Does disagreement among oil price forecasters reflect future volatility? Evidence from the ECB Surveys

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This is new research and the first time any of it has been presented. Comments and suggestions welcome.

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What information might we derive from crude oil price forecasts?

Our Contribution:

1. We attempt to empirically address this issue using crude oil price forecasts from the European Central Bank's Survey of Professional Forecasters (ECB SPF).

2. We suggest a simple method to measure the oil price volatility consistent with the level of disagreement over the forecasted average price.

Measuring disagreement among forecasters

1. Usually measured by the dispersion of point forecasts across the panel of respondents.

2. If the forecasters supply probabilities with point estimates so much the better.

Various reasons may explain why oil price forecasters disagree.

Bowles et al. (2007), use of disagreement as a measure of uncertainty makes sense, to the extent that different forecasters have differing outlook assessments. This can reflect the overall uncertainty surrounding the outlook.

Different information sets or knowledge at the time the forecast is made.

Role and relevance of exogenous variables can differ in mapping to a specific price level.

Strategic Behavior - for instance to influence the oil market or to gain attention from the media. Lamont (2002) hypothesizes that if forecasters are paid according to relative ability, they might scatter, since it is hard to win when making a forecast similar to others.

However, the reverse may hold be the case as well. Uncertainty surrounding the oil price may significantly contribute to explain the disagreement observed between forecasters.

Alternatively, the disparity in forecasters' models and beliefs may lead to more divergent forecasts when oil price volatility is greater. A more volatile oil price would then lead to a higher disagreement among forecasters.

Previous examinations of crude oil price forecasts

Surprisingly enough, little attention[4] has so far been paid to the empirical analysis of disagreement between oil price forecasters, whereas the price volatility, either implied or realized, is a straightforward available measure of the uncertainty surrounding the oil price.

Singleton (2012) uses monthly oil price forecasts from Consensus Economics and finds that greater dispersion in forecasts is positively correlated with future increases in futures price volatility.

The empirical analysis presented in this paper is based on ECB SPF oil price forecasts that, until now, had been used in two other studies only.

Pierdzioch et al. (2010) analyze whether oil price forecasters herd or anti-herd.

Reitz et al. (2012) investigate whether regressive and extrapolative expectations exhibit significant nonlinear dynamics.

[4] Including the studies on herding or anti-herding of oil price forecasters, like Pierdzioch et al. (2010).

Observed Disagreement and Oil Price Volatility

Our sample uses point forecasts for quarterly average prices, the observed disagreement cannot be directly compared with oil price volatility.

The distribution of the forecasts can however be interpreted as the distribution of the average price over the quarter considered.

This raises the following question: how to infer an oil price volatility measure that is consistent with this distribution?

Under the standard assumption that the oil price follows a geometric Brownian motion, we suggest a formula that serves to derive price volatility from the distribution of forecasts.

We use this simple reduced-form model as a benchmark to translate the observed disagreement into volatility. When applied to the ECB surveys, this method results in a disagreement-based volatility that is well correlated with the volatility observed ex post.

The Data: ECB SPF oil price forecasts

The European Central Bank (ECB) has collected quarterly assumptions/forecasts of Brent crude oil prices since 2002q1 in its' *Survey of Professional Forecasters*[5] (SPF). These oil-price forecasts refer to the average nominal spot price of Brent over the quarter. Our sample period is from 2002q1-2012q4 which includes 44 survey rounds.

The survey includes participants from the financial sector (mostly banks), non-financial research institutes and employer or employee organizations.

The replies to the SPF are typically sent[6] between days 16 and 21 of January (Q1 survey), April (Q2), July (Q3) and October (Q4). Thus, the survey participants have market information available to them for the first 15 days of each quarter.

Initially, the SPF surveyed forecasters for the current quarter and the subsequent next four quarters. We will refer to them as the 0-4 horizon forecasts. After 2010q1, the ECB stopped collecting the 4-quarter-ahead forecast.

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[5] The SPF collects point and probability estimates for Euro area annual HICP inflation, annual GDP growth, and the unemployment rate. In addition, they ask the participants to provide the assumptions they are using for the ECB's interest rate for main refinancing operations, the crude oil price, the USD/EUR exchange rate, and the annual change compensation cost per employee or labor costs.

[6] Communication with Victor Lopez Perez at the ECB-SPF on December 3rd, 2012.

Table A1. Number of forecasters providing a minimum number of forecasts, per horizon

Number of Forecasts	H0 – H3	H4
37 or more	24	na
30 or more	35	11
20 or more	55	45
10 or more	71	61
At least one	90	85

Our panel is unbalanced.

Difference in participation across forecasters

Difference in participation by same forecaster – non-continuity

Figure 1 illustrates the time series of available horizon-0 forecasts for each quarter. In the first year, there were about 35-40 participants, thereafter participation fluctuates between 45 and 55.

