BAYESIAN VAR FORECASTS, SURVEY INFORMATION AND STRUCTURAL CHANGE IN THE EURO AREA

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BAYESIAN VAR FORECASTS, SURVEY INFORMATION AND STRUCTURAL CHANGE IN THE EURO AREA [(*)]

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Abstract

We incorporate external information extracted from the European Central Bank's Survey of Professional Forecasters into the predictions of a Bayesian VAR, using entropic tilting and soft conditioning. The resulting conditional forecasts significantly improve the plain BVAR point and density forecasts. Importantly, we do not restrict the forecasts at a specific quarterly horizon, but their possible paths over several horizons jointly, as the survey information comes in the form of one- and two-year-ahead expectations. Besides improving the accuracy of the variable that we target, the spillover effects on "other-than-targeted" variables are relevant in size and statistically significant. We document that the baseline BVAR exhibits an upward bias for GDP growth after the financial crisis, and our results provide evidence that survey forecasts can help mitigate the effects of structural breaks on the forecasting performance of a popular macroeconometric model. Furthermore, we provide evidence of unstable VAR dynamics, especially during and after the recent Great Recession.

Keywords: Survey of Professional Forecasters, density forecasts, entropic tilting, soft conditioning.

JEL classification: C32, C53, E37.

Resumen

Incorporamos información externa, extraída de la encuesta «Survey of Professional Forecasters» del Banco Central Europeo, en las predicciones de un VAR Bayesiano, utilizando *entropic tilting* y *soft conditioning.* Las previsiones condicionales resultantes mejoran significativamente los pronósticos puntuales y de densidad del BVAR simple. Es importante destacar que no restringimos las predicciones en un horizonte trimestral específico, sino sus posibles trayectorias en varios horizontes de modo conjunto, debido a que la información de la encuesta se presenta en forma de expectativas a uno y dos años. Además de mejorar la precisión de la variable a la que nos dirigimos, los efectos indirectos sobre las demás variables son relevantes en tamaño y estadísticamente significativos. En el documento vemos que el BVAR simple muestra un sesgo positivo para el crecimiento del PIB después de la crisis financiera, y nuestros resultados proporcionan evidencia de que los pronósticos de las encuestas pueden ayudar a mitigar los efectos de los saltos estructurales en el desempeño de los pronósticos de un modelo macroeconométrico corriente. Además, proporcionamos evidencia de un VAR con parámetros variables en el tiempo inestable, especialmente durante y después de la reciente Gran Recesión.

Palabras clave: Survey of Professional Forecasters, pronósticos de densidad, *entropic tilting, soft conditioning.*

Códigos JEL: C32, C53, E37.

1 Introduction

Producing reliable forecasts is a central effort of many academics and central banks, and it is known that pooling the predictions of survey panelists provides precise forecasts of key macroeconomic variables (see e.g. Ang et al. (2007) and Stark (2010)). However, survey expectations are usually not available for all horizons or variables of interest and are often limited to point predictions. On the other hand, it is straightforward to generate both point and density forecasts from time series models for any variable at any horizon. The recent literature, therefore, tries to bridge this gap by incorporating external information into econometric models, to benefit from survey forecasts beyond the scope of the surveys itself.

We contribute to this literature by using two existing methods, entropic tilting and soft conditioning, to incorporate external information into the forecasts of a Bayesian Vector Autoregressive (BVAR) model estimated using real-time euro area data. We find that incorporating one- and two-year-ahead survey expectations on GDP growth, harmonised index of consumer prices (HICP) inflation, and the unemployment rate considerably improves predictive accuracy. Improvements are statistically and economically significant and the results hold for both point and density forecasts. In addition to improvements in the forecast accuracy of the variable for which external information is used, spillover effects on the rest of the variables are positive in terms of predictive accuracy, often statistically significant and qualitatively similar across the two methods. We provide evidence that around the two recent euro area recessions, as well as the slow recovery thereafter, SPF panelists predicted GDP growth more accurately than a BVAR model, hence integrating this information into the econometric model's forecasts leads to considerable gains. We consider the incorporation of additional information as a way to correct possible misspecifications in an otherwise useful model and our results do not advocate to abandon using BVARs for forecasting. In contrast, the positive spillover effects imply that not only the conditioning information itself is valuable but also that the BVAR translates the conditioning information on one variable into useful information on other variables.

The underlying econometric model is a four-variable Bayesian VAR with stochastic volatility (Clark & Ravazzolo, 2015), including real GDP growth, HICP inflation, the unemployment rate, and the 3-month Euribor rate. To mimic the actual forecasting environment that forecasters faced at a given point in time, we use real-time data vintages (building on the real-time database by Giannone et al., 2012) for the former three series (the interest rate variable is not revised). Due to a "ragged edge" problem, introduced by the mismatch between the timing of the survey and the data releases, we additionally apply the jumping-off procedure of Faust & Wright (2009) in combination with ECB/Eurosystem staff projections.[1]

To rule out alternative explanations for the improvements over the baseline BVAR, we perform additional forecasting exercises. First, to account for time-variation in parameters, we produce forecasts using a time-varying parameter BVAR. Second, to account for omitted variables, we produce forecasts using a large (14-variable) BVAR. Third, we use "dummy-initial-observation" and "sum-of-coefficients" priors to rule out that results are driven by overfitting the deterministic component. The model is implemented using the hierarchical BVAR of Giannone et al. (2015), which treats the informativeness of the prior as a random variable and thus also serves as a

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[1]To ensure that our results are not driven by the ECB/Eurosystem staff projections, we also conducted the forecasting exercises without the jumping-off approach. The results are very similar and shown in the Online Appendix.

robustness check against our choices of hyperparameters. Fourth, we estimate the baseline BVAR in levels. The results obtained via the baseline model are robust to all four alternative specifications.

Additionally, we document that the dynamics of the time-varying parameter BVAR have shifted towards the unstable region after the recent Great Recession and the following sovereign debt crisis.

The first method, entropic tilting, is based on Robertson et al. (2005). It has gained popularity in the recent years to incorporate external information into model-based forecasts, for example, see Krüger et al. (2017) for a macroeconomic application, or Altavilla et al. (2017) from the field of finance. In simple terms, by taking a possibly multivariate base distribution (e.g. the predictive distribution of a BVAR model) and a vector of moment conditions (e.g. the expected value of GDP growth at the one-quarter-ahead horizon is 0.4%), entropic tilting provides a new, "tilted" distribution which is closest to the base distribution in the Kullback–Leibler sense, and at the same time satisfies the moment conditions. Therefore, this method allows one to add judgment to an existing forecast distribution (*i*) in a principled manner which is rooted in information theory, (*ii*) without having to re-estimate or re-specify the model that provided the base distribution, and (*iii*) it allows to obtain a conditional forecast that incorporates uncertainty about the conditioning values.[2] Hence, the method offers a quite general and fast post-estimation adjustment tool. Furthermore, Giacomini & Ragusa (2014) showed that if the moment condition is indeed correct, then asymptotically the entropic tilting method cannot lead to worse forecasts than using the original, base distribution when the forecasts are evaluated using the logarithmic scoring rule.[3]

The second method, soft conditioning, is based on Waggoner & Zha (1999). Originally, the authors aimed at producing conditional forecasts in multivariate models, for instance, to extract GDP and inflation forecasts, given a specific future path of the policy rate. In a similar spirit, the method can be used to impose a future path of, say, GDP growth, where the path is based on external information. In our application, following Krüger et al. (2017), it amounts to retaining only those draws of the BVAR's predictive distribution that are within a corridor around the imposed survey expectations. Therefore, in general, and in contrast to entropic tilting, the expected value of the retained BVAR draws will not be equal to the survey expectation but merely shifted towards it. The predictions thus resemble a middle-way of the BVAR forecasts and the survey expectations. For the reader's convenience, we will generally use the term "tilt" for both methods and be more precise when needed.

We take the external forecasts from the Survey of Professional Forecasters (SPF) conducted by the ECB (ECB–SPF). For evaluations of the quality of the ECB–SPF forecasts, see Genre et al. (2013), Kenny et al. (2014) and Kenny et al. (2015). The overwhelming majority of panelists states that their forecasts, for horizons of one year or more, are based on judgment, or model-based with judgment adjustment, see European Central Bank (2019). Both the judgment adjustment, as well as the pooling of many opinions could be a factor in explaining the good forecasting performance of the survey. We extract the predictive mean and variance from the consensus (mean across forecasters) histogram forecasts of the fixed-horizon, one- and two-year-ahead panels for our baseline results.

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[2]Antolin-Diaz et al. (2019) show the equivalence of entropic tilting to linear restrictions on the mean and variance of the forecast distribution for the special case of Gaussian densities.

[3]More recently, Altavilla et al. (2017) suggested a test which can help researchers decide on which moments of the multivariate density they should impose external moment conditions.

Our sample of SPF forecasts ranges from 1999:Q1 to 2017:Q3. Importantly, the panelists forecast year-on-year growth rates of real GDP and HICP, and the unemployment rate one and two years ahead. As real GDP and the HICP enter the BVAR in 100 times logarithmic quarter-on-quarter differences, this implies that we do not impose a moment condition, for example, on the growth rate of GDP at *one* of the BVAR's specific horizons but rather on the product of quarterly GDP growth over *several* horizons.

The present paper is most closely related to Krüger et al. (2017) but differs in the following important ways. First, we tilt one-year-ahead and two-year-ahead forecasts instead of nowcasts (i.e. predictions for the current quarter) of the BVAR, due to the format of the ECB–SPF, and the lack of nowcasts in the survey. Second, as mentioned earlier, we impose the moment condition on GDP growth or HICP inflation over several horizons of the BVAR, i.e. not on any horizon directly, which is effectively a restriction on the possible paths of these variables over several horizons. Third, we are the first to apply entropic tilting and soft conditioning using the ECB–SPF in a euro-area forecasting exercise. Another related paper by Bańbura & van Vlodrop (2018) uses euro area Consensus Economics long-run forecasts to anchor a time-varying mean of a Bayesian VAR that captures low-frequency movements of the variables. Different from our work, they focus on long-run forecasts from Consensus Economics, the survey information only affects the time-varying mean, and the authors do not make use of survey density forecasts. Moreover, the present study is also related to Wright (2013), whose "democratic" prior incorporates information on the long-run mean of key US macroeconomic variables, leading to considerable gains in terms of point forecasts. In contrast, we utilize shorter-horizon forecasts, which are better aligned with the forecast horizons we consider, and we do not inform the BVAR's *priors* using the survey forecasts, but rather the BVAR's predictive distribution directly. We also contribute to the growing literature using real-time euro area data (see e.g. Jarociński & Lenza (2018) or McAdam & Warne (2019) and the papers cited therein). The paper is further related to Tallman & Zaman (2019), but the authors make use of nowcast and long-run (five-year-ahead) predictions and focus on U.S. data when applying entropic tilting. Additionally, Del Negro & Schorfheide (2013) provide evidence that incorporating survey expectations into a *structural* Dynamic Stochastic General Equilibrium (DSGE) model improves its forecasts.

Further, this paper relates to the literature on conditional forecasts and the forecasting exercises conducted at policy institutions as described in Angelini et al. (2019) and the references therein. Macroeconomic projections published by policy institutions, for instance by the ECB, are typically based on so-called "technical assumptions", which are a set of conditional values for certain variables such as policy rates or fiscal policy developments. Bańbura et al. (2015) show how to condition on a specific path of variables for large systems, extending earlier work by Waggoner & Zha (1999). While their method updates parameter estimates given the conditioning path, the future values are assumed to be known and fixed, i.e. uncertainty around the future path is not accommodated. As the SPF provides moments rather than "technical (fixed) assumptions" for future values, using moment restrictions is the obvious way to incorporate the information for improving forecasts. As noted in Andersson et al. (2010) and Antolin-Diaz et al. (2019), under the assumption of normality, the moment restrictions can be rewritten as a deviation from the unconditional distribution of the shocks of the BVAR. Assuming a correct specification of the BVAR, an improvement using the SPF would be attributed to the panelists' better understanding (or anticipation) of which shocks are driving the economy.

The remainder of the paper is organized as follows. Section 2 introduces the BVAR and the two methods that we use to incorporate external information into the BVAR. Section 3 describes the ECB-SPF, the real-time dataset, and the forecast evaluation methods. Section 4 presents the main empirical results, Section 5 contains results of alternative forecasting exercises, and Section 6 concludes. Additional results are collected in the Appendix and in the Online Appendix.

2 Methodology

2.1 Bayesian VAR

The baseline forecasts are obtained from a Bayesian VAR with stochastic volatility. The model is based on Clark & Ravazzolo (2015), who showed that allowing for stochastic volatility materially improves BVAR models' density forecasts. Let $\text{diag}(\cdot)$ denote the operator generating a diagonal matrix from its arguments, $\overset{iid}{\sim}$ stand for independently and identically distributed, and $\mathcal{N}(\mu, \Phi)$ denote the normal distribution with mean vector μ and variance-covariance matrix Φ. Let y_t be a $(K \times 1)$ vector of variables at time t. Then the BVAR model is given by

$$y_t = B_0 + \sum_{i=1}^{p} B_i y_{t-i} + A^{-1} \Sigma_t^{\frac{1}{2}} e_t, \tag{1}$$

$$\Sigma_t \equiv \text{diag}\left(\sigma_{1,t}^2, \ldots, \sigma_{K,t}^2\right), \tag{2}$$

$$\log(\sigma_{k,t}^2) = \log(\sigma_{k,t-1}^2) + \eta_{k,t} \quad \text{for} \quad k = 1, \ldots, K, \tag{3}$$

where B_0 is the $(K \times 1)$ vector of intercepts, B_is are the $(K \times K)$ coefficient matrices, A^{-1} is a lower triangular matrix with ones on the diagonal, $e_t \overset{iid}{\sim} \mathcal{N}(0, I_K)$ and $(\eta_{1,t}, ..., \eta_{K,t})' \overset{iid}{\sim} \mathcal{N}(0, \Xi)$, where Ξ is not constrained to be diagonal.

