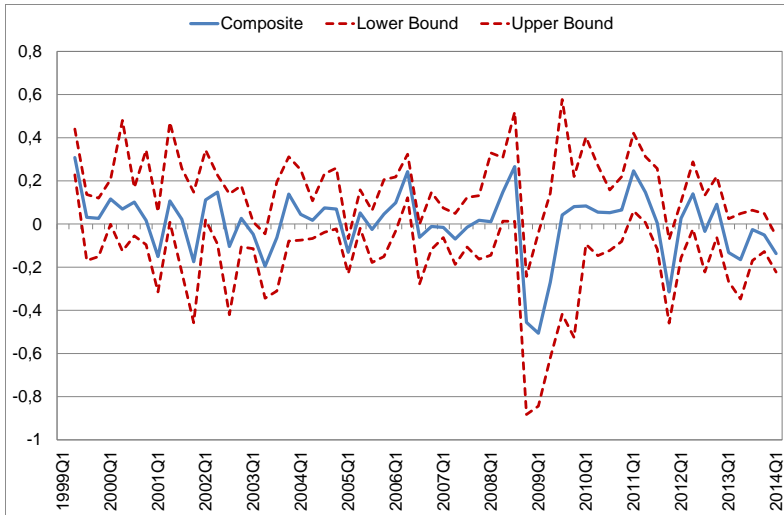
$$K_{tL} = [\min(\exp_{(t+1)i} - \exp_{ti}), i \in N_t(1,1)] \quad (3)$$

and

$$K_{tU} = [\max(\exp_{(t+1)i} - \exp_{ti}), i \in N_t(1,1)]. \quad (4)$$

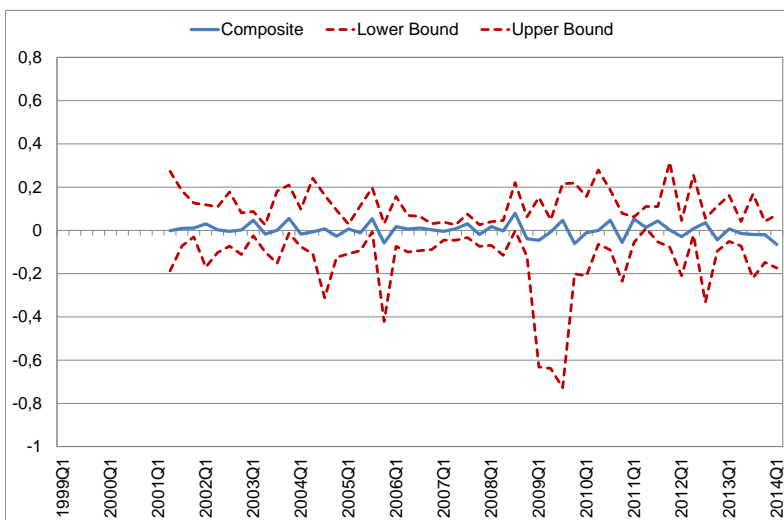
We construct bounds for the variable  $\exp_{(t+1)i}$  for every expert in group  $N_t(1,0)$ . We also construct bounds for the variable  $\exp_{ti}$  for every expert in group  $N_t(0,1)$ . We can then construct bounds for  $\Delta_{tU}$ . When the upper bound for  $\Delta_{tU}$  is constructed, we set  $\exp_{(t+1)i}$  at its upper bound for all experts belonging to group  $N_t(1,0)$  and  $\exp_{ti}$  at its lower bound for all experts belonging to group  $N_t(0,1)$ . When the lower bound for  $\Delta_{tU}$  is constructed, we set  $\exp_{(t+1)i}$  at its lower bound for all experts belonging to group  $N_t(1,0)$  and  $\exp_{ti}$  at its upper bound for all experts belonging to group  $N_t(0,1)$ .

Bounds for aggregated short term forecast revisions are presented in Figure 10. The constructed range for forecast revisions was relatively narrow until the end of 2007, but after the Lehman Brothers collapse it widened and the range moved clearly downwards (in 2008Q4 the lower bound was -0.88 and upper bound -0.24). The lower bound was clearly negative (-0.42) and upper bound clearly positive (0.58) in 2009Q3 due to very heterogeneous expectations.