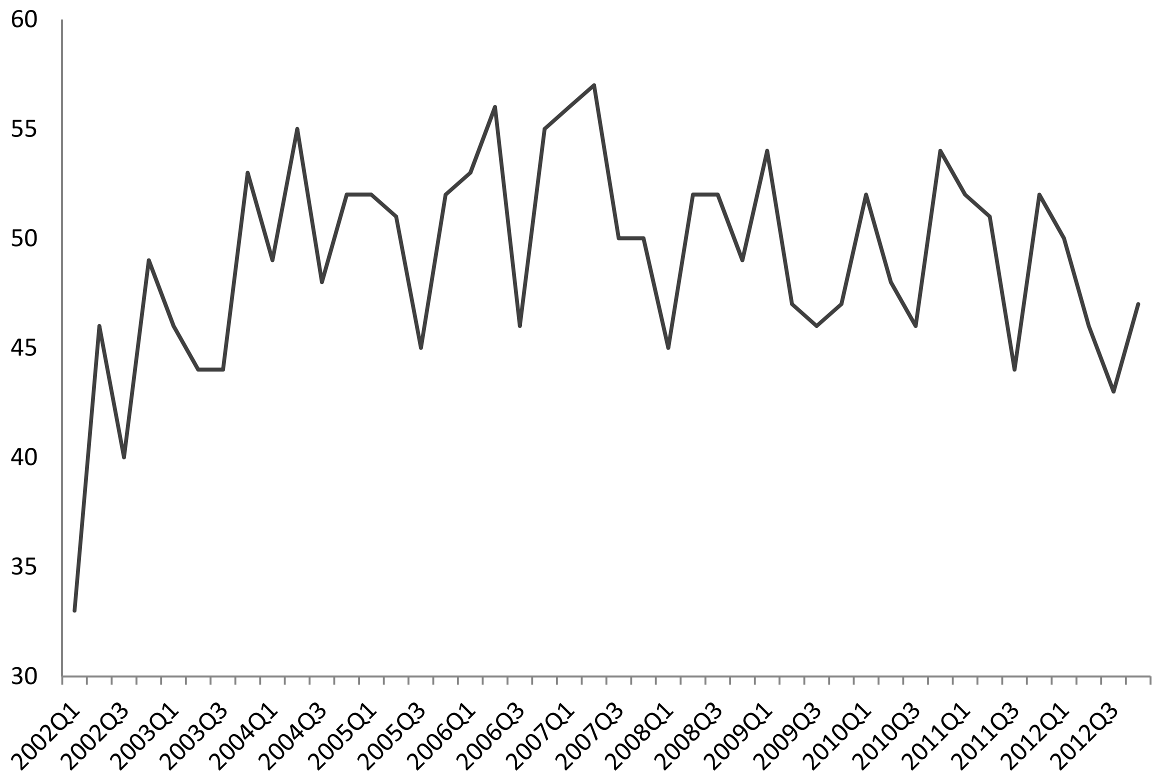

Figure 1 : Number of available forecasts per quarter (horizon 0, 90 forecasters)

Should you believe Oil Price Forecasters? The Hedgehog Example

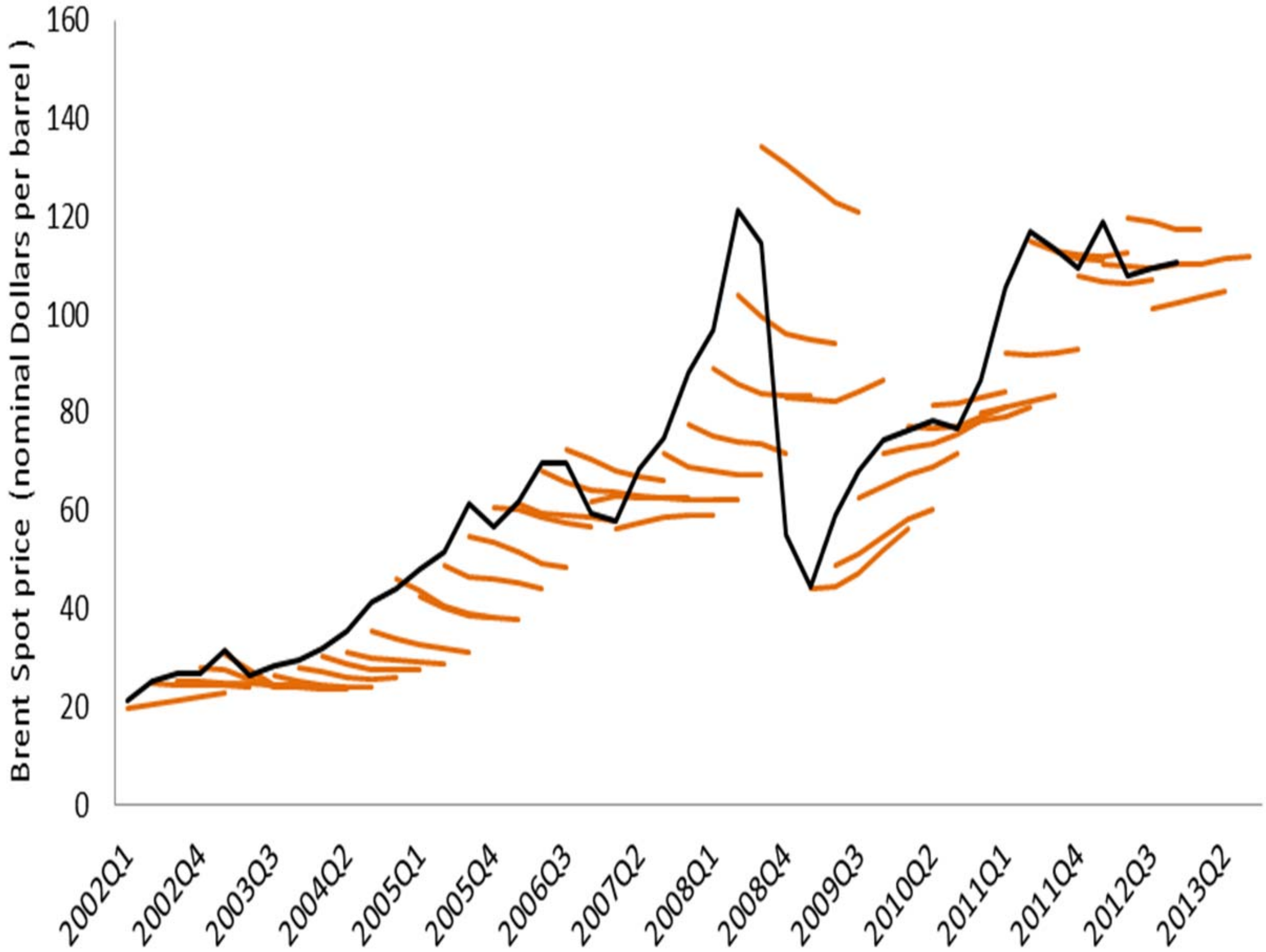

Figure 2: Actual average price and ECB SPF mean forecast (all horizons, 90 forecasters)

Another Example of a Hedgehog from Nelson and Peck, "The NERC Fan ..."