In the selection of the variables, we follow Krüger et al. (2017) and use a standard four-variable specification ($K = 4$), which includes 100 times the log-differences of real GDP and HICP, the level of the unemployment rate, and the end-of-quarter 3-month Euribor rate. The lag length is chosen according to a Bayesian Information Criterion (BIC, Schwarz, 1978) and is equal to $p = 2$.[4]

The Markov Chain Monte Carlo (MCMC) Gibbs sampler and the simulation of the predictive densities are standard, and we refer to Clark & Ravazzolo (2015) for further details. For the VAR coefficients, we use a Minnesota-type prior, following the baseline specification of Carriero et al. (2015), which shrinks all coefficients of the two log-differenced variables to zero and the first own-lag coefficient of the two variables in levels to 0.8 (and all of their other coefficients to zero). The only difference from Carriero et al. (2015) is that we apply somewhat more cross-variable shrinkage due to the short data sample.[5] In particular, we use an overall tightness parameter of 0.2, cross-variable tightness of 0.5 and linear lag decay. We retain each 8th draw after a burn-in sample of 5,000 draws and, based on the oversampling algorithm of Waggoner & Zha (1999), for each of the 4,000 retained parameter draws, we draw five forecasting paths. The final number of draws that we obtain for each y_{t+h}, where $h = 1, \ldots, 8$, is equal to 20,000, which we will refer to as MCMC draws.

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[4]In particular, at each forecast origin, we estimated the model using ordinary least squares with lag lengths from one to four. In the majority of cases the BIC suggested two lags.

[5]The BEAR toolbox documentation recommends very similar prior specifications (see Dieppe et al., 2016).

As a first variation of the baseline model, to account for potential changes in coefficients, we use a time-varying parameter VAR (TVP-VAR) based on Primiceri (2005) and Del Negro & Primiceri (2015). The model allows the elements of the coefficient matrices B_0 and B_is to follow a random walk. The prior means and covariance matrix of the VAR coefficients are based on a VAR model estimated by ordinary least squares on a training sample of 44 pre-sample observations. We use two lags to balance the number of estimated parameters and the flexibility of the model.

As a second alternative model, we use a medium-sized 14-variable BVAR with constant coefficients and a common stochastic volatility specification based on Chan (2018).[6] The usage of more predictors is motivated by the work of Bańbura et al. (2010) and Bańbura et al. (2015), who found that larger BVARs tend to forecast more accurately than smaller BVARs if sufficient shrinkage is applied in the larger models' estimation.

Additional robustness checks reported in the Online Appendix include the estimation of (*i*) a hierarchical BVAR following Giannone et al. (2015), in (log-)levels and using a Minnesota-type prior, a "dummy-initial-observation" and a "sum-of-coefficients" prior, and (*ii*) the baseline BVAR but using log-levels for real GDP and the HICP, and a Minnesota prior that shrinks the first own-lag coefficient to one and all other coefficients to zero. In Giannone et al. (2015), the hyperparameters that control the tightness of the priors are treated as random variables. The "dummy-initial-observation" and "sum-of-coefficients" priors provide some robustness against the potential overfitting of the BVAR because it penalizes large deviations of the model's steady state from the initial observations. Moreover, treating the hyperparameters as random variables provides some robustness to our specific choices of the hyperparameters for the previously discussed models.

2.2   Incorporating External Forecasts into the BVAR

The survey expectations that we use for real GDP and HICP are quarterly, one- and two-year-ahead year-on-year growth rates. First, let us consider the one-year-ahead growth rate. Let $q_{t+4,k}$ denote the level of variable q (either real GDP or HICP) at time $t + 4$. The quarterly, one-year-ahead year-on-year growth, $g_{t,4,k}$, takes the form of

$$g_{t,4,k} = \frac{q_{t+4,k}}{q_{t,k}} \, . \tag{4}$$

The SPF's mean prediction at time τ that we consider is then defined as $\mu_{\tau,4,\mathrm{SPF},k} = 100 \, \mathbb{E}(g_{t,4,k} - 1 \mid \Omega_\tau)$, where Ω_τ denotes the information set available to the SPF panelists at time τ. The SPF provides distributional forecasts in the form of histograms, which contain probabilities assigned to pre-specified bins of the variable in question. We refer to Section 3 for details on how we computed $\mu_{\tau,4,\mathrm{SPF},k}$ (and the variance $\sigma^2_{\tau,4,\mathrm{SPF},k}$) based on the ECB–SPF histograms, for the exact timing of the ECB-SPF forecasts, and for the data vintages that we use. We note that due to the format of the survey and the publication lag of the variables, τ does not equal t. Let $r_{t+1,k}$ denote the quarterly growth rate from t to $t + 1$, that means

$$r_{t+1,k} = \frac{q_{t+1,k}}{q_{t,k}} - 1 \, . \tag{5}$$

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[6] For details on the variables, see Section 5.2.

Real GDP and the HICP enter the BVAR in 100 times logarithmic differences which are related to the quarterly growth rates by $y_{k,t} \equiv 100 \left(\log(q_{t,k}) - \log(q_{t-1,k}) \right) = 100 \log \left(1 + r_{t,k} \right)$. Note that $g_{t,4,k}$ can straightforwardly be written as[7]

$$
\begin{aligned}
g_{t,4,k} &= \frac{(1 + r_{t+1,k})(1 + r_{t+2,k})(1 + r_{t+3,k})(1 + r_{t+4,k})q_{t,k}}{q_{t,k}} \\
&= (1 + r_{t+1,k})(1 + r_{t+2,k})(1 + r_{t+3,k})(1 + r_{t+4,k}),
\end{aligned}
\tag{6}
$$

and similarly for the case of the two-year-ahead growth rate,

$$
g_{t,8,k} = \prod_{j=1}^{8}(1 + r_{t+j,k}).
\tag{7}
$$

Notice that, by imposing moment conditions on the quarterly, year-on-year forecasts of the BVAR, we effectively constrain the paths of several horizons instead of one horizon directly. As the model provides quarterly forecasts, we first transform the predictions to quarterly, year-on-year forecasts and then apply entropic tilting and soft conditioning. A potential alternative to imposing moment conditions on the year-on-year forecast would be to linearly interpolate the SPF forecast to obtain quarter-on-quarter predictions. While this approach is easily implemented for point forecasts, there is no straightforward analog for density forecasts. In addition, we report positive spillover effects, i.e. improvements for variables for which no SPF information is used.

For the unemployment rate, the ECB-SPF provides level forecasts, hence there is no need to compute growth rates.

The following subsections describe the two procedures for incorporating the survey information.

2.2.1 Entropic Tilting

This section provides a brief overview of the entropic tilting methodology, following the approach by Robertson et al. (2005) and Krüger et al. (2017), which provided a simple procedure to tilt the MCMC draws from a Bayesian VAR. It essentially amounts to re-weighting the MCMC draws such that the re-weighted draws satisfy the moment restriction(s) and the new distribution is closest to the original one.

Let f_t denote a predictive distribution for the $(n \times 1)$ vector x_{t+h}, given in the form of MCMC draws $\{x_{t+h,s}\}_{s=1}^{S}$, each with corresponding probability $w_s = 1/S$.[8] The Kullback–Leibler Information Criterion or distance (KLIC) between f_t and another distribution $\widetilde{f}_t$ given by the set of probabilities $\{\widetilde{w}_s\}_{s=1}^{D}$ is defined as

$$
\text{KLIC}\left(\widetilde{f}_t, f_t\right) \equiv \sum_{s=1}^{S} \widetilde{w}_s \log\left(\frac{\widetilde{w}_s}{w_s}\right) = \sum_{s=1}^{S} \widetilde{w}_s \log\left(S\widetilde{w}_s\right).
\tag{8}
$$

---

[7]Note that the quarterly, year-on-year growth rate can be approximated as the sum of quarterly, quarter-on-quarter growth rates: $\log(g_{t,4,k}) = \log\left((1 + r_{t+1,k})(1 + r_{t+2,k})(1 + r_{t+3,k})(1 + r_{t+4,k})\right) \approx r_{t+1,k} + r_{t+2,k} + r_{t+3,k} + r_{t+4,k}$. In the implementation, we do not use the approximation of the natural logarithm but the exact growth rate.

[8]Note that x_{t+h} might span several forecast horizons, and the original weights w_s do not need to be uniform. In the empirical application, we will exploit the former.

Based on external information, such as survey forecasts, the researcher might want to modify the original distribution f_t, such that the new, "tilted" distribution $\widetilde{f}_t$ satisfies m moment conditions (which f_t does not satisfy in general). The moment conditions are collected in $(m \times 1)$ vector $\bar{g}_\tau$, formally $\mathbb{E}_{\widetilde{f}_t} g(x_{t+h}) = \bar{g}_\tau$, where $g : \mathbb{R}^n \to \mathbb{R}^m$, with $m \geq 1$, and $\mathbb{E}_{\widetilde{f}_t} g(x_{t+h}) \equiv \sum_{s=1}^S \widetilde{w}_s g(x_{t+h,s})$ denotes the expected value of $g(x_{t+h})$ under the distribution $\widetilde{f}_t$. At the same time, the researcher might not want to deviate "too much" from the original distribution f_t in terms of KLIC.

These two objectives can be achieved through entropic tilting, which takes the form of the following optimization problem:

$$\min_{\widetilde{f}_t \in H_t} \text{KLIC}(\widetilde{f}_t, f_t) \qquad \text{such that} \qquad \mathbb{E}_{\widetilde{f}_t} g(x_{t+h}) = \bar{g}_\tau , \tag{9}$$

where H_t is the set of feasible distributions given the MCMC draws for f_t. The solution to this problem is given by

$$\widetilde{w}_s^* = \frac{\exp(\gamma^{*\prime} g(x_{t+h,s}))}{\sum_{s=1}^S \exp(\gamma^{*\prime} g(x_{t+h,s}))} , \tag{10}$$

and

$$\gamma^* = \operatorname*{argmin}_{\gamma} \sum_{s=1}^S \exp\left(\gamma'(g(x_{t+h,s}) - \bar{g}_\tau)\right) , \tag{11}$$

where $\{\widetilde{w}_s^*\}_{s=1}^S$ denotes the new weights used to construct the tilted MCMC BVAR predictive density. Importantly, entropic tilting does *not* require any further simulation from the original BVAR distribution, as the method is just re-weighting the existing MCMC draws.

In our application, we are tilting the BVAR's raw predictive distribution towards the first and second moment forecast by the SPF, i.e. $\bar{g}_\tau$ contains the target distribution's the mean ($\mu_{\tau,4,\text{SPF},k}$ and $\mu_{\tau,8,\text{SPF},k}$) and variance ($\sigma^2_{\tau,4,\text{SPF},k}$ and $\sigma^2_{\tau,8,\text{SPF},k}$) for the appropriate variable(s).

2.2.2 Soft Conditioning

First suggested by Waggoner & Zha (1999), and successfully used by Krüger et al. (2017) in a setting similar to ours, we apply soft conditioning to incorporate survey information into a BVAR as an alternative to entropic tilting. Waggoner & Zha's (1999) Algorithm 2 describes how to generate a conditional forecast based on a multivariate model. In our setup, the conditioning value, i.e. the assumed path that a specific variable will follow in the future, is centered around the SPF mean prediction. To accommodate the probabilistic nature of our forecasts, we retain all draws that are inside an interval around that path. Similarly to Krüger et al. (2017), our soft-conditioning interval (SC-I) for variable k at time τ takes the form of the Cartesian product of the intervals:

$$\text{SC-I}_\tau^k = \left[\mu_{\tau,4,\text{SPF},k} \pm 1.96\sqrt{\sigma^2_{\tau,4,\text{SPF},k}}\right] \times \left[\mu_{\tau,8,\text{SPF},k} \pm 1.96\sqrt{\sigma^2_{\tau,8,\text{SPF},k}}\right] . \tag{12}$$

Simply put, draws that are outside of SC-I$_\tau^k$ are discarded. In the case of soft-conditioning on several variables simultaneously (e.g. GDP growth, HICP inflation and the unemployment rate), we take the Cartesian product of the intervals and discard the MCMC draws that are outside of it, as in Krüger et al. (2017).

3 Data and Evaluation Methods

3.1 Survey of Professional Forecasters

The Survey of Professional Forecasters is a quarterly survey of professional forecasters about euro area macroeconomic variables, conducted by the ECB in the middle of the first month of a quarter. It provides fixed-event (corresponding to the same calendar year in each survey round) and fixed-horizon (corresponding to a fixed number of time periods ahead) point and distribution forecasts for euro area real GDP growth, HICP inflation, and the unemployment rate.[9] The fixed-horizon forecasts are available for (and only for) one, two, and five years ahead and the SPF's distributional forecasts come in the form of histograms, which contain probabilities assigned to pre-specified bins of the variable in question. Our baseline results use the one- and two-year-ahead fixed-horizon density forecasts and use the consensus, i.e. equal-weighted average of the histograms of all panelists.[10] The SPF sample we make use of ranges from 1999:Q1 to 2016:Q4.

We computed the SPF's forecasts of the first and second moment based on the predictive histograms as follows. We closed the bins by assuming that the lower and upper bins are of the same width as the inner ones. Then, the mean of the SPF distribution was obtained as the probability-weighted average of the midpoints of each bin, and similarly the variance was computed as the probability-weighted squared deviations of the midpoints and the mean (see Giordani & Söderlind, 2003). The mean and variance of the two-year-ahead growth rate were obtained analogously.

Figures 1 and 2 plot the time series of the mean and standard deviation forecasts of the SPF panelists. Notably, the predicted standard deviation increases during the Great Recession and remains on a higher level for all variables and both forecast horizons.

Importantly, ECB-SPF forecast horizons are counted based on the latest month or quarter for which data had been released at the time of the prediction. This requires two timing decisions. First, the HICP and unemployment SPF forecasts have monthly targets, namely in the first, second, third and fourth quarters: December (of the current year), March, June, September for HICP; November (of the current year), February, May, and August for the unemployment rate. As the BVAR uses quarterly data, we treat the forecasts as having a "quarterly" target, associating the target month with the corresponding quarter. We think this timing decision could have at most minor effects on the results for two reasons: firstly, at the one-year-ahead horizon, neighboring months' forecasts would be very similar, and secondly, it would at most put the SPF predictions at a disadvantage relative to the BVAR, as the original SPF forecasts correspond to monthly year-on-year growth rates, while the BVAR is specified in quarterly terms.

Second, the timing convention of the SPF also implies that the BVAR is subject to the "ragged edge" problem, because the BVAR uses quarterly data, and GDP releases are less frequent and

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[9]The Harmonised Index of Consumer Prices (HICP) is a price index calculated by Eurostat and the national statistical institutes in the euro area, following a common methodology (hence harmonised). The ECB's price stability objective is defined in terms of the aggregate, euro area HICP. The ECB recently added core HICP inflation to the survey questions.