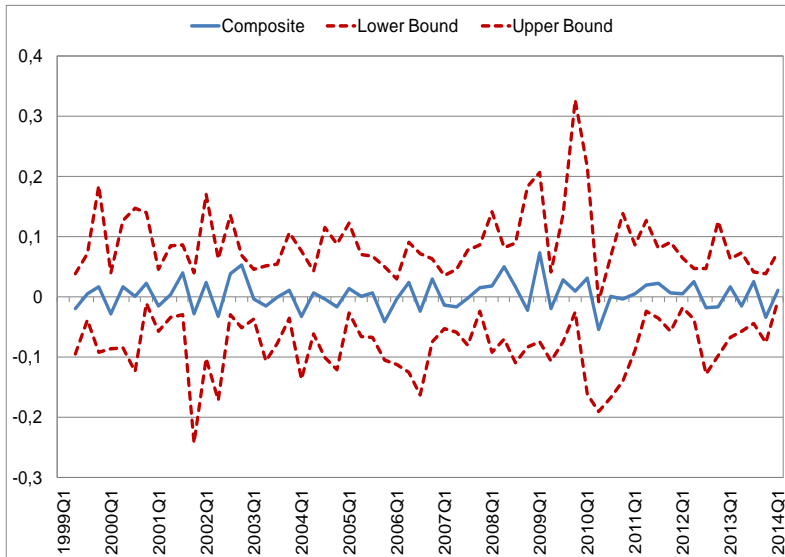
**Figure 10.** Bounds for short-term forecasts

The range for aggregated long term forecast revisions was exceptionally wide downwards in the middle of the crisis (see Figure 11). In 2009 the lower bound was temporarily very low (under -0.6 percentage points) for three quarters. It means that some survey respondents lowered their long term inflation forecasts quite dramatically at that time. After 2009 the range for long term forecast revisions has been relatively narrow again.

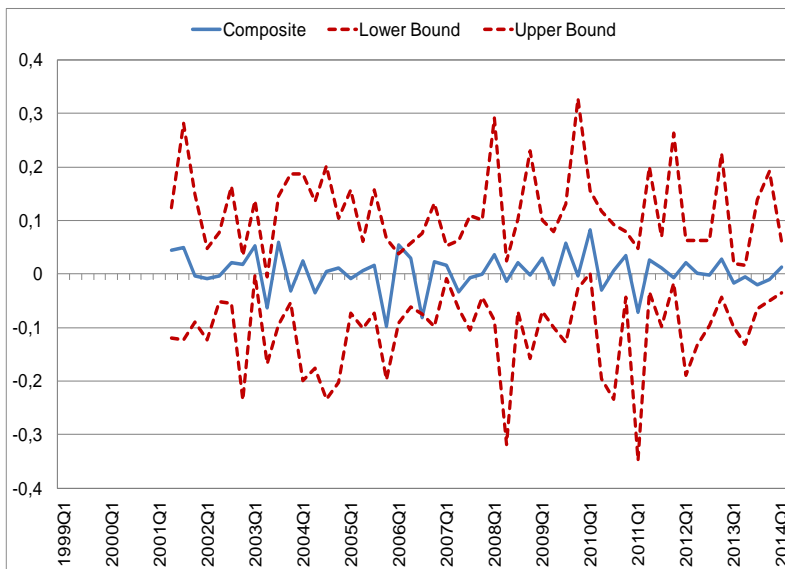


**Figure 11.** Bounds for long term forecasts

Figure 12 shows that the range for short term inflation uncertainty has also been quite narrow, with a few exceptions. In 2002 the range widened temporarily in both directions and in 2009-2011 it widened first upwards and then downwards. Compared to the short term uncertainty, bounds for long term inflation uncertainty have been somewhat wider and notable peaks have occurred (figure 13).



**Figure 12.** Bounds for short-term inflation uncertainty



**Figure 13.** Bounds for long term inflation uncertainty

We should emphasise that the bounds are constructed using only the most extreme forecast revisions in every period. They may be outliers (in which case all other revisions are clearly smaller). On the other hand, bounds are also related to the number of missing observations. If only a few forecasts are missing for groups  $N_t(1,0)$  and  $N_t(0,1)$ , the impacts of the most extreme forecast revisions on  $\Delta_{IU}$  are very limited; if there are many missing observations, the impact is stronger. All in all, we can conclude that the bounds in figures 10 – 13 are relatively stable only with few exceptions. Wider ranges in the middle of the crisis reveal, however, that we need to examine also micro level survey responses. Especially, in times of high forecast disagreement and increased forecast uncertainty a thorough analysis of survey responses is important.