180 Journal of Business & Economic Statistics, July 1985

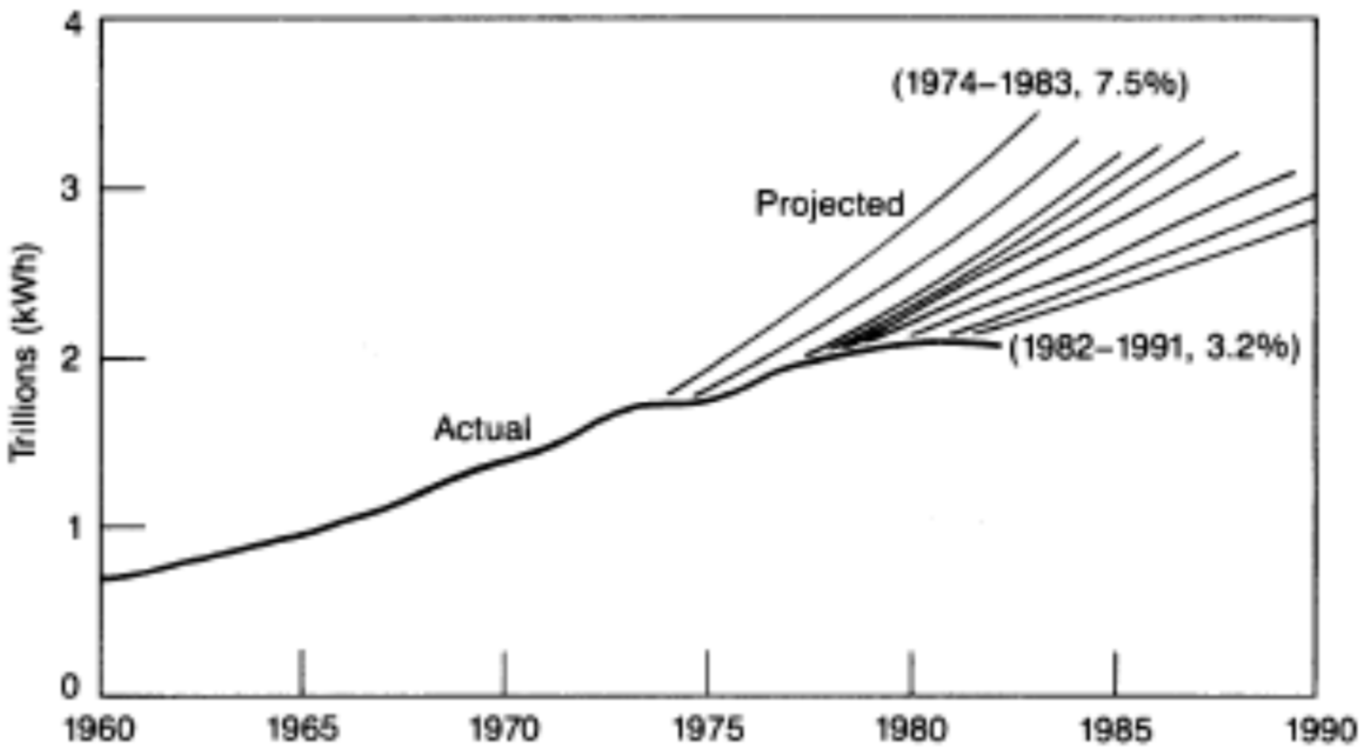

Figure 1. Actual (1960–1982) and Projected (1974–1990) Total Sales of Electricity and Growth Rates.

This fan comes from forecasts of quantity by engineers not economists!

3. Dispersion of forecasts, disagreement index and forecast uncertainty

Let $z_{t,h}$ be the number of forecasts made in quarter t for horizon h that are considered. The u^{th} price forecast is denoted as $F_{u,t,h}$. The dispersion of forecasts is captured by the standard deviation of forecasts $s_{t,h}$, with:

$$s_{t,h} = \sqrt{\frac{1}{z_{t,h}-1}\sum_{u=1}^{z_{t,h}}\left(F_{u,t,h} - \bar{F}_{t,h}\right)^2} \tag{1}$$

where $\bar{F}_{t,h}$ is the mean forecast value $\frac{\sum_{u=1}^{z_{t,h}} F_{u,t,h}}{z_{t,h}}$.

Our measure[7] of disagreement $D_{t,h}$ in quarter t for horizon h is the ratio of the standard deviation of forecasts to the mean forecast:

$$D_{t,h} = \frac{s_{t,h}}{\bar{F}_{t,h}} \tag{2}$$

[7] See for instance Siklos (2012) for alternative measures of forecast disagreement; note that the forecasters of the ECB professional survey only provide point estimates for the oil price, with no information on the underlying probability distributions.