[10]As pointed out by a discussant, the ECB-SPF point forecast is closely correlated with the ECB staff macroeconomic projections, which is published about a month before the respective SPF deadline. However, the ECB staff projections do not provide density forecasts in the form of histograms.

Figure 1: ECB–SPF histogram-based mean forecasts
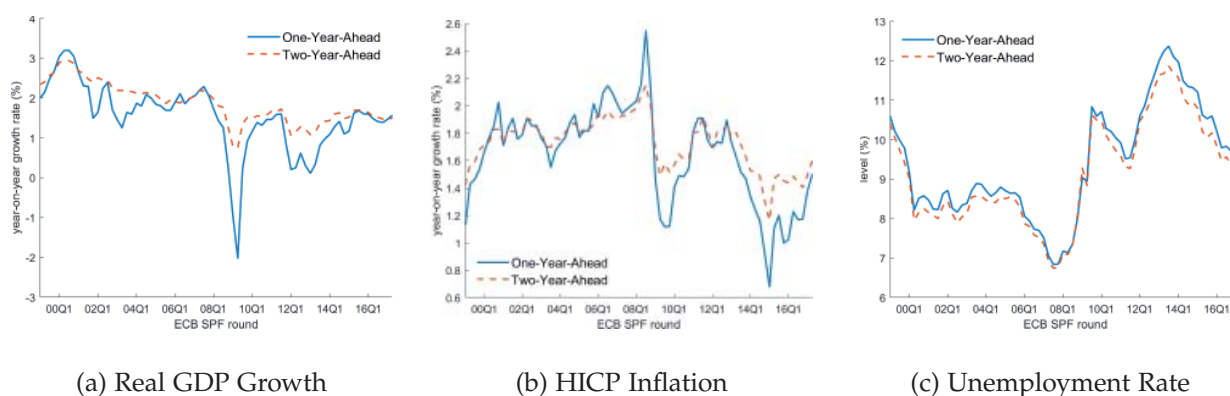
(a) Real GDP Growth   (b) HICP Inflation   (c) Unemployment Rate

Note: The figure displays the one-year-ahead and two-year-ahead ECB–SPF histogram-based mean forecasts. Panel (a) displays the mean forecast for real GDP growth, Panel (b) displays the mean forecast for HICP inflation, and Panel (c) displays the mean forecast for the unemployment rate. The timing of the horizontal axis is aligned to the ECB–SPF survey rounds, i.e. the forecast origin.

Figure 2: ECB–SPF histogram-based forecasts of the standard deviation
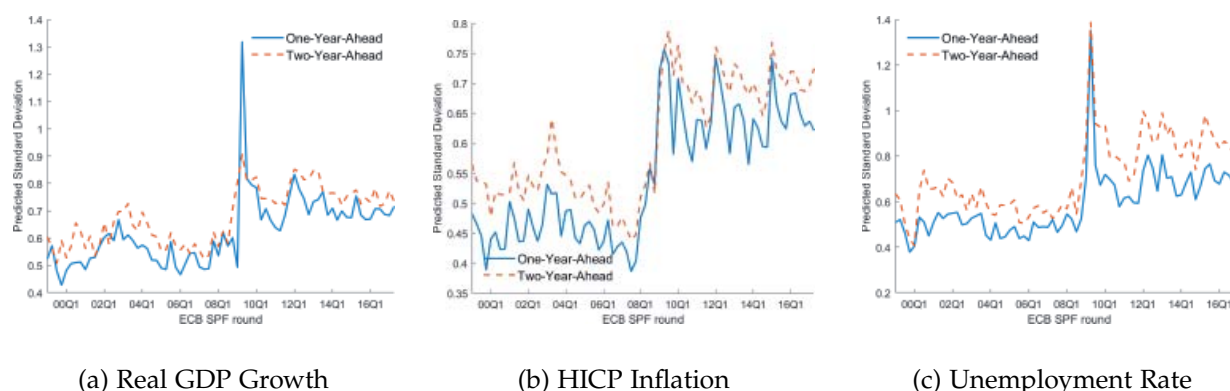
(a) Real GDP Growth   (b) HICP Inflation   (c) Unemployment Rate

Note: The figure displays the one-year-ahead and two-year-ahead ECB–SPF histogram-based forecasts of the standard deviation. Panel (a) displays the predicted standard deviation for real GDP growth, Panel (b) displays the predicted standard deviation for HICP inflation, and Panel (c) displays the predicted standard deviation for the unemployment rate. The timing of the horizontal axis is aligned to the ECB–SPF survey rounds, i.e. the forecast origin.

more delayed relative to releases of HICP and the unemployment rate.[11] In the SPF rounds conducted in the first, second, third, and fourth quarters, the target dates for GDP are the third (of the current year), fourth (of the current year), first (of the next year), and second (of the next year) quarters, respectively. For instance, at the time of the SPF deadline, typically two months of additional unemployment observations are available (three for HICP respectively) relative to the GDP release. We address this issue by using the jumping-off approach as developed in Faust & Wright (2009), which we describe in detail in the next subsection.

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[11]In all discussions of the "ragged edge" problem, we omit the Euribor, as it is financial markets data and available on a weekday basis.

3.2 Data for the Bayesian VAR and the Jumping-Off Method

The real-time data on real GDP, HICP, and the unemployment rate are taken from the ECB *Real Time Database* (Giannone et al., 2012) and our dataset ranges from 1991:Q1 to 2018:Q3. The vintages we use in the BVAR forecasts are synchronized according to the "deadline-to-reply" for SPF panelists to ensure that the BVAR and the SPF forecasts are based on the same real-time information set. Both real GDP and the unemployment rate are seasonally adjusted. We convert the latter to quarterly frequency by taking the average of the monthly observations. For HICP, the real-time data are not seasonally adjusted. Hence, we first apply the TRAMO-SEATS method to obtain seasonally adjusted data (U.S. Census Bureau (2017), implemented by Lengwiler (2017)), and then convert the monthly, seasonally adjusted HICP series to the quarterly frequency by averaging. The Online Appendix discusses some additional properties of the ECB Real Time Database.

In addition to the real-time data, we use data from the 18th update of the Area-wide Model database (Fagan et al., 2001), which dates back to 1970:Q1 and is provided by the Euro Area Business Cycle Network. We use this dataset for two reasons. First, we obtain the (end-of-quarter) 3-month Euribor interest rate from the database, where the last observation corresponds to 2017:Q4 (the remaining three observations are downloaded from the ECB Statistical Data Warehouse). Second, we use data on all four series between 1980:Q1 and 1990:Q4 to estimate hyperparameters for the prior of the time-varying parameter BVAR and to provide the scaling factors of the Minnesota-style prior covariance matrix of the BVAR coefficients.

Due to the "ragged edge" problem discussed above, we make use of the ECB's "(Broad) Macroeconomic Projection Exercise" (ECB-MPE) nowcasts, which consist of quarterly ECB and Eurosystem staff forecasts and provide, *inter alia*, quarter-on-quarter growth nowcasts of real GDP for the euro area.[12] The macroeconomic projections are published at the beginning of the last month of a given quarter (March, June, September, and December), and the nowcasts for quarter one, two, three and four are based on information up to the second half of February, May, August and November, respectively. Given this publication schedule, the ECB-MPE projections are at an information disadvantage of one month relative to the SPF. We consider this to be a minor concern for two main reasons. First, for HICP and the unemployment rate, we use the same data as available to the SPF. Second, at the forecast horizon of several quarters, the effect of one month of extra information is arguably rather small.

The ECB-MPE nowcasts are plugged-in for the missing GDP data at the forecast origin (missing relative to the latest HICP and unemployment observations) which is called a jumping-off procedure (Faust & Wright, 2009). Results are robust when dealing with the "ragged edge" problem without the jumping-off procedure and are shown in the Online Appendix.

The BVAR is estimated in a recursive (expanding window) manner, mainly due to the relatively short initial data sample. To give an example, for the first forecast, the estimation sample of the BVAR is based on the 1999:Q1 vintage (before the release of 1998:Q4 real GDP data), i.e. the in-sample ranges from 1991:Q1 to 1998:Q3. At the time of the SPF 1999:Q1 forecasts, the HICP data for 1998:Q4 and the unemployment rate data for 1998:M10 and 1998:M11 (which we average and take as the 1998:Q4 data) were already released, but not the 1998:Q4 GDP data. Therefore,

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[12]In June and December, the projections are performed at the Eurosystem level, and these rounds are called Broad Macroeconomic Projection Exercises. For simplicity, we will refer to all projections rounds as ECB-MPE.

we apply the jumping-off procedure: for the forecasts, the BVAR uses the realized HICP, Euribor and unemployment rate data for 1998:Q4 and we plug-in the ECB-MPE nowcast for the 1998:Q4 GDP growth value as no realization would have been available in real-time.

Consequently, the first prediction of the BVAR for $h = 1$ is for 1999:Q1. In total, the out-of-sample forecast errors we evaluate range from 1999:Q1 to 2016:Q4 for the $h = 1$ predictions, and from 2000:Q4 to 2018:Q3 for $h = 8$ predictions, i.e. the total out-of-sample size is, therefore, $P = 72$ for all horizons. Note that $h = 1$ corresponds to a nowcast, i.e. predictions for the quarter of the survey round.

3.3 Evaluation Methods

The evaluation of the forecasts is based on vintages one quarter after the initial estimate of GDP growth, HICP inflation and the unemployment rate (all at the quarterly frequency), which resembles the timing of second-estimate vintages for the U.S. and is frequently the choice in the literature (Faust & Wright, 2009; Krüger et al., 2017). To evaluate the accuracy of the point predictions, we use the root mean squared forecasts error (RMSFE). For the evaluation of the density forecasts, we use the continuous ranked probability score (CRPS) (Gneiting et al., 2007).

Let $\widehat{y}_{k,t+h}$ denote the mean of the predictive distribution (raw BVAR, or after applying either entropic tilting or soft conditioning) of variable k at horizon h generated at time t, and $y_{k,t+h}$ stand for the corresponding realization. Then the forecast error is defined as

$$\text{FE}_{k,t,h} \equiv y_{k,t+h} - \widehat{y}_{k,t+h}, \tag{13}$$

while the squared forecast error is given by

$$\text{SFE}_{k,t,h} \equiv \left(y_{k,t+h} - \widehat{y}_{k,t+h}\right)^2, \tag{14}$$

and the RMSFE is defined as

$$\text{RMSFE}_{k,h} \equiv \sqrt{P^{-1} \sum_{t=1}^{P} \text{SFE}_{k,t,h}}. \tag{15}$$

The CRPS is a popular, strictly proper scoring rule for distribution forecasts, defined as

$$\text{CRPS}_{k,t,h} \equiv \int_{-\infty}^{\infty} \left(\widetilde{F}_{k,t,h}(y) - \mathbb{1}\left[y_{k,t+h} \leq y\right]\right)^2 \mathrm{d}y, \tag{16}$$

where $\widetilde{F}_{k,t,h}(y)$ is the empirical cumulative distribution function of the given forecasting method (estimated at time t) for the kth variable at horizon h, and $\mathbb{1}\left[\cdot\right]$ is the indicator function. The average CRPS score is then given by

$$\text{CRPS}_{k,h} \equiv P^{-1} \sum_{t=1}^{P} \text{CRPS}_{k,t,h}, \tag{17}$$

where lower values correspond to more accurate forecasts.

We note that once one has obtained the entropically tilted or soft conditioned distribution, evaluating the RMSFE or CRPS statistics does *not* require further simulation, as the former can be

calculated by taking the (weighted) average of the original BVAR draws, while for the latter the algorithm by Hersbach (2000) can be used.

To compare model performances, we test for equal predictive ability (EPA) using the Diebold & Mariano (1995), henceforth DM test.[13] Let $L_t(\widetilde{y}^{(z)}_{k,t+h}, y_{k,t+h})$ denote the forecast loss — either squared forecast error defined in Equation (14) or CRPS in Equation (16) — of forecasting method z at time t for variable k, h quarters ahead, where $\widetilde{y}^{(z)}_{k,t+h}$ is the mean of the predictive distribution (for the RMSFE evaluation) or the full predictive distribution (for the CRPS measure). The null hypothesis of equal predictive accuracy, that forecasting method m is equally good as method n, is formally given by $H_0 : \mathbb{E}\left(L_t(\widetilde{y}^{(m)}_{k,t+h}, y_{k,t+h}) \right) = \mathbb{E}\left(L_t(\widetilde{y}^{(n)}_{k,t+h}, y_{k,t+h}) \right)$. In our analysis, method m corresponds to the baseline BVAR, while method n will be either entropic tilting or soft conditioning, targeting GDP growth, HICP inflation, the unemployment rate, or a combination of these. Denoting by $d_t \equiv L_t(\widetilde{y}^{(m)}_{k,t+h}, y_{k,t+h}) - L_t(\widetilde{y}^{(n)}_{k,t+h}, y_{k,t+h})$ the forecast loss differential, the test statistic can be written as

$$\text{DM}_{k,h} \equiv \sqrt{P}\,\frac{\frac{1}{P}\sum_{t=1}^{P} d_t}{\sqrt{\widehat{\sigma}^2_d}}\,, \tag{18}$$

where $\widehat{\sigma}^2_d$ is an estimate of the variance of d_t, which we obtain using the Bartlett kernel of Newey & West (1987).

4 Results for the Baseline Model

4.1 Main Results

In Table 1, Panel A shows the raw BVAR RMSFE results, while Panels B to E show the ratio of the RMSFE of the tilted BVAR and the raw BVAR. The panels' description indicates the variables which were tilted. The last two columns ($h = 4^*$ and $h = 8^*$) contain results for the one-year-ahead and two-year-ahead growth rates of GDP and HICP, corresponding to the original SPF survey question. Values below one indicate improvements over the raw BVAR. Boldface numbers imply a superior performance of the tilted BVAR. One, two or three asterisks imply rejection of the null hypothesis of equal predictive ability at the 10%, 5% and 1% significance level — that is, statistically significant differences in predictive performance. As Panel B shows, tilting towards the SPF GDP predictions yields improvements of the short- as well as medium-term forecasts, which are statistically significant at the first two horizons, as well as the one-year-ahead GDP prediction. The improvement at the first two horizons is an interesting result because the tilting is applied to quarterly, year-on-year growth rates, i.e. longer horizons. In terms of economic size, the tilting procedure leads to a reduction of the RMSFE of up to 20%. The spillover effects on "other-than-targeted" variables are relevant in size and statistically significant for the unemployment rate and the Euribor. The improvements for tilting HICP, in Panel C, are sizeable in economic terms and, while not statistically significant for HICP itself, show sizeable and statistically significant spillover effects to the Euribor. Tilting unemployment, shown in Panel D, yields improvements for the unemployment rate itself but a (small) decrease in predictive accuracy for GDP at longer horizons and HICP inflation, which points to misspecifications in the

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[13]For a discussion of asymptotic validity of the DM EPA test in this setup, see Krüger et al. (2017).

estimated relationship between the unemployment rate and real GDP growth and HICP inflation. Finally, tilting all three variables jointly in Panel E shows sizeable improvements for all four variables.

