

# An Introduction to the PRObability FORecasting (PROFOR) Toolbox for MATLAB

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# What is PROFOR?

- ▶ PROFOR provides macro models, estimation algorithms, techniques for forecast combination, forecast evaluation tools and real-time data suitable for short-term quarterly (or monthly) predictions
- ▶ Trial version (TBR via WBS website, Dec 2014) packages together many best practice forecasting methods
- ▶ A network of practitioners and academics supports project and trial version of PROFOR

# Summary of application

- ▶ UK macroeconomic forecasting application based on the (potentially) asymmetric predictive densities published by the Bank of England for inflation
- ▶ Forecast evaluation methods include examining calibration, predictive scores, and decision-theoretic forecast evaluation
- ▶ How much better is the BOE approach (one step ahead) than, say, an AR(1) benchmark?
- ▶ Tomorrow's session replicates analysis in live PROFOR session and provides further examples (models estimated, forecasts combined, then evaluated)

# What does PROFOR aim to do?

- ▶ Platform to produce real-time macro density forecasts
- ▶ Easy to modify/scalable, object oriented, well documented, examples, manual etc.
- ▶ No commercial value, released as freeware via WBS website; released under the GNU v 3 license

# What's in PROFOR?

- ▶ Models: ARs, VARs, IMA, TVP and regime switching VARs (plus stochastic volatility variants, Bayesian simulation options)
- ▶ Forecasts: iterative, quarterly and monthly
- ▶ Combinations: equal, log score, and CRPS weights for Linear Opinion Pools
- ▶ Evaluations: log scores, Brier scores and decomposition, CRPS, PITS (with one-shot tests), simple loss functions
- ▶ Data: real-time data (from FRED and/or xls), BOE and NB forecast data, external (e.g. user's) forecast densities

# Who's in the PROFOR team?

- ▶ Researchers: Craig and Leif Anders; Shaun Vahey, Liz Wakerly and Anthony Garratt
- ▶ Partner investigators: Michael Smith (Melbourne), Simon van Norden (HEC Montreal and CIRANO), Rodney Strachan (Queensland), Domenico Giannone (ULB)
- ▶ Advisory board: Francesco Ravazzolo (NB) and Simon Price (BOE)
- ▶ Partner research centres: CAMP, KOF, CIRANO, CAMA, Veissmann Research Centre, RPF at GWU
- ▶ Partner orgs: BOE, NB and WBS

- ▶ Sep-Nov 2014 trial version of toolbox preview to NB and BOE (feedback'd help!)
- ▶ Dec 2014 trial toolbox release on WBS website
- ▶ Mar 2015 Documentation for trial version complete (2 papers, plus user manual)
- ▶ Apr 2015 Next phase begins (non-Gaussian modelling, non-linear methods, mixed frequency)

# An Example: BOE fan charts

- ▶ Two “experts”, BOE and AR(1); see Gneiting and Ranjan (2011, JBES)
- ▶ Look at a bake-off between the two experts 2004Q1 through 2013Q4 consider calibration (via PITS), log scores and cost-loss ratio
- ▶ In this example, the policymaker would prefer BOE fan charts to call inflation events one step ahead? How much better is it though?



- ▶ “Given ... (the) asymmetric costs or benefits of particular outcomes, a central bank needs to consider not only the most likely future path for the economy, but also the distribution of possible outcomes about that path. The decision-makers then need to reach a judgment about the probabilities, costs, and benefits of the various possible outcomes ...”

Greenspan (2004, p 37).

- ▶ To the Governor, exceeding the inflation target (even in the short term) results in a substantial economic cost
- ▶ If inflation deviates from central target (2 percent) by more than 1 percentage point, the Governor must to send an open letter to the Chancellor
- ▶ The Governor sent letters to Chancellor between April 2007 and February 2012, all gave reasons for high inflation in short term; preceding Inflation Report forewarned of the target breach in each case