The forecast error in $t+h$, $e_{t,h}$, is the difference between the actual average nominal Brent oil price A_{t+h} and the mean forecast $\bar{F}_{t,h}$ made h quarters before:

$$e_{t,h} = A_{t+h} - \bar{F}_{t,h} \tag{3}$$

If disagreement reflects forecast uncertainty, one would expect a positive correlation between the dispersion of forecasts and the subsequent forecast error.

A first approach[8]

$$|e_{t,h}| = \alpha + \beta s_{t,h} + u_t \tag{4}$$

[8] By applying a similar approach to the dispersion of growth and inflation forecasts from a panel of German professional forecasters, Dopke and Fritsche (2006) do not find statistical evidence that dispersion is a reasonable measure of forecast uncertainty.

For all regressions, we apply the same following procedure. First, we check the stationary of both endogenous and exogenous variables with the ADF test. If the null assumption of a unit root cannot be rejected at a 5% level of significance, we perform the regression on the differenced series.

Table 1: Regressions of absolute forecast error versus standard deviation of forecasts

Group of forecasters	Horizon	Constant	Slope	R^2
90	0	-1.52	1.59**	0.32
71	0	-1.23	1.53**	0.31
55	0	-0.31	1.32*	0.21
24	0	-0.46	1.54**	0.30

Note: ***, **, and * denote statistical significance at 1%, 5%, and 10% levels, respectively; t-tests are based on standard errors corrected using the Newey-West procedure.

4. Does ex-post realized volatility explain ex-ante disagreement?

First, we estimate the (realized) volatility observed ex-post. To do so, we use weekly prices, by considering the closing spot price of the last working day of every week in the quarter. The forecasts are assumed to be conditional upon all available information at the time the forecast is produced. Since we do not know the actual date of production of these forecasts, we consider two alternative assumptions: either the forecast is produced at the start of the quarter, or it is produced just before returning the questionnaire to the ECB.

Let us consider any quarter t and let $N(h)$ be the number of weekly prices observed from the start of quarter t until the end of the forecasted quarter at horizon h. We estimate the following two series of realized volatility, both computed as the standard deviation[9] of price returns:

1. Full quarter volatility
2. Deadline adjusted volatility

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[9] See for instance Sadorsky (2006) and Matar et al. (2013); they do not adjust returns for convenience yield. When the price is assumed to follow a geometric Brownian motion as in Section 5, its volatility has to be estimated as the standard deviation of price returns.

- the 'full quarter' volatility $v_{t,h}$ corresponding to the assumption that the forecasts are produced when the first weekly price of the quarter is observed:

$$v_{t,h} = \sqrt{\frac{1}{N(h)-1}\sum_{k=1}^{N(h)-1}\left(ln\left(\frac{P_{k+1}}{P_k}\right) - \frac{ln\left(\frac{P_{N(h)}}{P_1}\right)}{N(h)}\right)^2} \tag{5}$$

Where P_k is the k^{th} weekly price observed during the period considered.

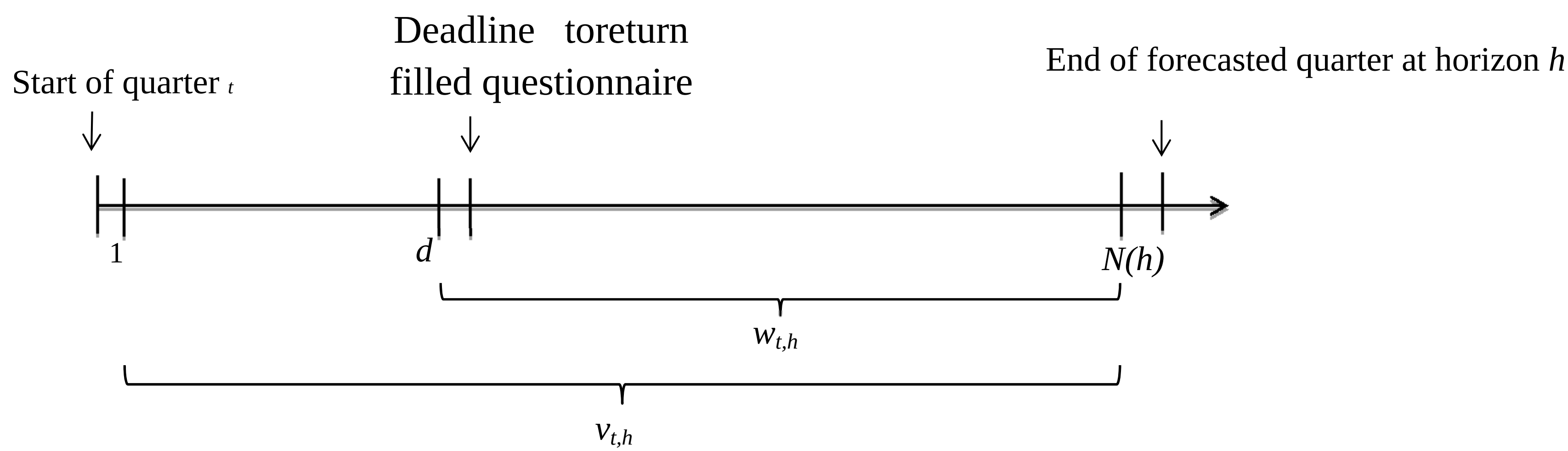
- the 'deadline adjusted' volatility $w_{t,h}$ corresponding to the assumption that the forecasts are produced just before the deadline to return the filled questionnaire to the ECB:

$$w_{t,h} = \sqrt{\frac{1}{N(h)-d}\sum_{k=d}^{N(h)-1}\left(ln\left(\frac{P_{k+1}}{P_k}\right) - \frac{ln\left(\frac{P_{N(h)}}{P_d}\right)}{N(h)-d+1}\right)^2} \tag{6}$$

Where *d* is the number of weekly prices realized before the deadline[10] to return the filled questionnaire to the ECB, as illustrated in Figure 4.