The economic size of the results implies that the tilted BVAR improves the quarter-on-quarter forecasts of GDP approximately by about 0.1 percentage points, and the year-on-year forecasts approximately by about 0.3 percentage points.[14]

Table 1: Entropic tilting versus BVAR forecasts: RMSFE

Forecast horizon	$h=1$	$h=2$	$h=3$	$h=4$	$h=5$	$h=6$	$h=7$	$h=8$	$h=4^*$	$h=8^*$
	Panel A. BVAR									
GDP	0.55	0.59	0.59	0.58	0.58	0.58	0.57	0.57	1.68	1.93
HICP	0.26	0.27	0.29	0.30	0.31	0.31	0.31	0.31	0.92	1.07
Unemployment	0.29	0.46	0.65	0.83	1.00	1.16	1.30	1.43	*N/A*	*N/A*
Euribor	0.35	0.66	0.94	1.20	1.44	1.64	1.82	1.97	*N/A*	*N/A*
	Panel B. Tilting GDP									
GDP	**0.80****	**0.86***	**0.91**	**0.98**	**1.00**	1.00	1.00	1.02	**0.81****	**1.00**
HICP	1.00	1.00	1.01	1.01	1.02	1.02	1.01	1.01	1.01	1.02
Unemployment	**0.96**	**0.93***	**0.92***	**0.93**	**0.93**	**0.94**	**0.95**	**0.96**	*N/A*	*N/A*
Euribor	**0.98**	**0.95****	**0.93****	**0.94****	**0.95***	**0.97**	**0.99**	**0.99**	*N/A*	*N/A*
	Panel C. Tilting HICP									
GDP	**0.98**	**0.98**	**0.98**	**0.99**	**0.99**	1.00	**1.00**	1.00	**0.98**	**0.99**
HICP	**0.93**	**0.98**	**0.93**	**0.93**	**0.92**	**0.92**	**0.91**	**0.91**	**0.91**	**0.88**
Unemployment	**0.98**	**0.98**	**0.98**	**0.98**	**0.99**	**0.99**	1.00	1.01	*N/A*	*N/A*
Euribor	**0.96**	**0.92**	**0.88***	**0.86***	**0.85***	**0.84***	**0.84****	**0.85****	*N/A*	*N/A*
	Panel D. Tilting Unemployment									
GDP	**0.99**	**0.97**	**0.99**	**0.99**	1.03**	1.10*	1.07	1.04***	**0.96**	**1.00**
HICP	1.03**	1.02**	1.02	1.02	1.02	1.03	1.02	1.03	1.03**	1.04
Unemployment	**0.93**	**0.88**	**0.86****	**0.86****	**0.87****	**0.88****	**0.88****	**0.89****	*N/A*	*N/A*
Euribor	1.04	**0.98**	**0.97**	**0.99**	**0.99**	**0.98**	**0.98**	**0.98**	*N/A*	*N/A*
	Panel E. Tilting GDP, HICP and Unemployment									
GDP	**0.80****	**0.86****	**0.93**	**1.00**	**1.00**	1.01	1.01	1.06**	**0.82****	**0.99**
HICP	**0.93**	**0.96**	**0.93**	**0.95**	**0.92**	**0.91**	**0.92**	**0.94**	**0.91**	**0.88**
Unemployment	**0.91**	**0.86***	**0.84****	**0.86****	**0.87****	**0.88****	**0.89****	**0.90****	*N/A*	*N/A*
Euribor	**0.93**	**0.84****	**0.83****	**0.83****	**0.84****	**0.85****	**0.86****	**0.86****	*N/A*	*N/A*

Note: Panel A displays the raw BVAR RMSFE. Panels B to E show the ratios of the RMSFE of the entropically tilted BVAR to the raw BVAR. Numbers in bold imply that the tilted BVAR improves over the raw BVAR. Asterisks *, ** and *** imply statistical significance of a two-sided Diebold & Mariano (1995) test of equal predictive ability at the 10%, 5%, 1% level. The variance is estimated using Bartlett kernel weights with bandwidth equal to the forecast horizon h. The evaluation sample size is $P = 72$ quarters. The columns $h = 4^*$ and $h = 8^*$ show the results for the one- and two-year-ahead, year-on-year predictions, respectively.

Table 2 shows the results for the density forecast evaluation. Improvements due to tilting are comparable to the RMSFE results, and even stronger in terms of economic size and statistical significance.

Figure 3 shows the results for entropically tilting all three variables jointly — the plot corresponds to Panel E of Tables 1 and 2.

Table 3 shows the absolute (Panel A) and relative (Panels B to E) RMSFE statistics for the case of soft conditioning. Results are similar to entropic tilting, but the reductions in the RMSFEs tend to be somewhat smaller.

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[14]These numbers are calculated via the product of the RMSFE ratio and the RMSFE of the BVAR, assuming a constant forecast error of the BVAR.

Figure 3: Entropic Tilting using all three SPF forecasts vs. BVAR
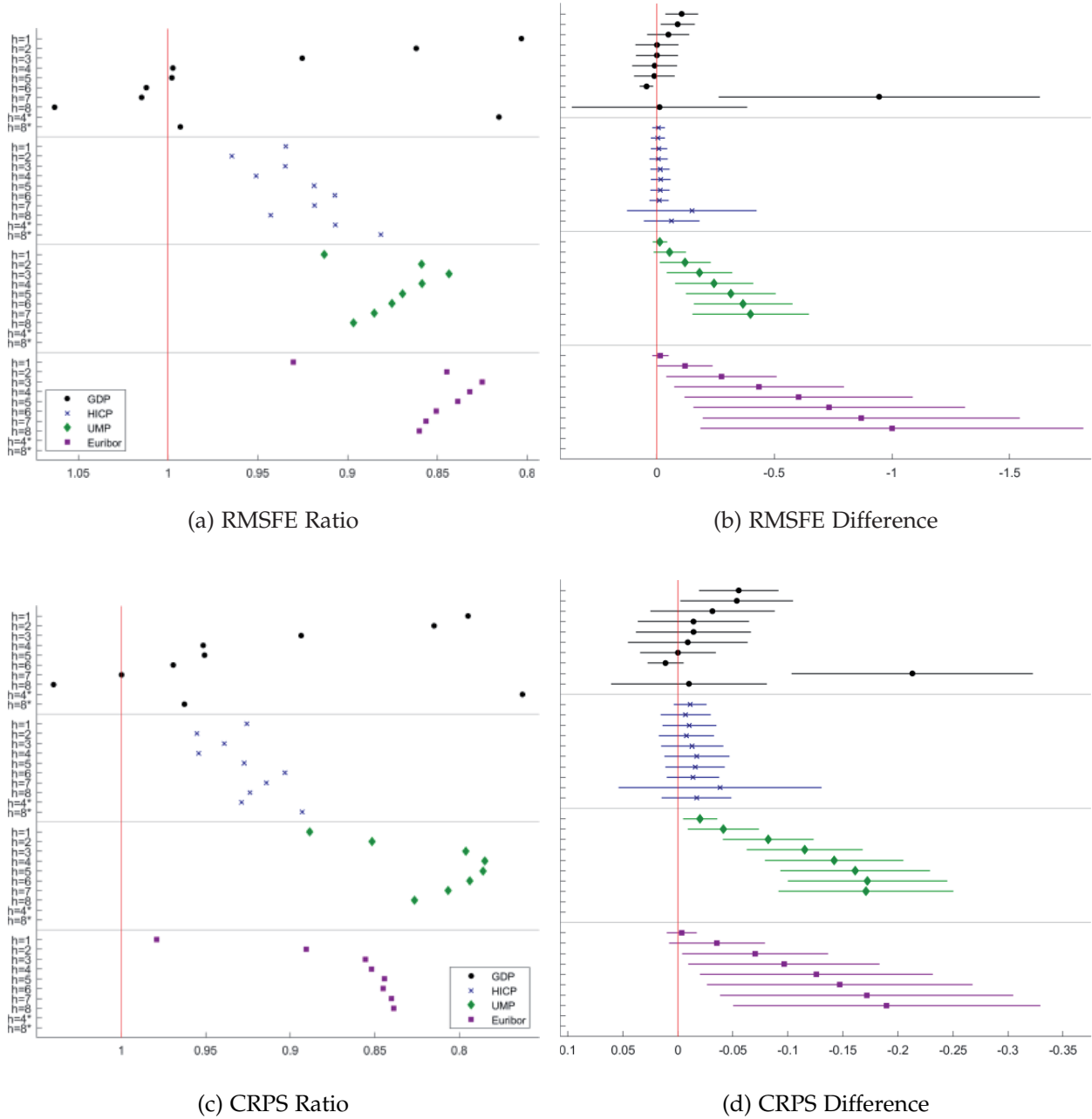
(a) RMSFE Ratio

(b) RMSFE Difference

(c) CRPS Ratio

(d) CRPS Difference

Note: The figure shows results when tilting the BVAR predictions jointly towards the one- and two-year-ahead SPF forecasts of real GDP growth, HICP inflation and the unemployment rate. Panels (a) and (c) display the RMSFE and the CRPS ratio of the tilted BVAR and the raw BVAR. A number smaller than one implies that the tilted BVAR outperforms the raw BVAR. Panels (b) and (d) display the RMSFE and CRPS loss differential of the tilted BVAR minus the raw BVAR. A number smaller than zero implies that the tilted BVAR outperforms the raw BVAR. The axis label *h* denotes the forecast horizon. The horizontal lines centered around a marker denote 90% confidence intervals, for which the variance is estimated using Bartlett kernel weights with bandwidth equal to the forecast horizon *h*. To improve legibility, all RSMFE loss differentials of the Euribor are normalized by the respective value for $h = 8^*$.

In terms of density forecasts, Table 4 demonstrates that incorporating SPF information on GDP growth through soft conditioning considerably improves the raw BVAR forecasts (Panel B), and additionally tilting inflation and unemployment towards SPF forecasts results in some additional gains (Panel E).

Table 2: Entropic tilting versus BVAR forecasts: CRPS

Forecast horizon	h = 1	h = 2	h = 3	h = 4	h = 5	h = 6	h = 7	h = 8	h = 4*	h = 8*
					Panel A. BVAR					
GDP	0.27	0.29	0.29	0.29	0.29	0.29	0.28	0.28	0.90	1.08
HICP	0.15	0.16	0.17	0.17	0.18	0.18	0.18	0.18	0.54	0.63
Unemployment	0.18	0.28	0.40	0.54	0.66	0.78	0.89	0.99	*N/A*	*N/A*
Euribor	0.17	0.32	0.49	0.65	0.81	0.95	1.07	1.18	*N/A*	*N/A*
					Panel B. Tilting GDP					
GDP	**0.79*****	**0.81***	**0.86**	**0.93**	**0.95**	**0.96**	**0.97**	**1.00**	**0.76*****	**0.97**
HICP	1.00	1.01	1.02	1.02	1.02	1.02	1.01	1.01	1.02	1.02
Unemployment	**0.97**	**0.95**	**0.93**	**0.93**	**0.93**	**0.94**	**0.95**	**0.96**	*N/A*	*N/A*
Euribor	**0.98**	**0.95***	**0.93****	**0.93****	**0.94****	**0.95****	**0.96**	**0.96**	*N/A*	*N/A*
					Panel C. Tilting HICP					
GDP	**0.98**	**0.98**	**0.98**	**0.99**	**0.99**	**0.99**	**0.99**	**1.00**	**0.98**	**0.99**
HICP	**0.93***	**0.97**	**0.92**	**0.92**	**0.92**	**0.91**	**0.90**	**0.90**	**0.93**	**0.89**
Unemployment	**0.98**	**0.98**	**0.98**	**0.99**	**0.99**	**1.00**	1.01	1.01	*N/A*	*N/A*
Euribor	**0.98**	**0.95**	**0.91**	**0.89**	**0.87**	**0.86***	**0.86***	**0.86***	*N/A*	*N/A*
					Panel D. Tilting Unemployment					
GDP	1.01	1.01	1.02	**1.00**	1.05*	1.08*	1.10	1.06**	**0.96**	**0.99**
HICP	1.03*	1.02**	1.01	1.02	1.01	1.02	1.01	1.02	1.04*	1.01
Unemployment	**0.91****	**0.88****	**0.83*****	**0.81*****	**0.81*****	**0.80*****	**0.81*****	**0.83*****	*N/A*	*N/A*
Euribor	1.06	1.00	**0.98**	**0.99**	**0.98**	**0.96**	**0.96**	**0.97**	*N/A*	*N/A*
					Panel E. Tilting GDP, HICP and Unemployment					
GDP	**0.79*****	**0.82***	**0.89**	**0.95**	**0.95**	**0.97**	**1.00**	1.04	**0.76*****	**0.96**
HICP	**0.93**	**0.96**	**0.94**	**0.95**	**0.93**	**0.90**	**0.91**	**0.92**	**0.93**	**0.89**
Unemployment	**0.89*****	**0.85****	**0.80*****	**0.79*****	**0.79*****	**0.79*****	**0.81*****	**0.83*****	*N/A*	*N/A*
Euribor	**0.98**	**0.89**	**0.86***	**0.85***	**0.84****	**0.85****	**0.84****	**0.84****	*N/A*	*N/A*

Note: Panel A displays the raw BVAR CRPS. Panels B to E show the ratios of the CRPS of the entropically tilted BVAR to the raw BVAR. Numbers in bold imply that the tilted BVAR improves over the raw BVAR. Asterisks *, ** and *** imply statistical significance of a two-sided Diebold & Mariano (1995) test of equal predictive ability at the 10%, 5%, 1% level. The variance is estimated using Bartlett kernel weights with bandwidth equal to the forecast horizon h. The evaluation sample size is $P = 72$ quarters. The columns $h = 4^*$ and $h = 8^*$ show the results for the one- and two-year-ahead, year-on-year predictions, respectively.