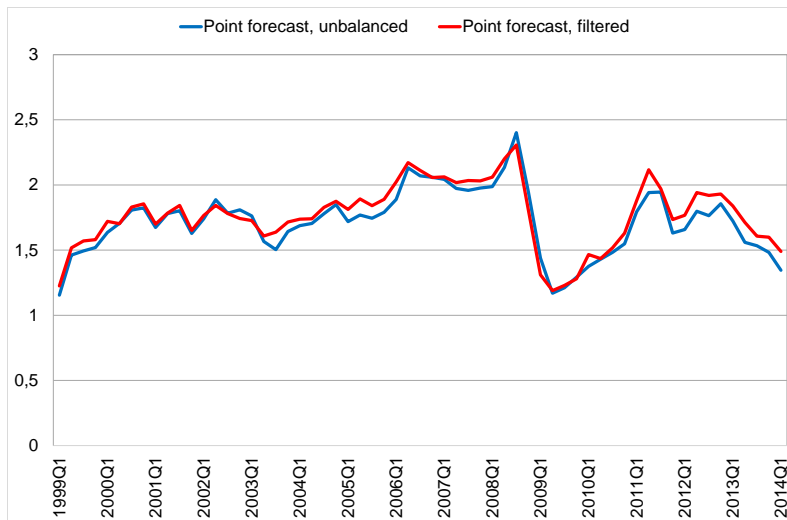
### **3.3 Aggregated expectations based on balanced panel data**

So far we have constructed aggregated forecast revisions and corresponding bounds by focusing only on those forecasters, who have replied to the survey regularly, in two consecutive periods. Next, we construct alternative aggregated expectations in a level form and pay more attention to missing survey responses. First, we report aggregates, based on filtered balanced panel. Then we construct alternative aggregates using balanced data, where missing observations of individual forecasters are replaced by relating them to the average forecast change from period  $t-1$  to period  $t$ .

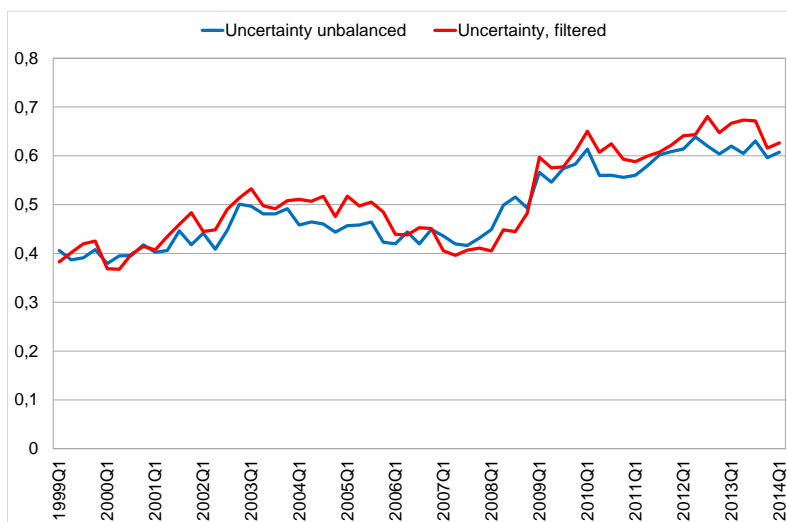
In filtering we fill in missing observations for individual forecasters using simple linear interpolation. Since individual expectations are very persistent, it is reasonable to assume that forecasters change their views only gradually. The idea of filtering is to pay attention to those forecasters who have only few missing replies in a row (very passive forecasters are potentially more inaccurate when responding to the survey). First, we pick up only those “quite regular” forecasters and then we balance the data by using simple linear interpolation. Finally, we calculate aggregated expectations using the fully balanced panel. It is worth noting that filtering decreases always sample size, which may be problematic if the original sample is relatively small.

The evolution of the aggregated point forecasts and individual uncertainties in the original data (unbalanced panel) and in the filtered data (balanced panel) are presented in figures 14 and 15. In the filtered data we have limited the number of missing observations in a row to four (the gap between responses was no more than one year), which means that there are 20 forecasters in figure 14 and 18 forecasters in figure 15. Although filtering reduces the number of survey responses substantially, it is quite clear that it does not change our view of aggregated inflation expectations.