[10]Typically between the 17th and the 24th day of the first month; for each quarter, *d* is the last weekly price prior to the deadline indicated by the ECB at: http://www.ecb.int/stats/prices/indic/forecast/shared/files/SPF_rounds_dates.pdf?06a8d73c8231cca300071f251923c9b9

Figure 4: Full quarter volatility $v_{t,h}$ and deadline adjusted volatility $w_{t,h}$



Typically between the 17th and the 24th day of the first month; for each quarter, *d* is the last weekly price prior to the deadline indicated by the ECB at: http://www.ecb.int/stats/prices/indic/forecast/shared/files/SPF_rounds_dates.pdf?06a8d73c8231cca300071f251923c9b9

Figure 5: ex-post volatilities and disagreement index, group of 90 forecasters

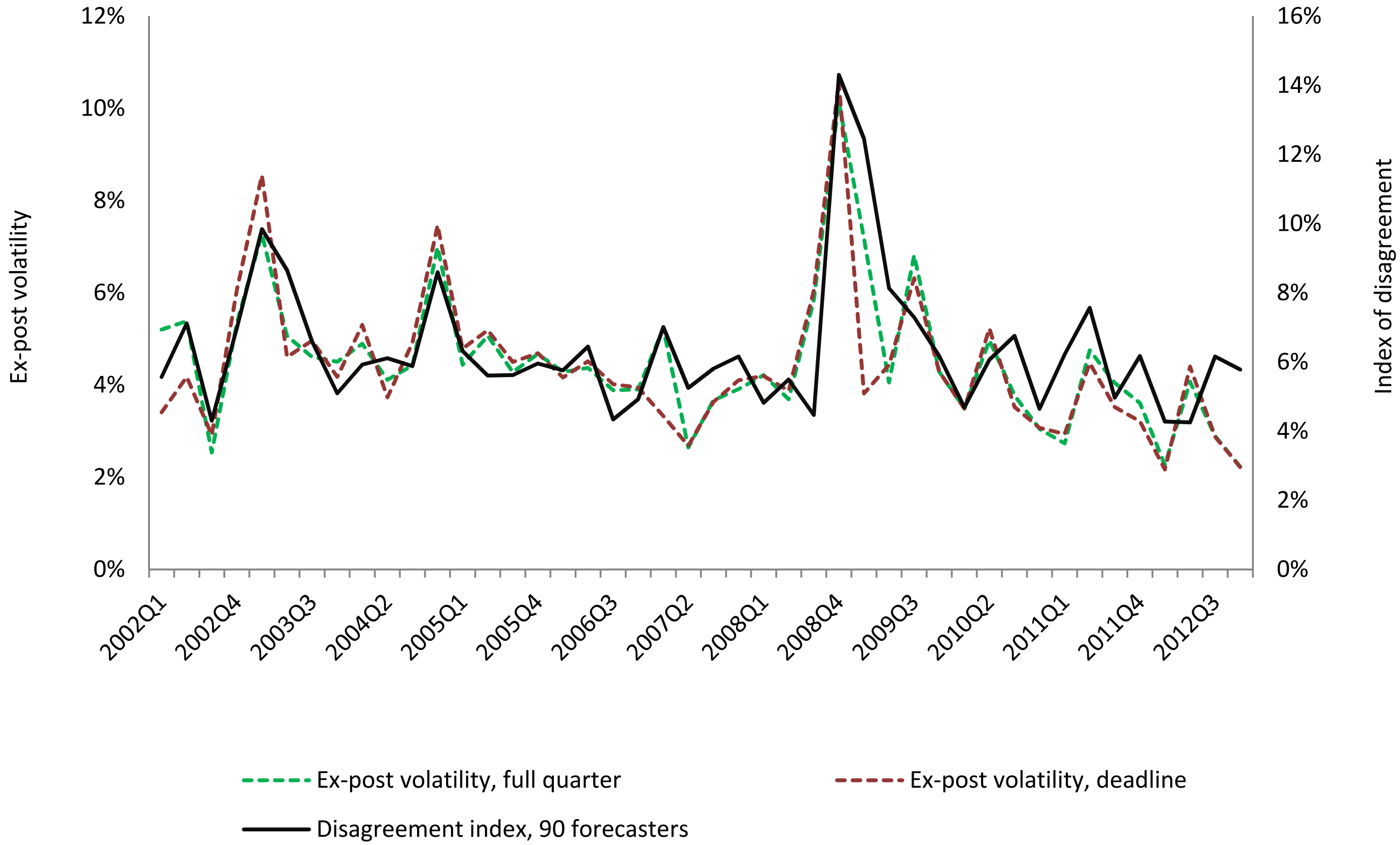
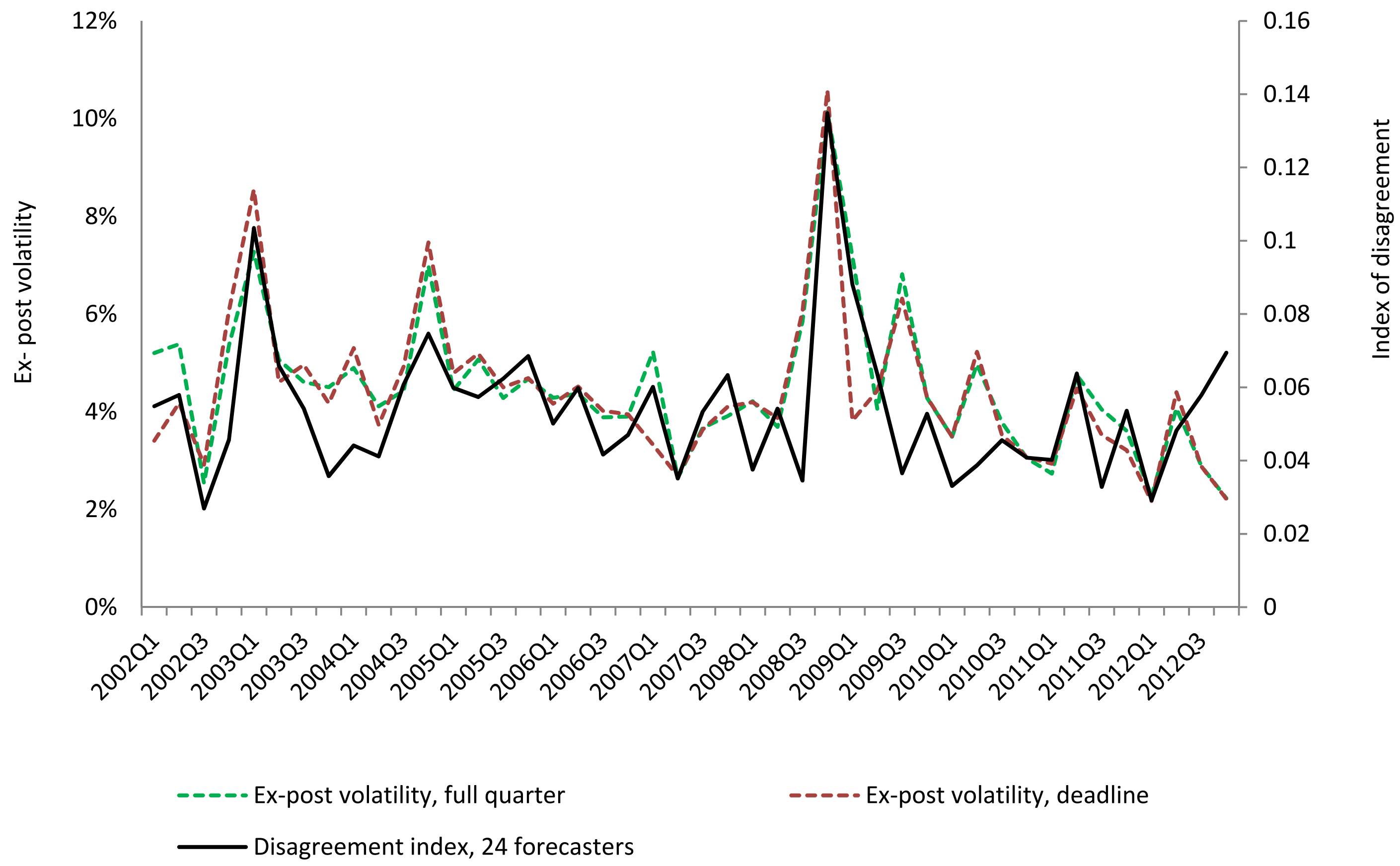