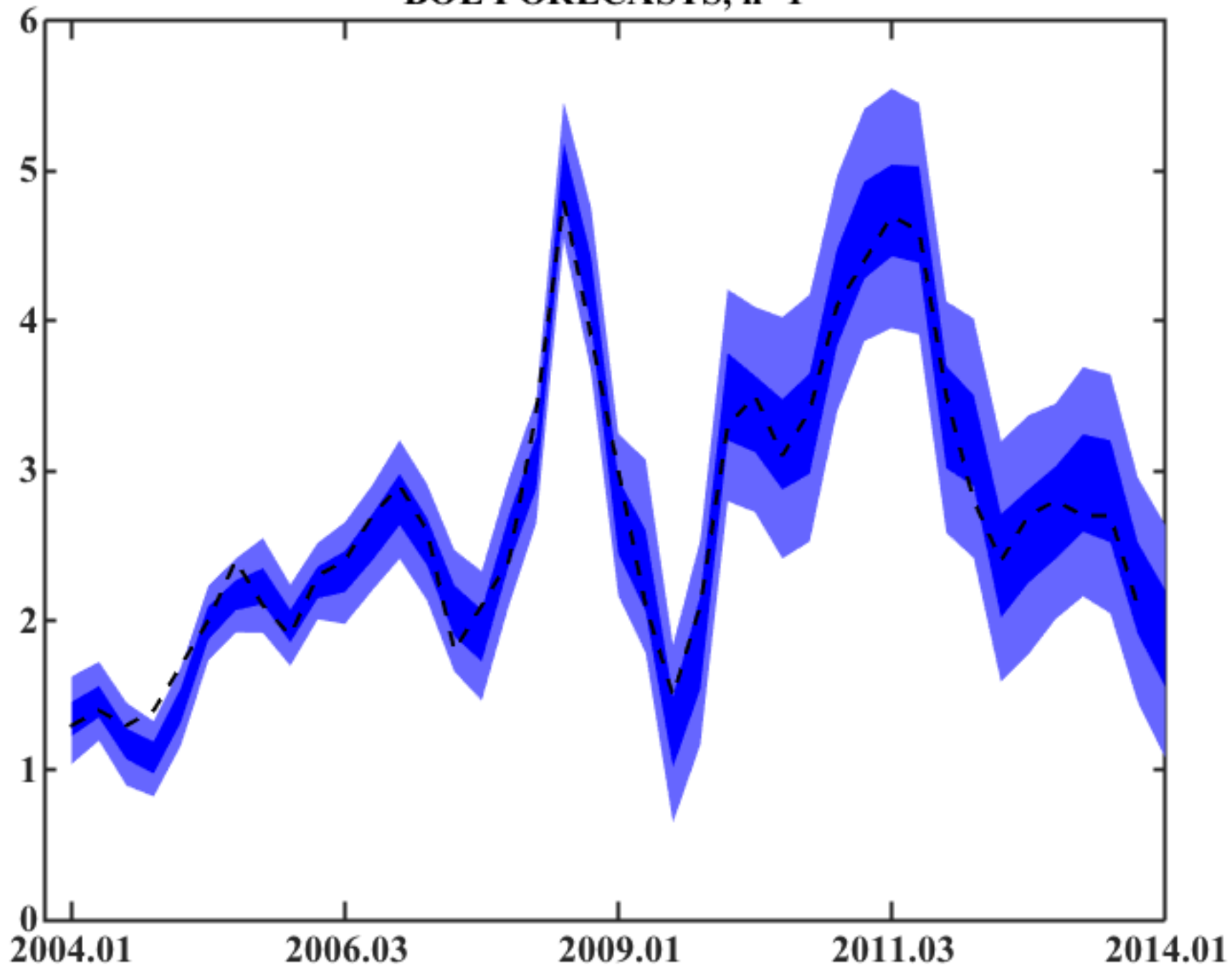
- ▶ For example, the Governor's "Opening Remarks" to the Bank of England's *Inflation Report* Press Conference in February 2010 stressed

"The January figure for CPI inflation is likely to have exceeded 3% ... This would be the third episode when inflation has temporarily moved above the target ... requiring me to write an open letter to the Chancellor."

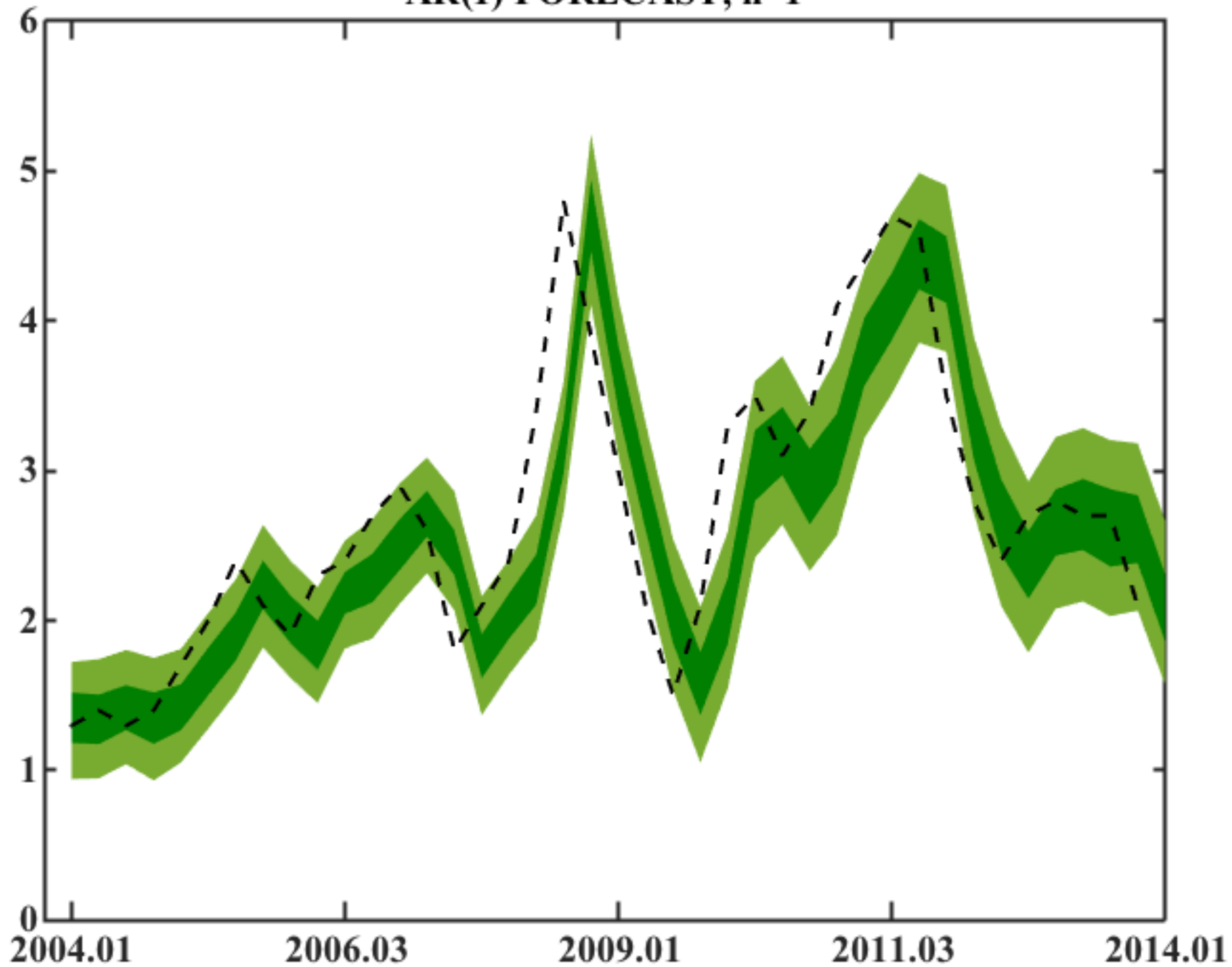
- ▶ Following eg Granger and Pesaran (2000), Berrocal et al (2010), relative cost of unanticipated inflation  $R = C/L$ ,  $0 < R < 1$ , unknown
- ▶ Issue (1-step ahead) inflation event warning iff  $Pr(\pi_t > \bar{\pi}) > R$
- ▶ Define  $TEL = n_{10}L + (n_{01} + n_{00})C$