Appendix A additionally shows results of the multi-horizon forecast comparison test of Quaedvlieg (2019), which controls the family-wise error rate of the multiple hypothesis tests displayed in Table 1 and the tables thereafter. Those results confirm that entropic tilting and soft conditioning indeed improve both point and density forecasts. Appendix B contains further results, using only one-year-ahead SPF predictions, demonstrating the robustness of our findings.

The histograms in Panel (a) of Figure 4 show an example of the two-quarter-ahead raw BVAR predictive distribution and its entropically tilted counterpart for real GDP growth based on the 2013:Q3 SPF round (that is, the BVAR's latest observation corresponds to 2013:Q2, and the target date is 2013:Q4). The tilted distribution is shifted to the left, less dispersed and exhibits a higher probability mass around the realization. Panel (b) is the soft conditioning counterpart of Panel (a), showing a very similar effect: the BVAR distribution is shifted closer to the actual realization, and its dispersion is reduced.

Table 3: Soft Conditioning versus BVAR forecasts: RMSFE

Forecast horizon	$h=1$	$h=2$	$h=3$	$h=4$	$h=5$	$h=6$	$h=7$	$h=8$	$h=4^*$	$h=8^*$
					Panel A. BVAR					
GDP	0.55	0.59	0.59	0.58	0.58	0.58	0.57	0.57	1.68	1.93
HICP	0.26	0.27	0.29	0.30	0.31	0.31	0.31	0.31	0.92	1.07
Unemployment	0.29	0.46	0.65	0.83	1.00	1.16	1.30	1.43	*N/A*	*N/A*
Euribor	0.35	0.66	0.94	1.20	1.44	1.64	1.82	1.97	*N/A*	*N/A*
					Panel B. Soft Conditioning GDP					
GDP	**0.88****	**0.91*****	**0.93**	**0.97**	**0.99**	**0.99**	**1.00**	1.01	**0.89****	**0.98**
HICP	1.00	1.00	1.00	1.00	1.01	1.01	1.01	1.01	1.00	1.01
Unemployment	**0.98**	**0.96***	**0.96****	**0.96***	**0.96**	**0.97**	**0.97**	**0.98**	*N/A*	*N/A*
Euribor	**0.99***	**0.97****	**0.96****	**0.96*****	**0.97*****	**0.98***	**0.99**	**0.99**	*N/A*	*N/A*
					Panel C. Soft Conditioning HICP					
GDP	**0.99**	**0.99**	**0.99**	**1.00**	**1.00**	1.00	1.00	**1.00***	**0.99**	**1.00**
HICP	**0.97***	**0.98**	**0.95**	**0.94**	**0.94**	**0.93**	**0.92***	**0.93***	**0.94**	**0.90***
Unemployment	**0.99**	**0.99**	**0.99**	**0.99**	**0.99**	1.00	1.00	1.00	*N/A*	*N/A*
Euribor	**0.99**	**0.96***	**0.94***	**0.93***	**0.92***	**0.92****	**0.92****	**0.93****	*N/A*	*N/A*
					Panel D. Soft Conditioning Unemployment					
GDP	**0.99***	**0.99***	**1.00**	1.00	**1.00**	**1.00**	**1.00**	1.01	**1.00**	**1.00**
HICP	1.00	1.00	1.00	1.00	1.01	1.01	1.01	1.01	1.00	1.02
Unemployment	**0.98**	**0.97**	**0.96***	**0.97***	**0.97***	**0.97***	**0.97***	**0.97***	*N/A*	*N/A*
Euribor	1.01	1.01	1.01	1.01	1.01	1.01*	1.01*	1.01*	*N/A*	*N/A*
					Panel E. Soft Conditioning GDP, HICP and Unemployment					
GDP	**0.87****	**0.90****	**0.93**	**0.97**	**0.99**	**0.99**	**1.00**	1.01	**0.88****	**0.98**
HICP	**0.97**	**0.98**	**0.96**	**0.95**	**0.94**	**0.94**	**0.93***	**0.93****	**0.95**	**0.91***
Unemployment	**0.96***	**0.94***	**0.93***	**0.94***	**0.94***	**0.95**	**0.96**	**0.97**	*N/A*	*N/A*
Euribor	**0.98**	**0.94****	**0.91****	**0.90****	**0.91****	**0.91****	**0.92****	**0.93****	*N/A*	*N/A*

Note: Panel A displays the raw BVAR RMSFE. Panels B to E show the ratios of the RMSFE of the soft conditioned BVAR to the raw BVAR. Numbers in bold imply that the soft conditioned BVAR improves over the raw BVAR. Asterisks *, ** and *** imply statistical significance of a two-sided Diebold & Mariano (1995) test of equal predictive ability at the 10%, 5%, 1% level. The variance is estimated using Bartlett kernel weights with bandwidth equal to the forecast horizon h. The evaluation sample size is $P = 72$ quarters. The columns $h = 4^*$ and $h = 8^*$ show the results for the one- and two-year-ahead, year-on-year predictions, respectively.

4.2 Tilting Towards the Mean Only

The previous results are based on jointly tilting towards the SPF mean and variance prediction. To understand better where the main gains in forecasting performance come from, Table 5 shows results when tilting only towards the SPF mean while leaving the second moment of the predictive density unchanged.[15] Comparing the results to table Table 2, we see that the main part of the gain comes from tilting towards the SPF mean.

In Section 5.2, we discuss the forecasting results of a larger BVAR with a common stochastic volatility component. We document that in this model, tilting both the mean and the variance becomes more important.

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[15]We only display results of the CRPS here because the RMSFE results are by definition unchanged.

Table 4: Soft Conditioning versus BVAR forecasts: CRPS

Forecast horizon	$h=1$	$h=2$	$h=3$	$h=4$	$h=5$	$h=6$	$h=7$	$h=8$	$h=4^*$	$h=8^*$
					Panel A. BVAR					
GDP	0.27	0.29	0.29	0.29	0.29	0.29	0.28	0.28	0.90	1.08
HICP	0.15	0.16	0.17	0.17	0.18	0.18	0.18	0.18	0.54	0.63
Unemployment	0.18	0.28	0.40	0.54	0.66	0.78	0.89	0.99	*N/A*	*N/A*
Euribor	0.17	0.32	0.49	0.65	0.81	0.95	1.07	1.18	*N/A*	*N/A*
					Panel B. Soft Conditioning GDP					
GDP	**0.87****	**0.88***	**0.91***	**0.95**	**0.97**	**0.97**	**0.98**	1.00	**0.89***	1.01
HICP	1.00	1.00	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.02
Unemployment	**0.99**	**0.98**	**0.98**	**0.98**	**0.98**	**0.98**	**0.99**	**0.99**	*N/A*	*N/A*
Euribor	**0.98*****	**0.97*****	**0.96*****	**0.96*****	**0.96*****	**0.97****	**0.97**	**0.97**	*N/A*	*N/A*
					Panel C. Soft Conditioning HICP					
GDP	**0.99**	**0.99**	**0.99**	**0.99**	**0.99***	**0.99****	**1.00****	**1.00**	**0.99**	**1.00**
HICP	**0.97**	**0.98**	**0.96**	**0.95**	**0.94**	**0.94**	**0.93***	**0.93***	**0.97**	**0.93**
Unemployment	**1.00**	**0.99**	**1.00**	**1.00**	**1.00**	1.01	1.01**	1.02**	*N/A*	*N/A*
Euribor	**0.99**	**0.97**	**0.95**	**0.94***	**0.93****	**0.93***	**0.93****	**0.93****	*N/A*	*N/A*
					Panel D. Soft Conditioning Unemployment					
GDP	**0.99***	**0.99**	**1.00**	**1.00**	**0.99***	**1.00**	**1.00**	1.00	**1.00**	**1.00**
HICP	1.00	1.00*	1.00	1.01	1.01	1.01	1.01	1.01	1.01*	1.02
Unemployment	**0.99**	**0.98**	**0.97**	**0.97**	**0.98**	**0.98**	**0.99**	**0.99**	*N/A*	*N/A*
Euribor	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	*N/A*	*N/A*
					Panel E. Soft Conditioning GDP, HICP and Unemployment					
GDP	**0.87*****	**0.88***	**0.91*****	**0.95**	**0.97**	**0.97**	**0.98**	1.01	**0.90****	1.01
HICP	**0.98**	**0.99**	**0.97**	**0.96**	**0.96**	**0.95**	**0.95**	**0.95**	**0.99**	**0.96**
Unemployment	**0.98**	**0.96**	**0.96**	**0.96**	**0.97**	**0.98**	**0.99**	**1.00**	*N/A*	*N/A*
Euribor	**0.98**	**0.95****	**0.92****	**0.91****	**0.91****	**0.91*****	**0.92****	**0.92****	*N/A*	*N/A*

Note: Panel A displays the raw BVAR CRPS. Panels B to E show the ratios of the CRPS of the soft conditioned BVAR to the raw BVAR. Numbers in bold imply that the soft conditioned BVAR improves over the raw BVAR. Asterisks *, ** and *** imply statistical significance of a two-sided Diebold & Mariano (1995) test of equal predictive ability at the 10%, 5%, 1% level. The variance is estimated using Bartlett kernel weights with bandwidth equal to the forecast horizon h. The evaluation sample size is $P = 72$ quarters. The columns $h = 4^*$ and $h = 8^*$ show the results for the one- and two-year-ahead, year-on-year predictions, respectively.

Figure 4: The effect of entropic tilting and soft conditioning on two-quarter-ahead (2013:Q4 over 2013:Q3) GDP growth forecast in the 2013:Q3 SPF round

(a) Entropic tilting
(b) Soft conditioning
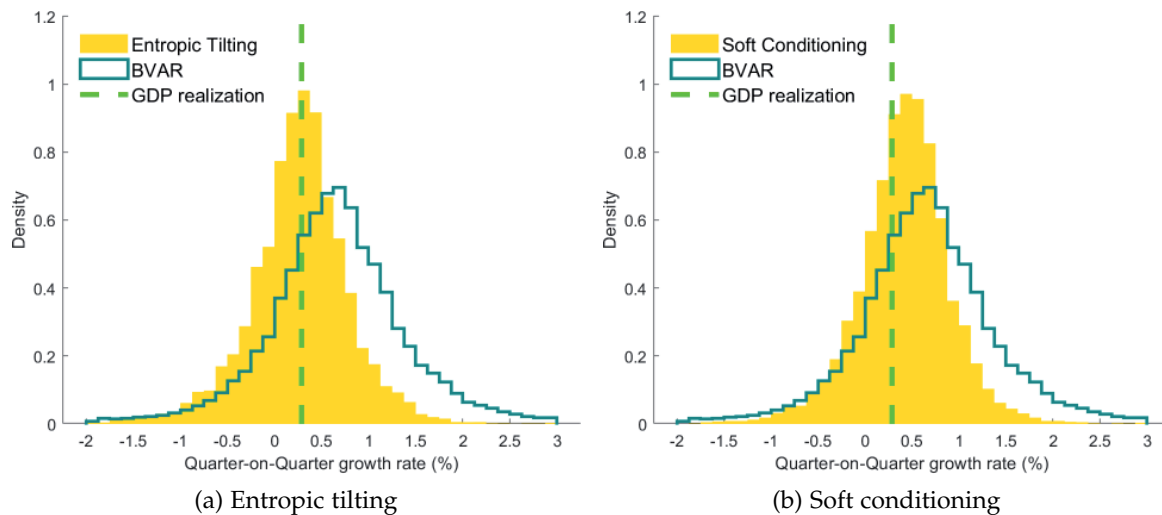
Note: Panel (a) displays the histograms of the predictive distribution of GDP growth (2013:Q4 over 2013:Q3) produced by the BVAR and the entropically tilted BVAR (tilted to the SPF GDP growth forecast), at the 2013:Q3 SPF round. The BVAR's latest observation corresponds to 2013:Q2, and its forecast horizon is $h = 2$ quarters. Panel (b) shows analogous results for soft conditioning. The vertical dashed line indicates the realization.

Table 5: Entropic tilting towards SPF mean and BVAR variance: CRPS

Forecast horizon	$h=1$	$h=2$	$h=3$	$h=4$	$h=5$	$h=6$	$h=7$	$h=8$	$h=4^*$	$h=8^*$
					Panel A. BVAR					
GDP	0.27	0.29	0.29	0.29	0.29	0.29	0.28	0.28	0.90	1.08
HICP	0.15	0.16	0.17	0.17	0.18	0.18	0.18	0.18	0.54	0.63
Unemployment	0.18	0.28	0.40	0.54	0.66	0.78	0.89	0.99	N/A	N/A
Euribor	0.17	0.32	0.49	0.65	0.81	0.95	1.07	1.18	N/A	N/A
					Panel B. Tilting GDP					
GDP	**0.82*****	**0.83****	**0.88**	**0.97**	**1.00**	1.00	1.01	1.01	**0.76****	**0.99**
HICP	1.00	1.01	1.01	1.01	1.00	1.00	**1.00**	0.99	1.01	**0.99**
Unemployment	**0.96**	**0.93**	**0.92**	**0.93**	**0.94**	**0.95**	**0.96**	**0.96**	N/A	N/A
Euribor	**1.00**	**0.98**	**0.97**	**0.96***	**0.96****	**0.96****	**0.97***	**0.97**	N/A	N/A
					Panel C. Tilting HICP					
GDP	**0.99**	**0.99**	**0.99**	**1.00**	**0.99**	1.00	1.00	1.00	**0.98**	**0.99**
HICP	**0.95**	**0.98**	**0.93**	**0.93**	**0.93***	**0.91****	**0.91****	**0.93****	**0.93**	**0.88****
Unemployment	**0.99**	1.00	1.01	1.02**	1.02**	1.03***	1.03***	1.03***	N/A	N/A
Euribor	**0.99**	**0.97**	**0.95**	**0.94**	**0.94**	**0.94***	**0.94***	**0.95***	N/A	N/A
					Panel D. Tilting Unemployment					
GDP	**0.94*****	**0.95**	**0.97**	**0.97***	1.01	1.01	1.04**	1.04**	**0.92*****	**0.99**
HICP	1.01	1.02*	1.02*	1.02	1.01	1.01	1.00	1.01	1.03**	1.01
Unemployment	**0.92***	**0.88****	**0.83*****	**0.82*****	**0.82*****	**0.83*****	**0.84*****	**0.86*****	N/A	N/A
Euribor	1.02	**0.99**	**0.97**	**0.97**	**0.96**	**0.95**	**0.96**	**0.96**	N/A	N/A
					Panel E. Tilting GDP, HICP and Unemployment					
GDP	**0.79*****	**0.84***	**0.90**	**0.99**	1.02	1.01	1.04*	1.08	**0.76****	**0.99**
HICP	**0.95**	**0.98**	**0.94**	**0.93**	**0.93**	**0.93**	**0.94**	**0.94**	**0.94**	**0.90**
Unemployment	**0.90***	**0.86****	**0.82*****	**0.82*****	**0.82*****	**0.84*****	**0.86*****	**0.87****	N/A	N/A
Euribor	**0.98**	**0.92**	**0.90***	**0.91***	**0.90****	**0.90****	**0.91****	**0.91***	N/A	N/A

Note: Panel A displays the raw BVAR CRPS. Panels B to E show the ratios of the CRPS of the entropically tilted BVAR to the raw BVAR. Numbers in bold imply that the tilted BVAR improves over the raw BVAR. Asterisks *, ** and *** imply statistical significance of a two-sided Diebold & Mariano (1995) test of equal predictive ability at the 10%, 5%, 1% level. The variance is estimated using Bartlett kernel weights with bandwidth equal to the forecast horizon h. The evaluation sample size is $P = 72$ quarters. The columns $h = 4^*$ and $h = 8^*$ show the results for the one- and two-year-ahead, year-on-year predictions, respectively.