Figure 6: ex-post volatilities and disagreement index, group of 24 forecasters



We test for the existence of a relationship between disagreement and price volatility.

$$D_{t,h} = \alpha + \beta v_{t,h} + u_t \qquad (7)$$

$$D_{t,h} = \alpha + \beta w_{t,h} + u_t \qquad (8)$$

Table 2: Regression of disagreement index with respect to ex-post volatility, horizon 0.

Horizon	Endogenous variable	Exogenous variable	Constant	Slope	R^2
0	Disagreement index, 90	Full quarter volatility	0.02**	1.05***	0.62
0	Disagreement index, 71	Full quarter volatility	0.02**	0.99***	0.58
0	Disagreement index, 55	Full quarter volatility	0.02***	0.85***	0.51
0	Disagreement index, 35	Full quarter volatility	0.02***	0.88***	0.48
0	Disagreement index, 24	Full quarter volatility	0.01	0.92***	0.47
0	Disagreement index, 24	Deadline adjusted volatility	0.02**	0.80***	0.40
0	Disagreement index, 55 ++	Deadline adjusted volatility	---	0.46***	0.19

Note: ***, **, and * denote statistical significance at 1%, 5%, and 10% levels, respectively; t-tests are based on standard errors corrected using the Newey-West procedure.

Table 2: Regression of disagreement index with respect to ex-post volatility, horizon 2.

Horizon	Endogenous variable	Exogenous variable	Constant	Slope	R^2
2	Disagreement index, 90 ++	Full quarter volatility	---	1.24***	0.18
2	Disagreement index, 71 ++	Full quarter volatility	---	1.30***	0.20
2	Disagreement index, 55 ++	Full quarter volatility	---	1.12***	0.15
2	Disagreement index, 90 ++	Deadline adjusted volatility	---	1.03***	0.15
2	Disagreement index, 71 ++	Deadline adjusted volatility	---	1.07***	0.17
2	Disagreement index, 55 ++	Deadline adjusted volatility	---	0.91***	0.13
2	Disagreement index, 35 ++	Deadline adjusted volatility	---	0.61*	0.05

Note: ***, **, and * denote statistical significance at 1%, 5%, and 10% levels, respectively; t-tests are based on standard errors corrected using the Newey-West procedure.

Construction or Calibration of volatility based on disagreement

Since every forecast considered is a price averaged over a quarter, the observed disagreement is not directly comparable to oil price volatility.

Using a simple benchmark model for the oil price allows us to translate the observed disagreement into volatility.

The distribution of forecasts provided at a given date for a given horizon may be interpreted as the distribution of the average price over the corresponding period.