Event Forecast	Event Observed	
	Yes	No
Yes	$n_{00}$	$n_{01}$
No	$n_{10}$	$n_{11}$

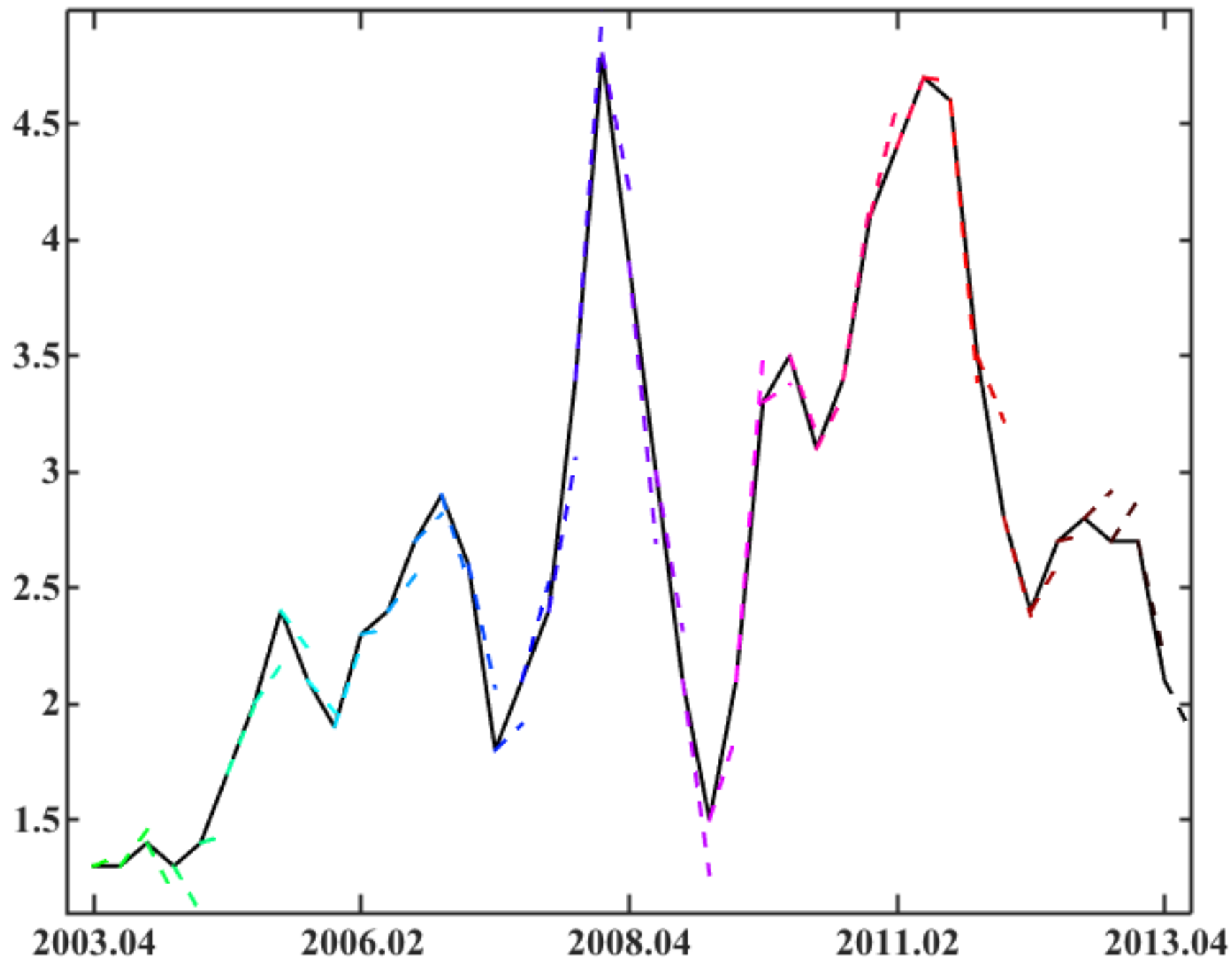
**BOE FORECASTS, h=1**



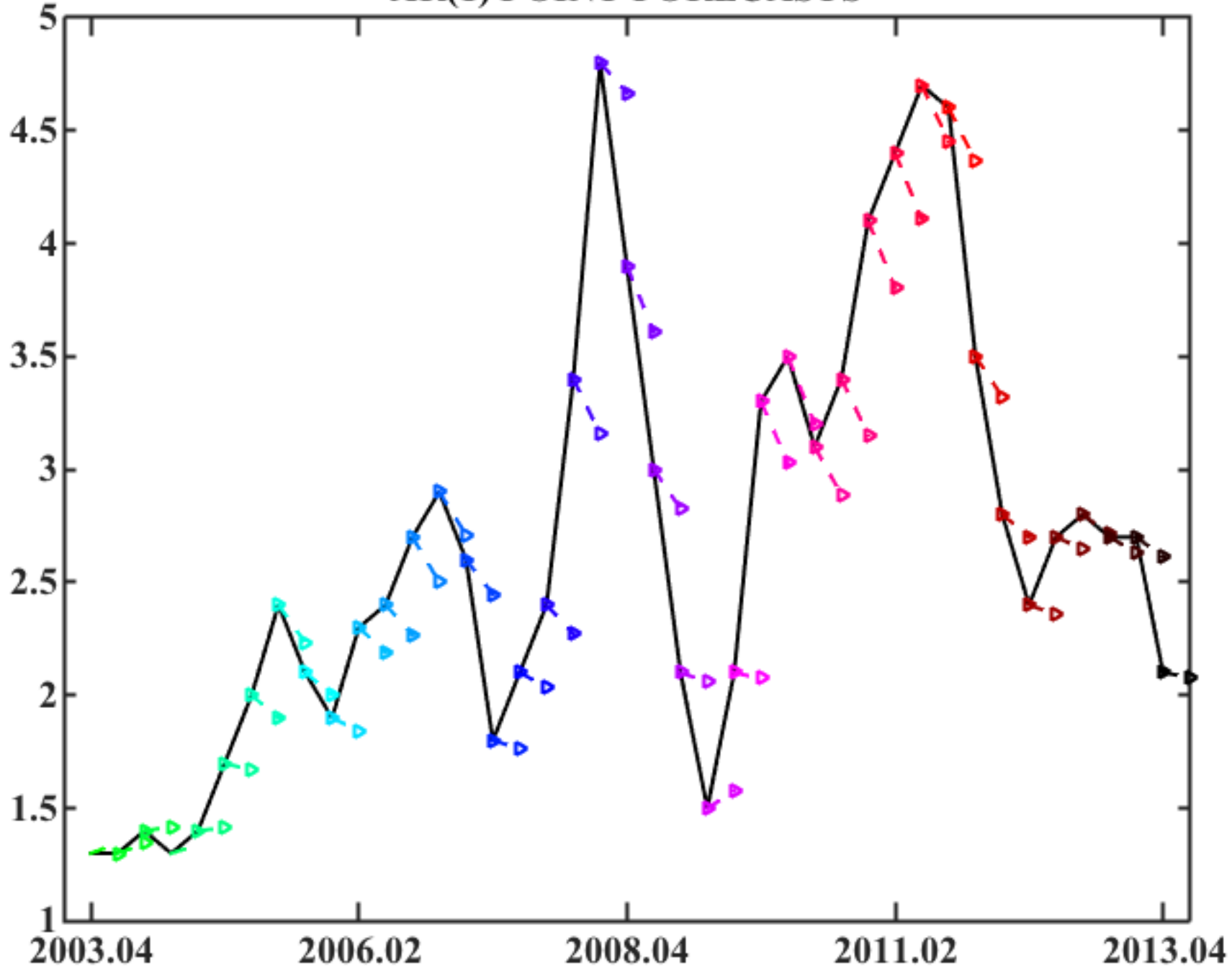
AR(1) FORECAST, h=1



# BOE POINT FORECASTS

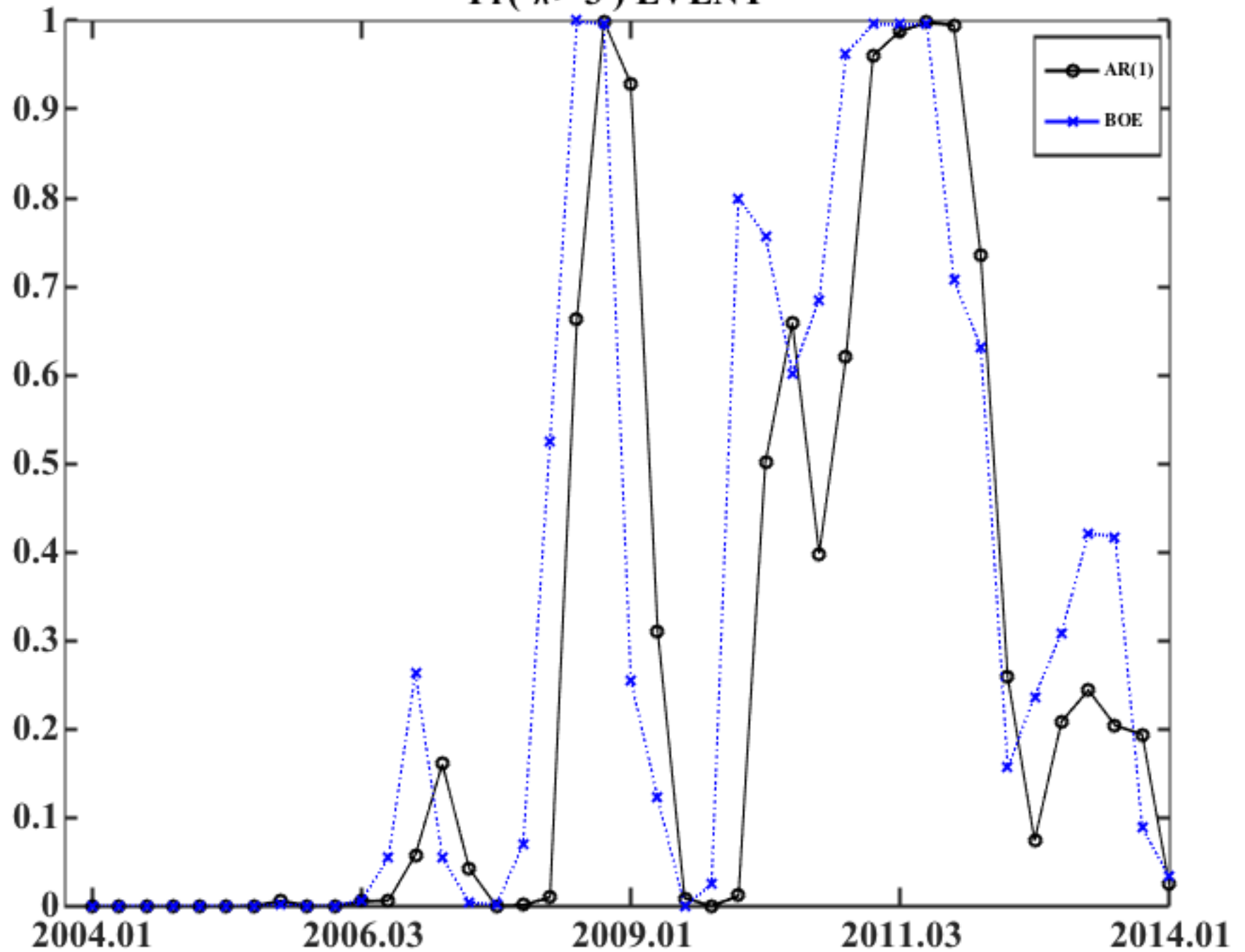


# AR(1) POINT FORECASTS

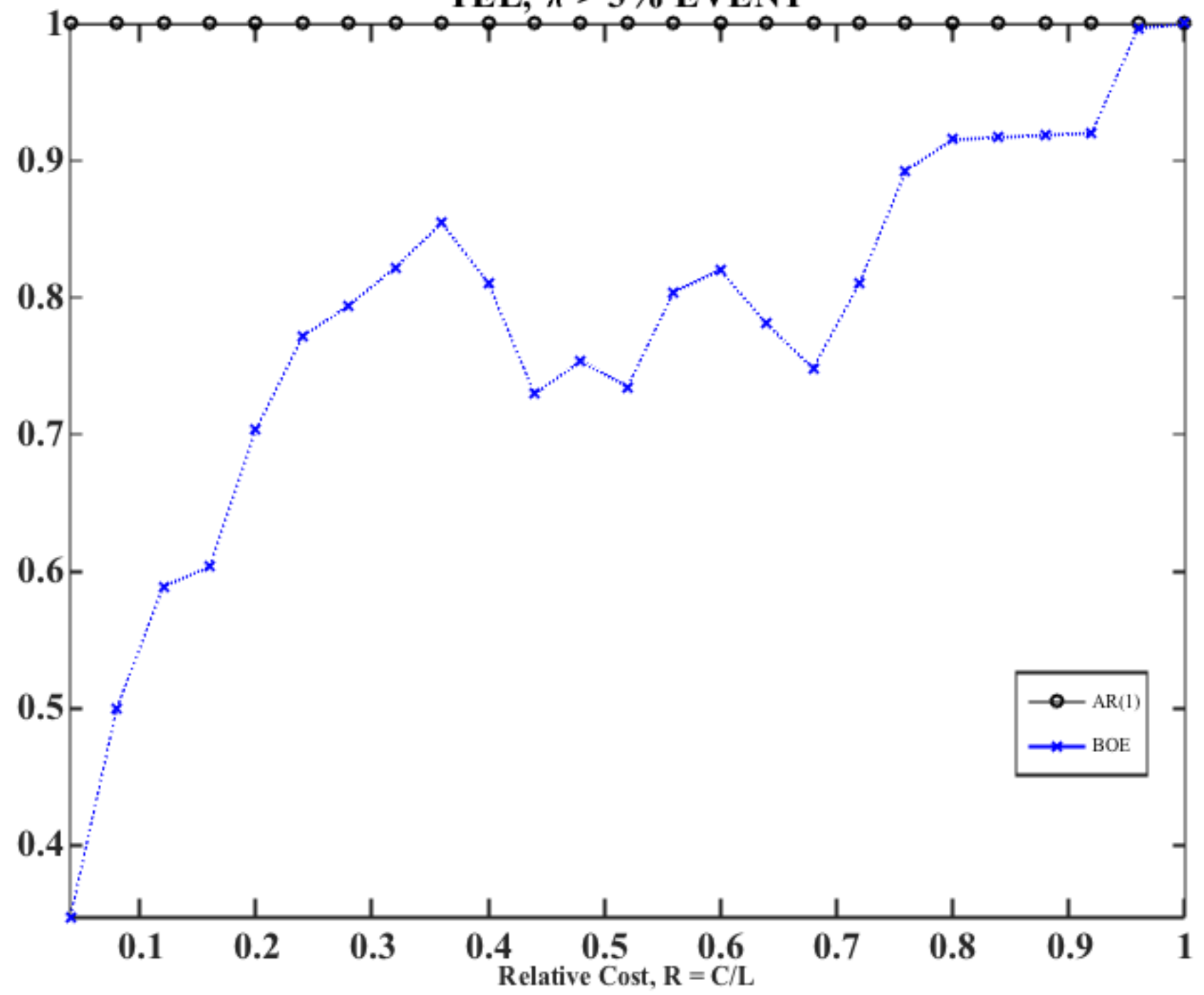




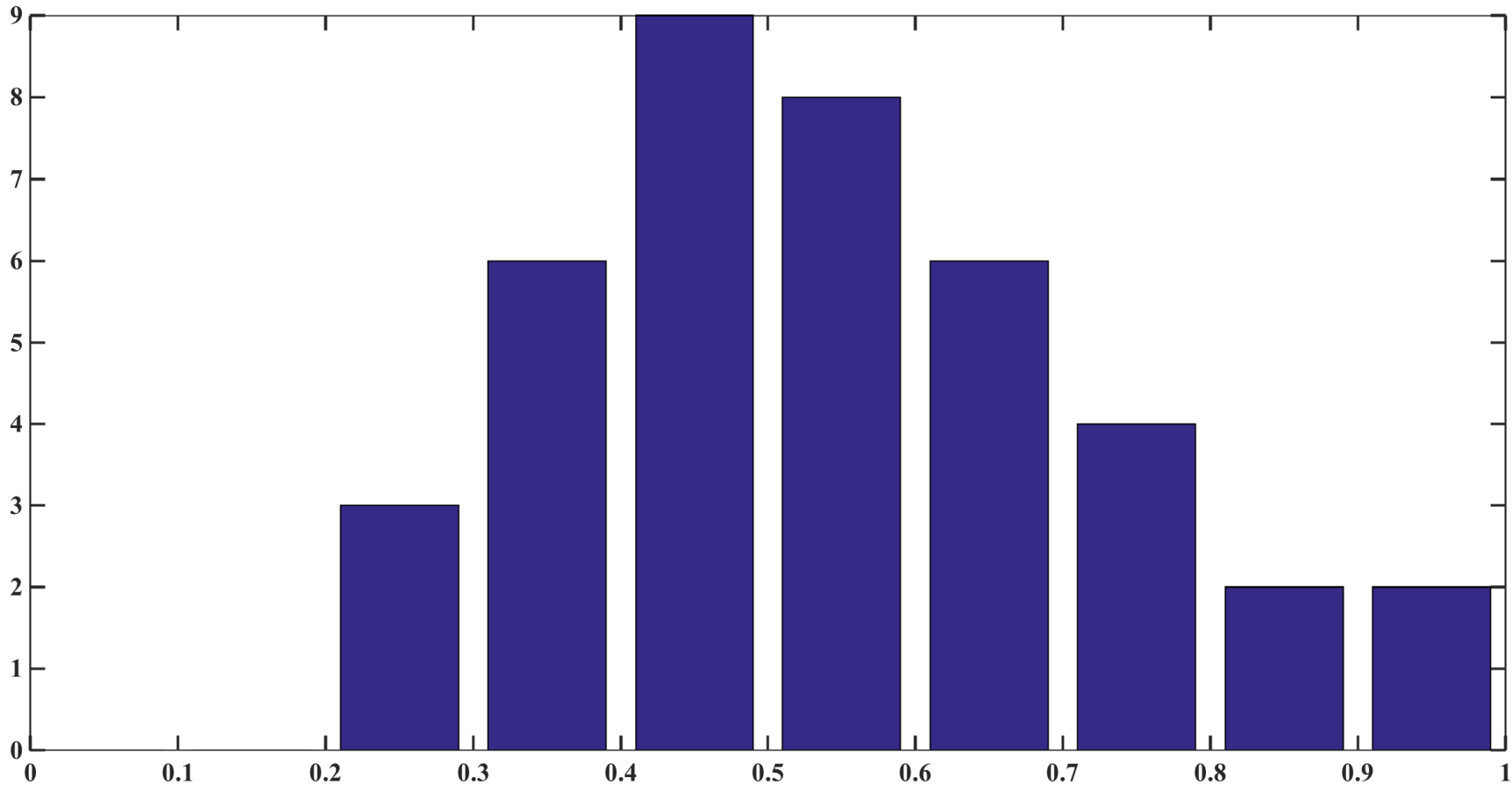