4.3   Structural Change and Survey Forecasts

After the Great Recession, the euro area experienced lower real growth, inflation and interest rates than in the pre-crisis years. In what follows, we adopt the CEPR Euro Area Business Cycle Dating Committee's chronology and take 2008:Q1 as the peak of the business cycle before the Great Recession, and 2009:Q2 as the trough of the crisis.[16]

To investigate the potential bias of the raw and the tilted BVAR's predictions, we regressed the forecast error in Equation (13) on a constant, and conducted a *t*-test on the coefficient, testing the null hypothesis of a zero coefficient (or unbiasedness). Table 6 shows the bias of the forecast error of the raw BVAR and the entropically tilted BVAR before the Great Recession with the last realized forecast error dated 2008:Q1, and after the Great Recession with forecast origins 2009:Q3 to 2016:Q4. Taking into account the small subsample sizes due to the split, $38 - h$ and 30 data

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[16]The full chronology and the analyses are available at `https://cepr.org/content/euro-area-business-cycle-dating-committee`.

points before and after the crisis, respectively, we consider the results of the hypothesis tests as being suggestive rather than decisive evidence. Panel A shows that prior to the financial crisis, the BVAR exhibits no bias for growth, a small positive and statistically significant bias for inflation in the short run, i.e. it underestimated inflation (recall that in Equation (13) we defined the forecast error as the realization minus the point forecast) and a somewhat larger but non-significant bias for the interest rate. However, as Panel D demonstrates, after the crisis, the bias is negative for GDP growth, statistically significant, and considerably larger in size — the BVAR overestimates real GDP growth. After tilting the model's forecasts, as Panel F displays, the statistical significance of the bias in the real GDP growth predictions disappears at all horizons but $h = 8$. Importantly, at horizons used directly in the tilting procedure, ($h = 1, \ldots, 7$), the tilted BVAR exhibits virtually no bias, similarly to the one-year-ahead year-on-year predictions ($h = 4^*$). While the raw BVAR is slow to adjust to the structural break, the SPF adapts quickly in real-time. Importantly, in a dynamic system, such as a VAR, a structural break in one of the variables can cause a bias in other variables, as multiple-step-ahead forecasts are conditioned on the draws of the other variables. In fact, Panels E and F show that the spillover effects from correcting the bias in real GDP forecasts reduce the size of the bias of the unemployment rate and the Euribor forecasts. Moreover, comparing Panel F to Panel E demonstrates that using one- *and* two-year-ahead SPF predictions leads to further improvements relative to using only one-year-ahead SPF forecasts.

Figure 5 reflects some of the results of the previous table by showing the evolution of the point forecasts of the three competing models and the corresponding realizations. The BVAR tends to overestimate real GDP growth after the financial crisis. It also somewhat underestimates inflation before the recession.

Figure 6 shows the CRPS loss differential of the raw BVAR and the tilted BVAR. Negative values imply a superior performance of the tilted BVAR. The performance improvement using tilting is similar to what we can observe in Figure 5. External information can help to deal with this type of structural change and is easily implemented via entropic tilting or soft conditioning.

A potential, model-based remedy to the deteriorating effect of structural changes on the forecasting performance is allowing for time-varying parameters. Hence, we investigate the performance of a time-varying parameter BVAR with stochastic volatility (TVP-VAR) in the next section.

Table 6: Forecast bias — before and after the Great Recession

Forecast horizon	$h=1$	$h=2$	$h=3$	$h=4$	$h=5$	$h=6$	$h=7$	$h=8$	$h=4^*$	$h=8^*$
Panel A. BVAR - Before Great Recession										
GDP	−0.01	−0.02	−0.01	−0.02	−0.03	−0.04	−0.04	−0.04	−0.28	−0.28
HICP	0.08**	0.10**	0.10	0.10	0.10	0.10	0.10	0.09	0.38	0.28
Unemployment	−0.05	−0.07	−0.10	−0.13	−0.14	−0.15	−0.15	−0.14	N/A	N/A
Euribor	−0.04	−0.05	−0.06	−0.08	−0.14	−0.21	−0.33	−0.47	N/A	N/A
Panel B. Tilting GDP One-Year-Ahead - Before Great Recession										
GDP	−0.07	−0.07	−0.06	−0.03	−0.04	−0.05	−0.06	−0.06	−0.37	−0.34
HICP	0.08**	0.09**	0.10*	0.10	0.10	0.10	0.10	0.09	0.38	0.28
Unemployment	−0.04	−0.06	−0.08	−0.11	−0.13	−0.14	−0.14	−0.13	N/A	N/A
Euribor	−0.05	−0.08	−0.10	−0.13	−0.18	−0.25	−0.36	−0.51	N/A	N/A
Panel C. Tilting GDP One- and Two-Year-Ahead - Before Great Recession										
GDP	−0.06	−0.07	−0.06	−0.13	−0.14	−0.15	−0.15	−0.09	−0.37	−0.72
HICP	0.08**	0.10**	0.09	0.10	0.10	0.10	0.10	0.09	0.38	0.27
Unemployment	−0.05	−0.07	−0.10	−0.13	−0.14	−0.14	−0.12	−0.11	N/A	N/A
Euribor	−0.02	−0.02	−0.01	−0.03	−0.09	−0.18	−0.31	−0.46	N/A	N/A
Panel D. BVAR - After Great Recession										
GDP	−0.27***	−0.33**	−0.31**	−0.29*	−0.30*	−0.29*	−0.27*	−0.29*	−0.81*	−1.09
HICP	0.01	0.02	−0.00	−0.01	−0.02	−0.03	−0.05	−0.06	0.04	−0.14
Unemployment	0.04	0.09	0.14	0.19	0.23	0.25	0.27	0.27	N/A	N/A
Euribor	0.01	−0.05	−0.16	−0.27*	−0.39**	−0.51**	−0.64***	−0.76***	N/A	N/A
Panel E. Tilting GDP One-Year-Ahead - After Great Recession										
GDP	−0.06	−0.07	−0.07	−0.25*	−0.30**	−0.29**	−0.28*	−0.29**	−0.09	−1.06
HICP	0.01	0.03	0.02	0.01	−0.00	−0.01	−0.02	−0.04	0.10	−0.06
Unemployment	0.00	0.00	−0.00	0.02	0.04	0.07	0.09	0.10	N/A	N/A
Euribor	0.06	0.10	0.12	0.07	−0.02	−0.14	−0.27	−0.41*	N/A	N/A
Panel F. Tilting GDP One- and Two-Year-Ahead - After Great Recession										
GDP	−0.06	−0.08	−0.05	−0.10	−0.12	−0.11	−0.11	−0.26*	−0.09	−0.36
HICP	0.01	0.03	0.02	0.01	0.01	0.00	−0.01	−0.02	0.10	0.01
Unemployment	0.01	0.02	0.02	0.02	0.01	−0.01	−0.03	−0.04	N/A	N/A
Euribor	0.05	0.08	0.09	0.08	0.07	0.03	−0.01	−0.09	N/A	N/A

Note: Panels A to F display the means of the forecast errors of the BVAR and the entropically tilted BVAR, before and after the Great Recession. Asterisks *, ** and *** imply statistical significance of a two-sided *t*-test of unbiasedness at the 10%, 5%, 1% level. The variance is estimated using Bartlett kernel weights with bandwidth equal to the forecast horizon h when $h < 4$, and 4 otherwise (due to the small sample size). The evaluation sample size is $38 − h$ quarters in Panels A to C, and 30 quarters in Panels D to F. The columns labeled $h=4^*$ and $h=8^*$ show the results for the one-year-ahead and two-year-ahead, year-on-year predictions, respectively.

Figure 5: Mean predictions with tilting
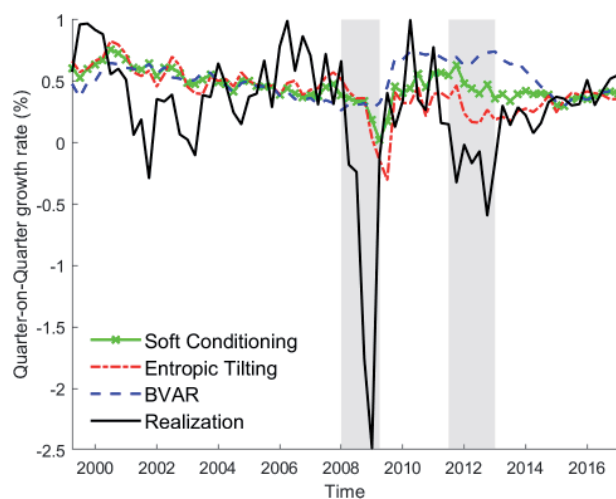
(a) GDP, $h = 2$
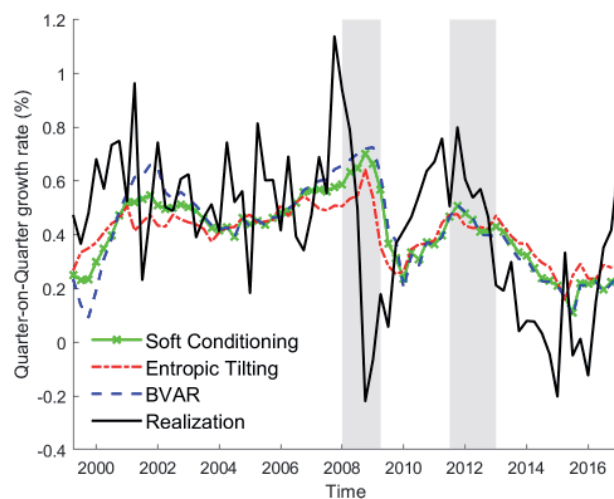
(b) HICP, $h = 2$
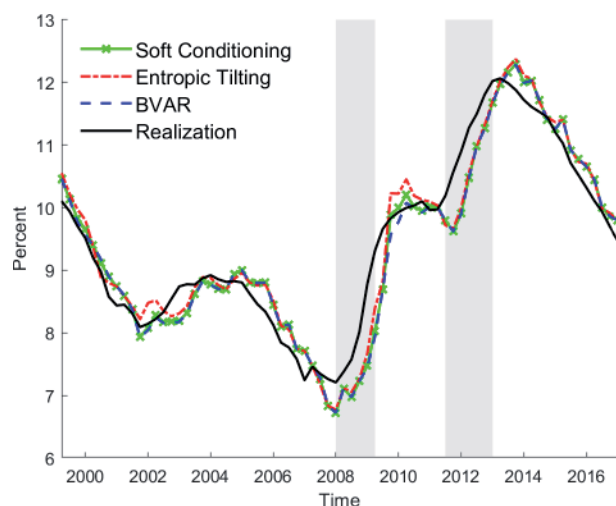
(c) Unemployment rate, $h = 2$
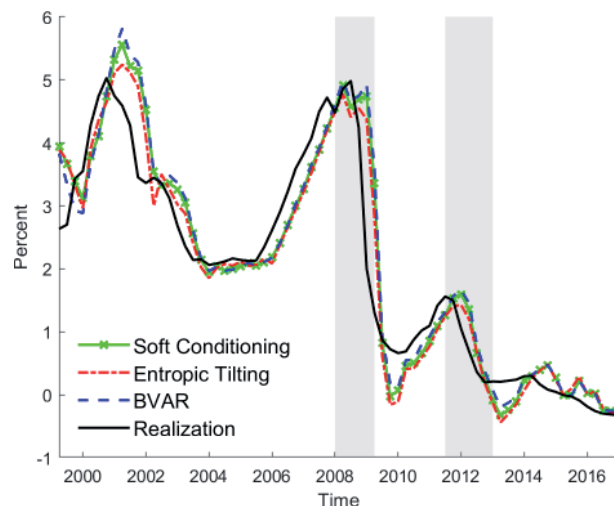
(d) Euribor, $h = 2$

Note: The figures show mean predictions of the raw BVAR, the entropically tilted BVAR and soft conditioning. Time on the horizontal axis corresponds to the target dates, h denotes the forecasting horizon. The entropic tilting and soft conditioning results are based on the specification that incorporates SPF GDP forecasts for Panel (a), the SPF HICP forecasts for Panel (b), the SPF unemployment rate forecasts for Panel (c) and the joint tilting for Panel (d). Shaded areas correspond to CEPR recession dates.