If we examine the standard deviation of the forecasts is equivalent to examining the standard deviation of the average price.

But, what is the relationship between the standard deviation of the average price and the volatility of the underlying price? Under the standard assumption that the oil price follows a geometric Brownian motion, we infer the price volatility implied by this distribution.

6. Disagreement-based volatility from ECB Surveys

Figure 7 : Ex-post volatility and disagreement-based volatility
(full quarter, group of 90 forecasters, horizon 0)

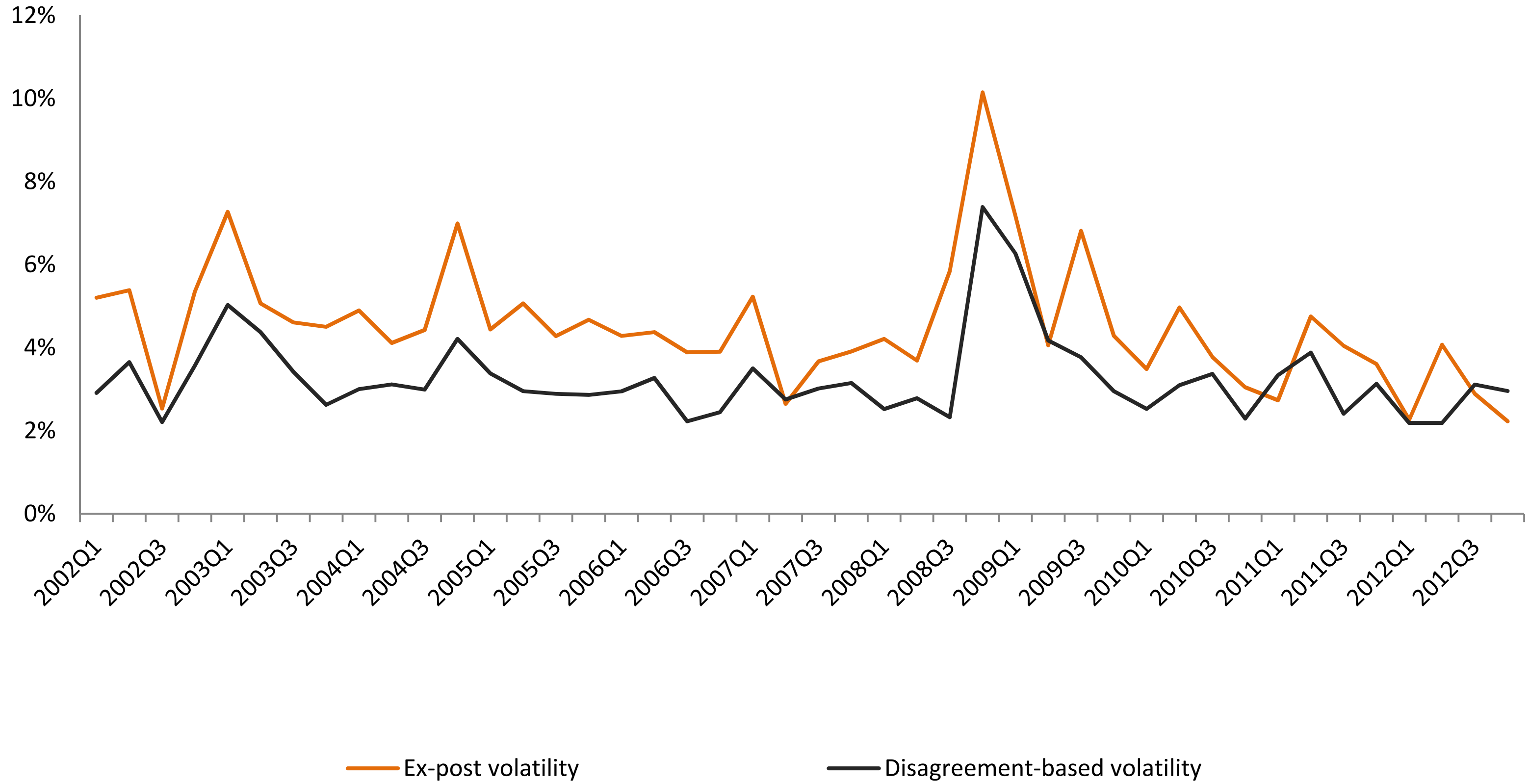
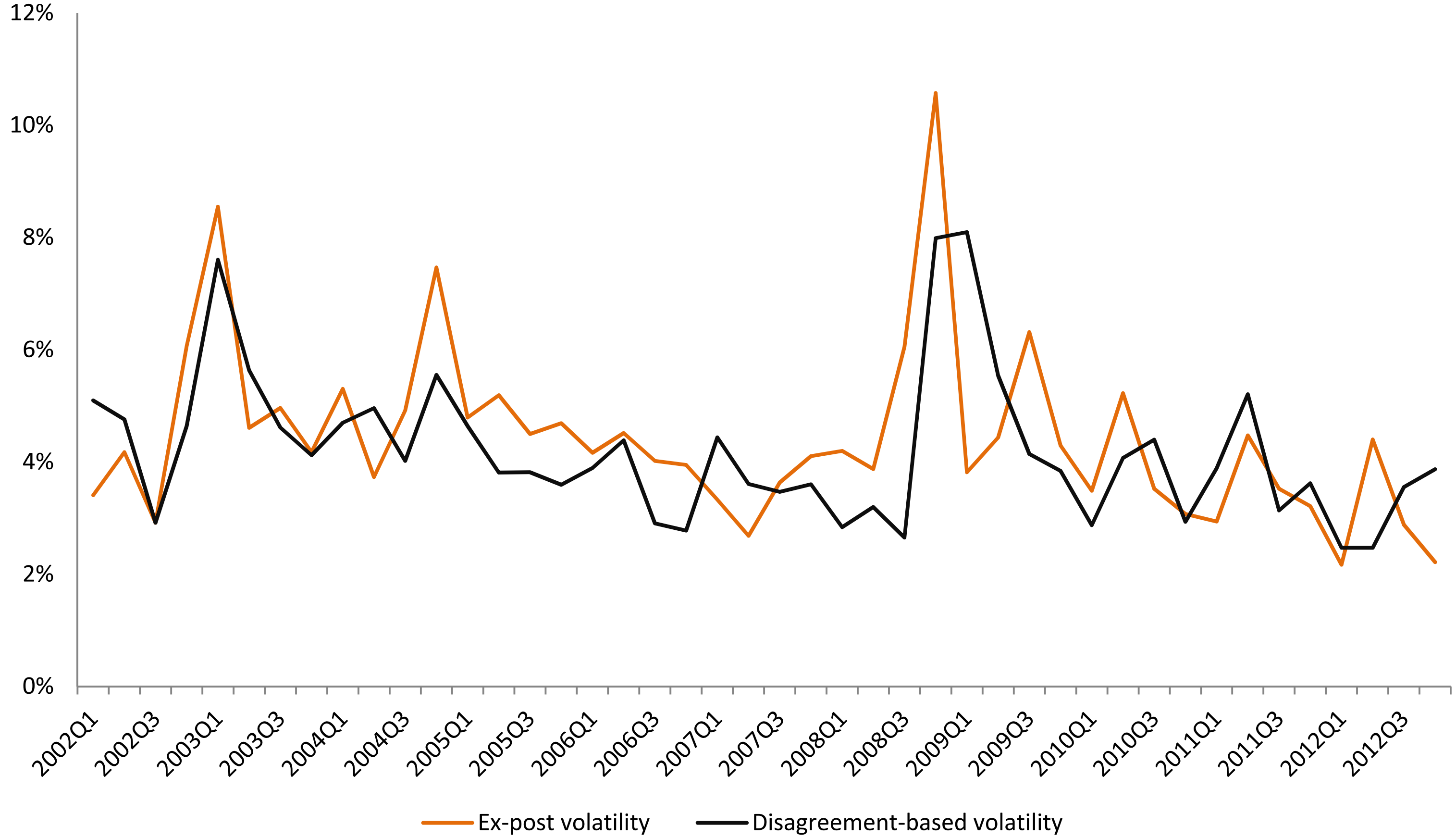