### Pr( $\pi > 3$ ) EVENT



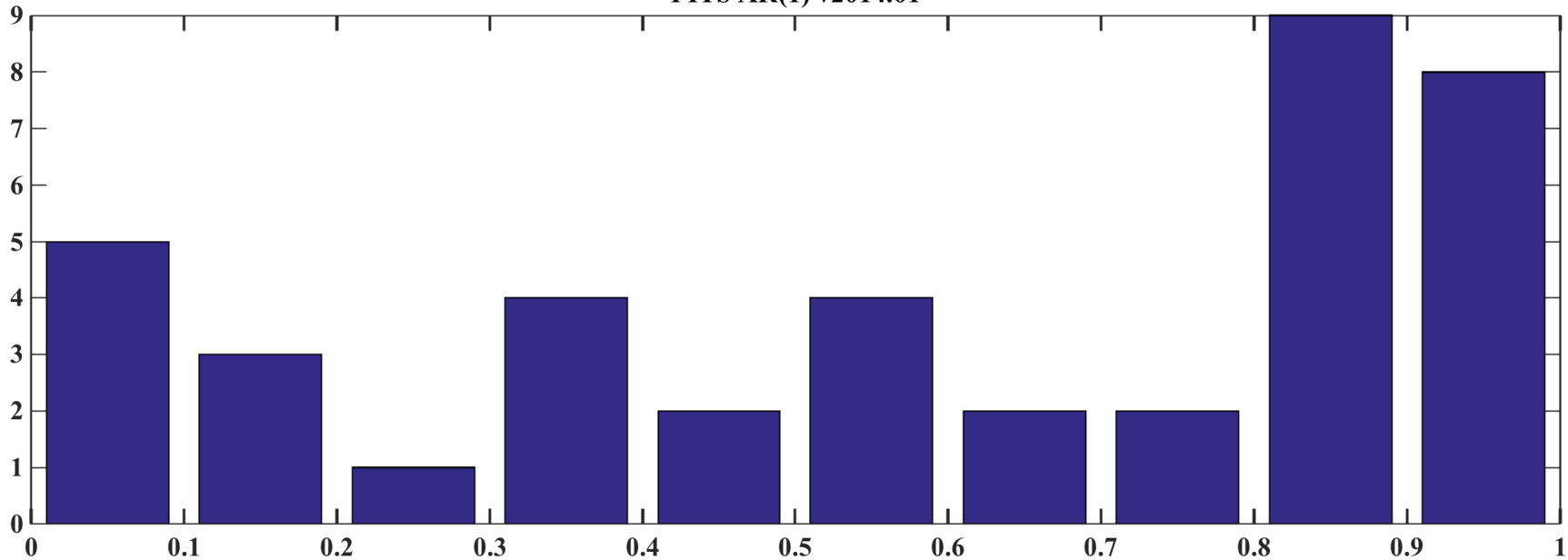
### TEL, $\pi > 3\%$ EVENT



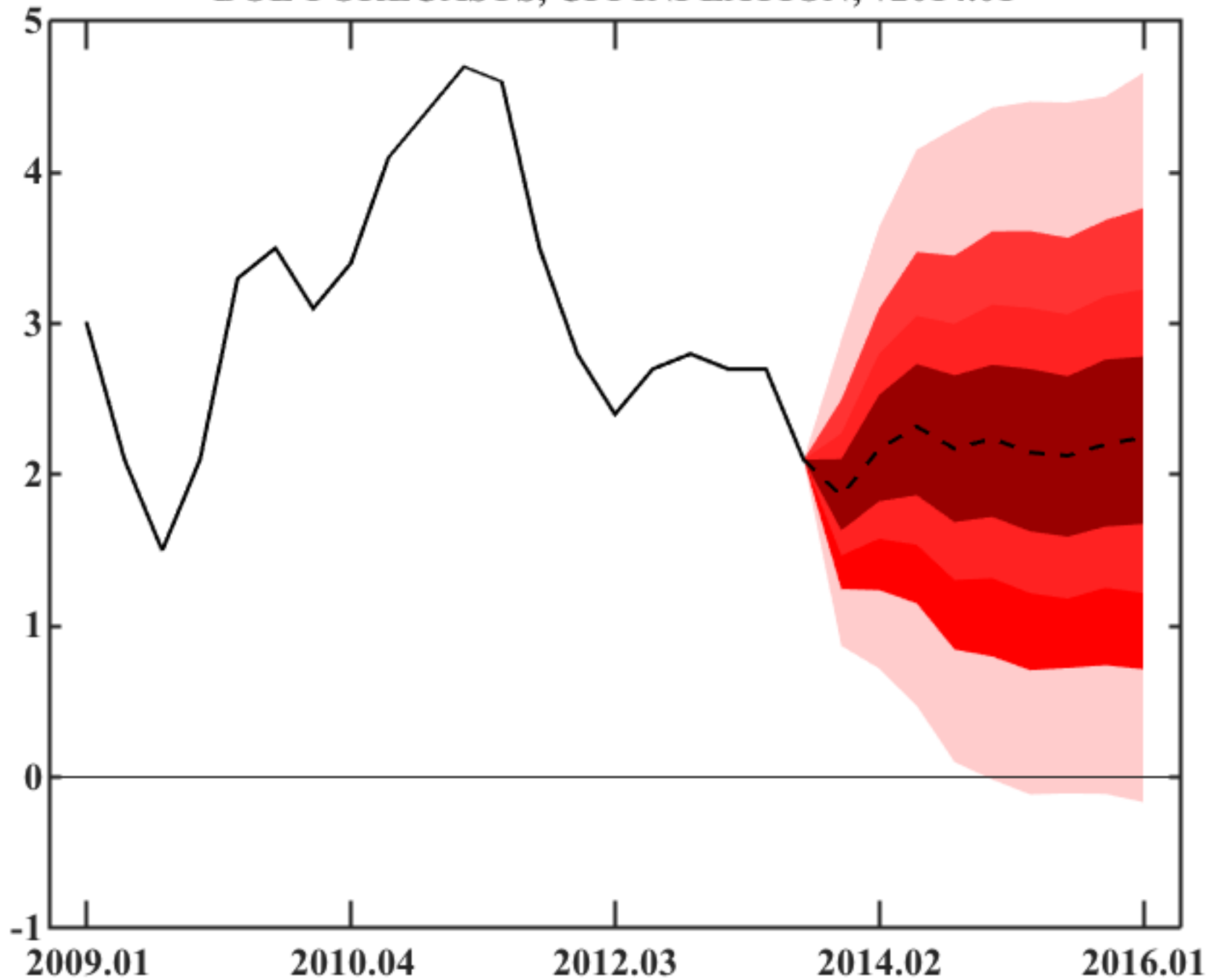
BOE PITS v2014.01



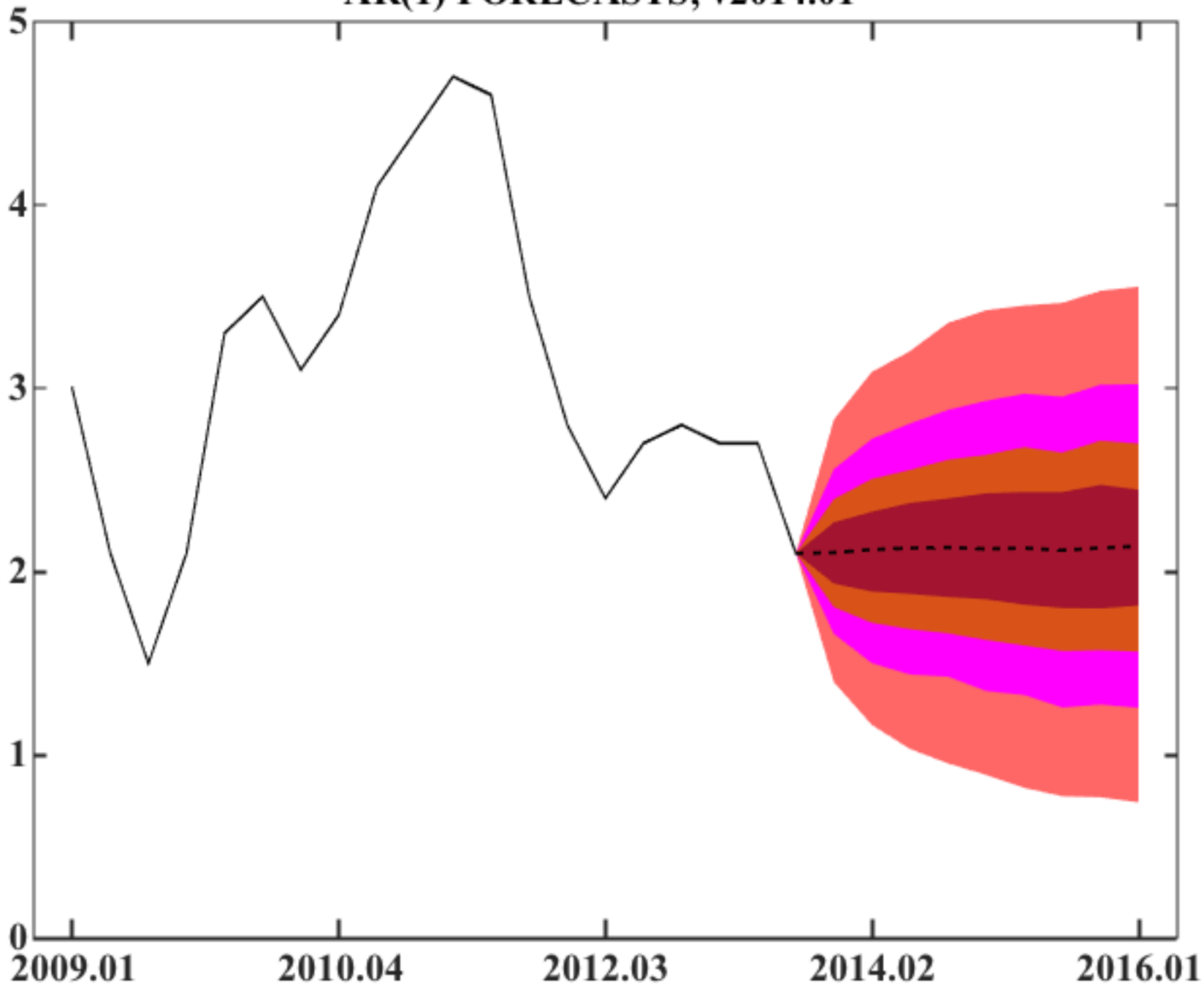
PITS AR(1) v2014.01



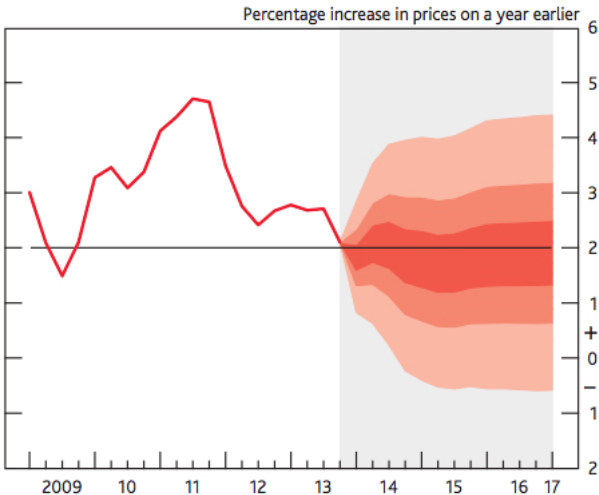
**BOE FORECASTS, CPI INFLATION, v2014.01**



**AR(1) FORECASTS, v2014.01**



## CPI inflation