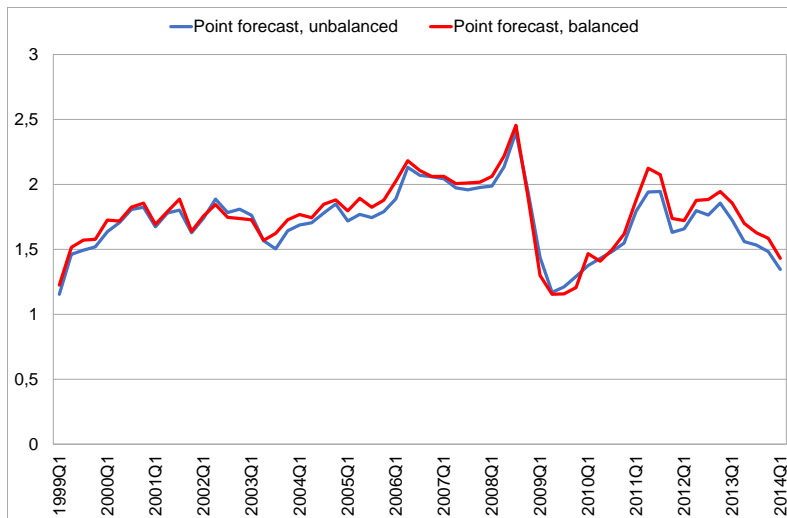


**Figure 14.** Aggregated short-term point forecasts in the unbalanced and filtered data.

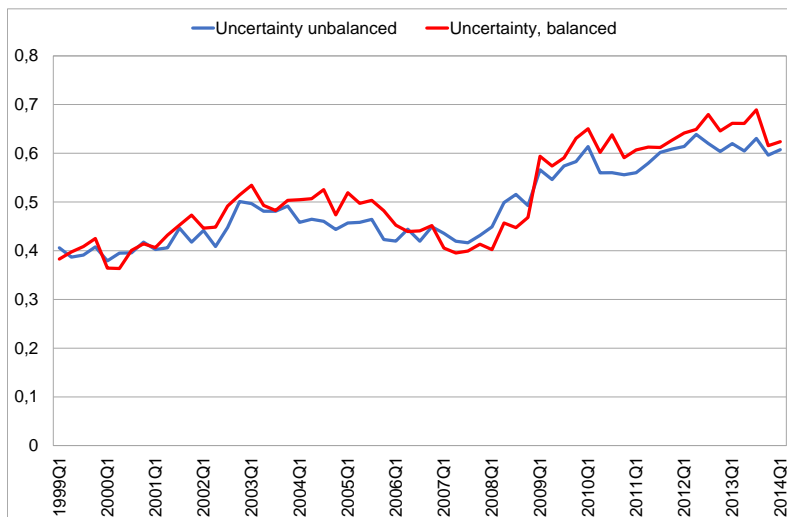


**Figure 15.** Aggregated short-term individual uncertainties in the unbalanced and filtered data

Finally, we construct a fully balanced panel by assuming that in every period the deviation of individual forecasters' survey response from the mean forecast is equal to the corresponding deviation in the previous period. Aggregated expectations are reported in figures 16 and 17. As can be seen, this comparison also shows that aggregated expectations based on the unbalanced and balanced data are quite similar. It gives more support to the view that the impacts of changing panel composition on aggregated survey information is very limited.



**Figure 16.** Aggregated short-term point forecasts in the unbalanced and balanced data



**Figure 17.** Aggregated short-term individual uncertainties in the unbalanced and balanced data

## 4 Conclusions

This paper has analysed the impacts of changing panel composition on aggregated inflation expectations based on the ECB SPF. We have investigated aggregated forecast revisions based on sub-panels of fixed composition. We have also constructed bounds for aggregated forecast revisions using the most extreme individual forecast changes observed in the data. When assessing the relevance of aggregated expectations in a level form, we have considered balanced panel data sets.

Our analyses suggest that the impacts of changing panel composition on aggregated survey information is very limited. It means that the original unbalanced panel data seems to represent the whole forecaster population reliably. However, micro level analysis of expectations would also be useful, especially in times of wide disagreement across forecasters and high levels of inflation uncertainty.

Inflation expectations are in the core of monetary policy analysis and they are continuously analysed using alternative proxies based on survey data and financial market information. Euro area inflation is currently on a very low level, and possible deflation risks and anchoring of long term expectations are widely discussed. It is worth emphasising that in the current low inflation environment, 0.1 – 0.2 percentage point difference between alternative survey aggregates is not necessarily negligible from the monetary policy point of view. Therefore, micro level analysis of expectations should not be ignored in the ECB SPF survey data.

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