Figure 8: ex-post volatility and disagreement-based volatility (deadline adjusted, group of 90 forecasters, horizon 0)



For every horizon and group of forecasters, we use regressions of the following types:

$$v_{t,h} = \alpha + \beta \sigma_{t,h}^{f} + u_t \tag{23}$$

Where $\sigma_{t,h}^{f}$ is the full-quarter disagreement-based volatiliy

Table 3: Regressions () of ex-post volatility against disagreement-based volatility (horizon 0, full quarter)

Exogenous variable	Constant	Slope	R^2
Disagreement based volatility, 90 forecasters	0.01**	1.15***	0.61
Disagreement based volatility, 71 forecasters	0.01**	1.15***	0.58
Disagreement based volatility, 55 forecasters	0.01	1.18***	0.51
Disagreement based volatility, 35 forecasters	0.01**	1.07***	0.48
Disagreement based volatility, 24 forecasters	0.02***	1.01***	0.47

Note: ***, **, and * denote statistical significance at 1%, 5%, and 10% levels, respectively; t-tests are based on standard errors corrected using the Newey-West procedure.

For every horizon and group of forecasters, we use regressions of the following types:

$$\boldsymbol{w_{t,h} = \alpha + \beta \sigma^{d}_{t,h} + u_t} \qquad (24)$$

Where $\boldsymbol{\sigma^{d}_{t,h}}$ is the deadline-adjusted disagreement-based volatility.

Table 4: Regressions () of ex-post volatility against disagreement-based volatility (horizon 0, deadline adjusted)

Exogenous variable	Constant	Slope	R^2
Disagreement based volatility, 90 forecasters	0.01**	0.70***	0.35
Disagreement based volatility, 71 forecasters	0.02**	0.68***	0.30
Disagreement based volatility, 55 forecasters	0.02**	0.67***	0.26
Disagreement based volatility, 35 forecasters	0.02***	0.62***	0.27
Disagreement based volatility, 24 forecasters	0.02***	0.71***	0.36

Note: ***, **, and * denote statistical significance at 1%, 5%, and 10% levels, respectively; t-tests are based on standard errors corrected using the Newey-West procedure.

7. Conclusion

For short forecast horizons, we find statistical evidence that the oil price volatility observed ex post explains ex-ante disagreement between oil price forecasters of the ECB's professional survey. The results appear robust to size of panel.

Since the forecasts considered are quarterly average prices, the observed disagreement is however not directly comparable to oil price volatility. We therefore use the geometric Brownian motion as a benchmark model to translate the observed disagreement into volatility.

This may lead one to consider our disagreement index, or the disagreement-based volatility, as an informative index for future volatility in oil prices.

In other words, could one of these indices be a good predictor of oil price volatility? In this respect, they can be tested against volatility implied from derivatives markets. An interesting issue would be to determine if the volatility derived from disagreement contains incremental information, relative to the volatility priced by option markets. One might suspect that the myriads of agents interacting on these markets should reveal more about volatility than the level of disagreement between ninety forecasters. To ascertain this is left for future research.

Thank you
Comments and Suggestions Welcome