projection (wide bands)<sup>(a)</sup>



## Some questions of interest

- ▶ Can log score based evaluations of forecast densities mask predictive content? Yep: log score differentials aren't sufficient to indicate that policymaker can use expert in real time to give an early warning indicator
- ▶ What additional steps—beyond log scores—might be useful to analyse forecast performance? Some tricks from PROFOR toolbox (spvahey@gmail.com)



- ▶ CRPS Hersbach (2000), Ravazzolo-Vahey (2009, 2013) maximising sharpness conditional on calibration; plus threshold scoring rules, Gneiting-Ranjan (2011), Garratt-Mitchell-Vahey (2013)
- ▶ Analyse PITS to check calibration (reliability) eg Diebold-Gunther-Tay (1998), Jore-Mitchell-Vahey (2010); plus resolution vNorden-Galbraith (2008)
- ▶ Utilise loss function (if you know it!) Granger-Pesaran (2000a, 2000b)

- ▶ Example shows that in terms of one step ahead forecasts, the Bank's forecasts are substantially better for early warning signals of inflationary pressures. We can quantify the magnitude using a loss function.
- ▶ But, there are issues. PITS reveal forecast densities are too diffuse.
- ▶ AR(1) benchmark too narrow (usually, and lagging), implying gains from combination

- ▶ John Kay (FT, September 21 2010):

“There will always be a demand for forecasts, so there will always be a supply. But the reputation of economic forecasters, like other quacks and charlatans, depends more on the slickness of their presentations than the value of their work”