Figure 6: CRPS Differences

(a) GDP, $h = 2$

(b) HICP, $h = 2$

(c) Unemployment rate, $h = 2$

(d) Euribor, $h = 2$
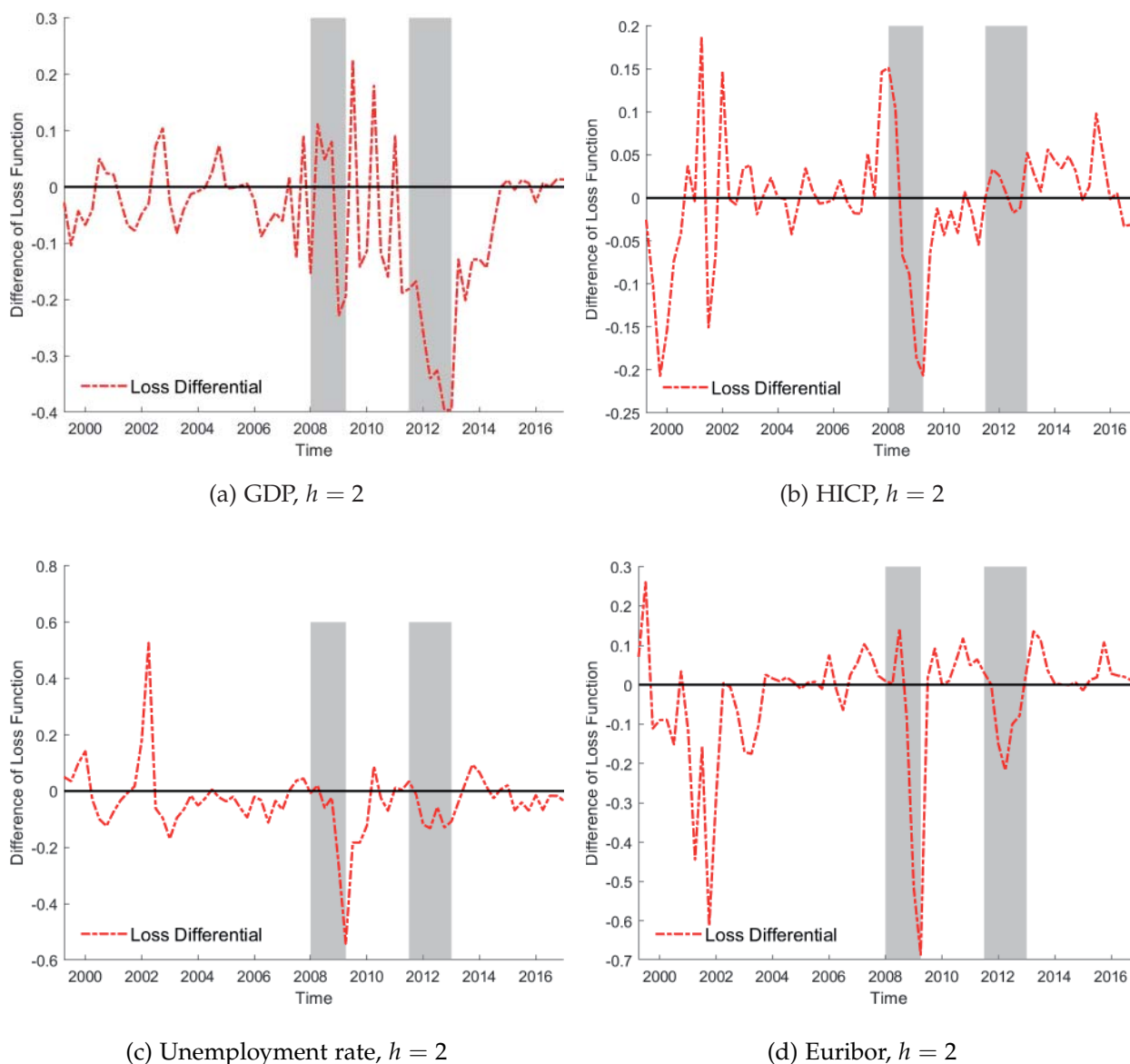
Note: The figures show the differences of the CRPS of the raw BVAR and the entropically tilted BVAR. Time on the horizontal axis corresponds to the target dates, h denotes the forecasting horizon. A negative value implies a smaller loss for the tilted BVAR. The entropic tilting results are based on the specification that incorporates SPF GDP forecasts for Panel (a), the SPF HICP forecasts for Panel (b), the SPF unemployment rate forecasts for Panel (c) and the joint tilting for Panel (d). Shaded areas correspond to CEPR recession dates.

5   Results for Alternative Models

5.1   Time-varying parameter VAR

Using U.S. data, D'Agostino et al. (2013) showed that allowing for time-varying parameters, as in Primiceri (2005), can improve the forecasting performance of a BVAR. The time variation might help mitigate the effect of persistently lower growth rates after the financial crisis on the forecasting performance.

We ensured that the resulting VAR is stable by using the multi-move sampler of Koop & Potter (2011) that allows for inequality restrictions. Without the inequality restrictions of smaller than unit eigenvalues of the companion form matrices of the time-varying autoregressive coefficients, the predictive densities exhibited very large dispersion which deteriorated the TVP-VAR's forecasting performance.

Figure 7 shows the proportion of time-varying coefficient draws that imply unstable VAR dynamics at each point in time between 1991:Q4 and 2016:Q2, when we estimated the TVP-VAR *without* imposing the stability condition.[17] To the best of our knowledge, this is the first study documenting that the Great Recession and the following sovereign debt crisis pushed an otherwise standard time-varying parameter VAR towards unstable dynamics.[18,19] This finding extends those of D'Agostino et al. (2013), who performed a forecasting exercise using a TVP-VAR for pre–Great Recession U.S. data.

Figure 7: Proportion of unstable TVP-VAR coefficient matrices
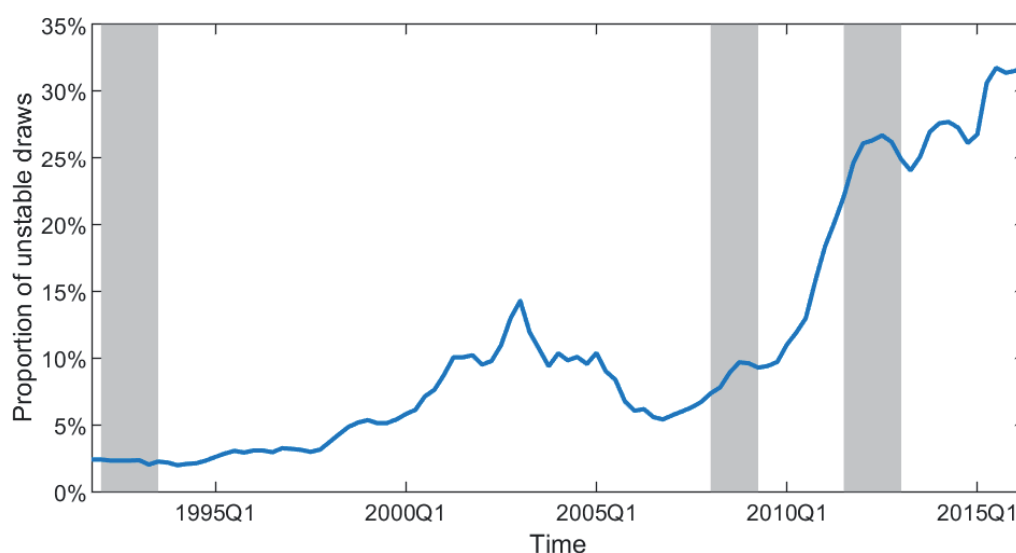
Note: The figure displays the proportion of time-varying coefficient draws which imply unstable VAR dynamics. The horizontal axis spans from 1991:Q4 to 2016:Q2. Shaded areas correspond to CEPR recession dates.

Table 7 displays the results of the forecast unbiasedness test based on the TVP-VAR predictions and entropic tilting. As conjectured, the TVP-VAR exhibits a considerably smaller deviation from a zero mean for all four variables, and the bias is only statistically significant for the case of GDP at $h = 1$ after the Great Recession (Panel C).

Given that the TVP-VAR provides unbiased forecasts, does allowing for time-variation consequentially make entropic tilting redundant? As Table 8 demonstrates, this is not the case. Panels A and B show the ratios of the RMSFE and CRPS of the entropically tilted BVAR (jointly tilting GDP,

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[17]Due to differencing and lagging, 3 observations at the beginning of the sample are lost relative to 1991:Q1.

[18]In unreported results, we investigated the source of the instability, and found that excluding either the interest rate variable or the unemployment rate strongly reduces the proportion of unstable draws. In other words, the instability is driven by the joint presence of both level variables.

[19]We thank an anonymous referee for pointing this out.

Table 7: TVP-VAR: forecast bias — before and after the Great Recession

Forecast horizon	$h=1$	$h=2$	$h=3$	$h=4$	$h=5$	$h=6$	$h=7$	$h=8$	$h=4^*$	$h=8^*$
	Panel A. TVP-VAR - Before Great Recession									
GDP	−0.10	−0.15	−0.15	−0.16	−0.17	−0.17	−0.18	−0.17	−0.60	−0.87
HICP	0.01	−0.01	−0.05	−0.06	−0.09	−0.11	−0.13	−0.15	−0.15	−0.62
Unemployment	−0.03	−0.04	−0.06	−0.07	−0.08	−0.09	−0.08	−0.09	N/A	N/A
Euribor	−0.19**	−0.46**	−0.76*	−1.06*	−1.37*	−1.66*	−1.97*	−2.27*	N/A	N/A
	Panel B. Tilting GDP One- and Two-Year-Ahead - Before Great Recession									
GDP	−0.04	−0.08	−0.08	−0.13	−0.14	−0.15	−0.16	−0.17	−0.37	−0.72
HICP	−0.01	−0.03	−0.07	−0.09	−0.11	−0.13	−0.15	−0.17	−0.24	−0.71*
Unemployment	−0.04	−0.06	−0.09	−0.13	−0.16	−0.18	−0.19	−0.21	N/A	N/A
Euribor	−0.21***	−0.50**	−0.81**	−1.11**	−1.41**	−1.71**	−2.01**	−2.31**	N/A	N/A
	Panel C. TVP-VAR - After Great Recession									
GDP	−0.14*	−0.17	−0.17	−0.19	−0.22	−0.23	−0.23	−0.25	−0.38	−0.82
HICP	0.06	0.09	0.09	0.09	0.10	0.09	0.09	0.07	0.36	0.36
Unemployment	−0.01	0.00	0.02	0.05	0.08	0.11	0.14	0.17	N/A	N/A
Euribor	0.05	0.08	0.06	0.02	−0.06	−0.16	−0.28	−0.43	N/A	N/A
	Panel D. Tilting GDP One- and Two-Year-Ahead - After Great Recession									
GDP	−0.06	−0.07	−0.06	−0.08	−0.11	−0.12	−0.13	−0.20	−0.09	−0.36
HICP	0.06	0.10	0.11	0.12	0.13	0.13	0.13	0.12	0.42	0.52
Unemployment	−0.02	−0.03	−0.05	−0.06	−0.07	−0.08	−0.09	−0.09	N/A	N/A
Euribor	0.07*	0.14	0.19	0.22	0.24	0.24	0.21	0.16	N/A	N/A

Note: Panels A to D display forecast error means of the TVP-VAR and tilted TVP-VAR, before and after the Great Recession. Asterisks *, ** and *** imply statistical significance of a two-sided *t*-test of unbiasedness at the 10%, 5%, 1% level. The variance is estimated using Bartlett kernel weights with bandwidth equal to the forecast horizon h when $h < 4$, and 4 otherwise (due to the small sample size). The evaluation sample size is $38 - h$ quarters in Panels A and B, and 30 quarters in Panels C and D. The columns labeled $h = 4^*$ and $h = 8^*$ show the results for the one- and two-year-ahead, year-on-year predictions, respectively.

HICP and the unemployment rate) against the TVP-VAR, where values less than one indicate that the entropically tilted BVAR performs better than the TVP-VAR. It is noticeable that apart from marginal improvements regarding unemployment density forecasts, the TVP-VAR performs considerably worse both in terms of point and density forecasts for all variables at all horizons. The entropically tilted BVAR significantly outperforms the TVP-VAR particularly in the case of short-horizon GDP forecasts and medium-horizon interest rate forecasts.

Table 8: Entropically tilted BVAR vs. TVP-VAR: RMSFE and CRPS

Forecast horizon	$h=1$	$h=2$	$h=3$	$h=4$	$h=5$	$h=6$	$h=7$	$h=8$	$h=4^*$	$h=8^*$
	Panel A. Relative RMSFE									
GDP	**0.86***	**0.89****	**0.93***	**0.96**	**0.94**	**0.95**	**0.94**	**0.99**	**0.86****	**0.90**
HICP	**0.91**	**0.93**	**0.85**	**0.81**	**0.75**	**0.72**	**0.70**	**0.68**	**0.81**	**0.63**
Unemployment	1.00	**0.99**	**0.98**	**0.98**	**0.98**	**0.97**	**0.96**	**0.96**	N/A	N/A
Euribor	**0.85***	**0.71****	**0.66****	**0.64***	**0.62***	**0.61***	**0.60***	**0.59****	N/A	N/A
	Panel B. Relative CRPS									
GDP	**0.88****	**0.84****	**0.92**	**0.93**	**0.90**	**0.91**	**0.91**	**0.95**	**0.83****	**0.89**
HICP	**0.94**	**0.99**	**0.93**	**0.89**	**0.82**	**0.76**	**0.73**	**0.70**	**0.92**	**0.71**
Unemployment	**0.96**	1.02	1.02	1.02	1.01	1.01	1.00	1.00	N/A	N/A
Euribor	**0.90**	**0.77**	**0.70****	**0.67*****	**0.64*****	**0.63****	**0.60****	**0.59****	N/A	N/A

Note: Panels A and B display the ratios of the RMSFE and CRPS of the entropically tilted BVAR (jointly tilting GDP, HICP and the unemployment rate) to the TVP-VAR. Numbers in bold imply that the entropically tilted BVAR outperforms the TVP-VAR. Asterisks *, ** and *** imply statistical significance of a two-sided Diebold & Mariano (1995) test of equal predictive ability at the 10%, 5%, 1% level. The variance is estimated using Bartlett kernel weights with bandwidth equal to the forecast horizon h. The evaluation sample size is $P = 72$ quarters. The columns $h = 4^*$ and $h = 8^*$ show the results for the one- and two-year-ahead, year-on-year predictions, respectively.

Figure 8 shows the forecast comparison of the TVP-VAR to the tilted TVP-VAR in terms of RMSFE and CRPS, for the case of a joint tilting towards all three variables. Again, tilting improves the forecast performance in almost all cases, except at short horizons of the interest rate forecast. Tables C.1 and C.2 in Appendix C display the full set of results, including when tilting variables individually. The gains from individual tilting are particularly large for the case of GDP but reductions in the RMSFE and the CRPS are economically and also statistically significant for other variables as well. The Online Appendix shows additional results for soft conditioning, which are qualitatively the same.

Figure 8: Entropic Tilting using all three SPF forecasts vs. TVP-VAR

(a) RMSFE Ratio

(b) RMSFE Difference

(c) CRPS Ratio

(d) CRPS Difference
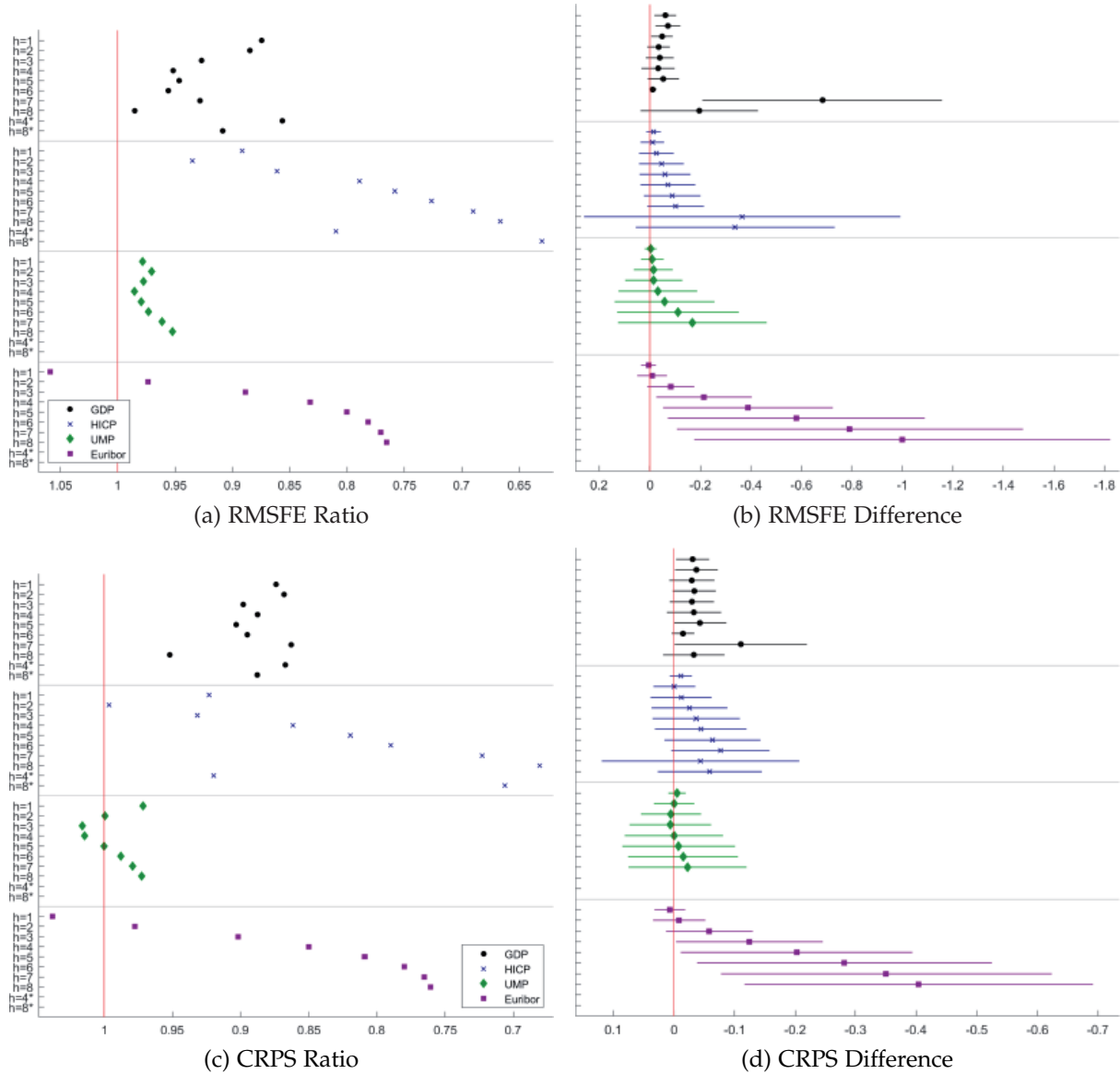
Note: The figure shows results when tilting the TVP-VAR predictions jointly towards the one- and two-year-ahead SPF forecasts of real GDP growth, HICP inflation and the unemployment rate. Panels (a) and (c) display the RMSFE and CRPS ratio of the tilted TVP-VAR and the raw TVP-VAR. A number smaller than one implies that the tilted TVP-VAR outperforms the raw BVAR. Panels (b) and (d) display the RMSFE and CRPS loss differential of the tilted BVAR minus the raw TVP-VAR. A number smaller than zero implies that the tilted TVP-VAR outperforms the raw TVP-VAR. The axis label h denotes the forecast horizon. The horizontal lines centered around a marker denote 90% confidence intervals, for which the variance is estimated using Bartlett kernel weights with bandwidth equal to the forecast horizon h. To improve legibility, all RSMFE loss differentials of the Euribor are normalized by the respective value for $h = 8^*$.

5.2 BVAR with Larger Information Set

Bańbura et al. (2015) showed that large BVARs are a viable tool for predictions when a large set of predictors is available, and to rule out that the results are driven by omitted variables, we produced real-time forecasts using a large BVAR with 14 variables. To additionally allow for time-variation in the volatility, we used the model proposed by Chan (2018), which contains a common stochastic volatility component.[20] Following Chan (2018), the own-lag coefficients of variables that are stationary are shrunk towards zero, whereas the coefficients of the first own-lag of variables in levels are shrunk towards one.[21] We adopt the lag specification of $p = 4$, used by Bańbura et al. (2015) and Chan (2018). Table 9 gives a description of the variables used and which transformation we applied before estimating the model.

Table 9: Dataset for BVAR with 14 variables

Variable	Data source	Transformation	Identifier
Real GDP	ECB RTD	Δlog-level	RTD.Q.S0.S.G_GDPM_TO_C.E
Real Personal Consumption	ECB RTD	Δlog-level	RTD.Q.S0.S.G_FCHI_TO_C.E
Final Government Consumption	ECB RTD	Δlog-level	RTD.Q.S0.S.G_FCGG_TO_C.E
Real Exports	ECB RTD	Δlog-level	RTD.Q.S0.S.G_XGS_TO_C.E
Real Imports	ECB RTD	Δlog-level	RTD.Q.S0.S.G_MGS_TO_C.E
Real Gross Capital Formation	ECB RTD	Δlog-level	RTD.Q.S0.S.G_GFCF_TO_C.E
HICP	ECB RTD	Δlog-level	RTD.M.S0.N.P_C_OV.X
Unemployment Rate	ECB RTD	level	RTD.M.S0.S.L_UNETO.F
3-month Euribor	AWM	level	STN
10-year benchmark yield	AWM	level	LTN
US-EUR Exchange Rate	AWM	level	EXR
Commodity Price Index excl. Oil	AWM	log-level	PCOMU
Oil Price	AWM	log-level	POILU
Euro Stoxx 50	ECB RTD	Δlog-level	RTD.M.S0.N.C_DJE50.X

Note: ECB RTD denotes the ECB Real Time database and AWM denotes the Area Wide Model database. The column Transformation indicates which variable entered the model in levels, log-levels or in log-differences.

Figure 9 shows the results for the case of jointly tilting real GDP growth, HICP inflation, and the unemployment rate. We observe that using the information of the SPF survey improves the point and density forecasts of a BVAR, even when the BVAR uses a large set of predictors. Improvements are large for GDP growth at the short horizon and large for HICP inflation, the unemployment rate, and the Euribor at longer horizons. Overall, the results are similar to the baseline four-variable BVAR case. Tables D.1 and D.2 in Appendix D further document the spillover effects on the additional "other-than-targeted" real variables in the large BVAR. In

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[20]The priors that we use are taken from Chan (2018), to which we refer for further details. The priors on the autoregressive coefficients are very similar to Bańbura et al. (2015), but the overall model differs as the specification proposed by Bańbura et al. (2015) does not have a common stochastic volatility component.

[21]Results are robust to shrinking level variables towards 0.8 instead of one, as in the baseline specification of the four-variable BVAR.

particular, tilting GDP and tilting the unemployment rate leads to RMSFE improvements for horizons up to five-quarter-ahead for real personal consumption expenditures, real exports, real imports, and real gross capital formation. Improvements under the CRPS loss are qualitatively similar and somewhat stronger. Overall, the results underline the usefulness of combining external information with the multivariate system of a BVAR. The Online Appendix displays results for soft conditioning.

Figure 9: Entropic Tilting using all three SPF forecasts vs. large BVAR
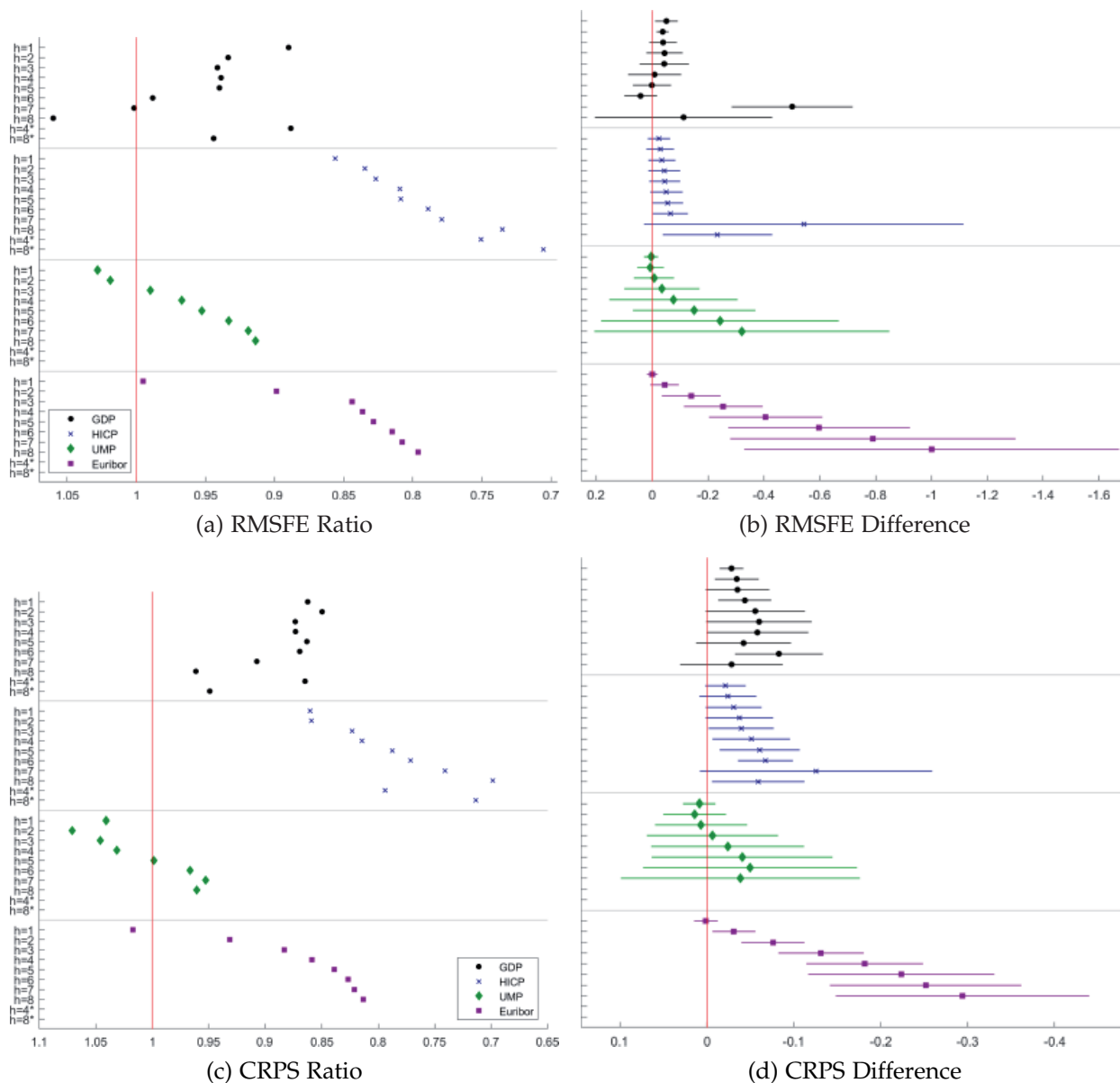
(a) RMSFE Ratio

(b) RMSFE Difference

(c) CRPS Ratio

(d) CRPS Difference

Note: The figure shows results when tilting the large BVAR predictions jointly towards the one- and two-year-ahead SPF forecasts of real GDP growth, HICP inflation and the unemployment rate. Panels (a) and (c) display the RMSFE and CRPS ratio of the tilted large BVAR and the raw large BVAR. A number smaller than one implies that the tilted large BVAR outperforms the raw large BVAR. Panels (b) and (d) display the RMSFE and CRPS loss differential of the tilted large BVAR minus the raw large BVAR, respectively. A number smaller than zero implies that the tilted large BVAR outperforms the raw large BVAR. The axis label *h* denotes the forecast horizon. The horizontal lines centered around a marker denote 90% confidence intervals, for which the variance is estimated using Bartlett kernel weights with bandwidth equal to the forecast horizon *h*. To improve legibility, all RSMFE loss differentials of the Euribor are normalized by the respective value for $h = 8^*$.

Figure 10 shows the CRPS ratios of the tilted large BVAR and the raw large BVAR, coming from two different tilting strategies. Panel (a) shows the baseline tilting towards the SPF mean and variance, whereas Panel (b) shows tilting towards the SPF mean while keeping the variance of the raw predictive density fixed. In both cases, we tilt real GDP growth, HICP inflation, and the unemployment rate jointly. Note that the two graphs have the same scale. Although we do not provide a formal test of differences, we observe that tilting both, the mean and the variance as in Panel (a), leads to additional gains in terms of the CRPS. Table D.3 additionally shows the results of Panel (b) as well as tilting the variables individually. Comparing Table D.3 to Table D.2, we see a similar pattern from additionally using the SPF variance when tilting the variables individually.

Figure 10: Entropic Tilting using SPF mean and variance versus SPF mean only: CRPS Ratios
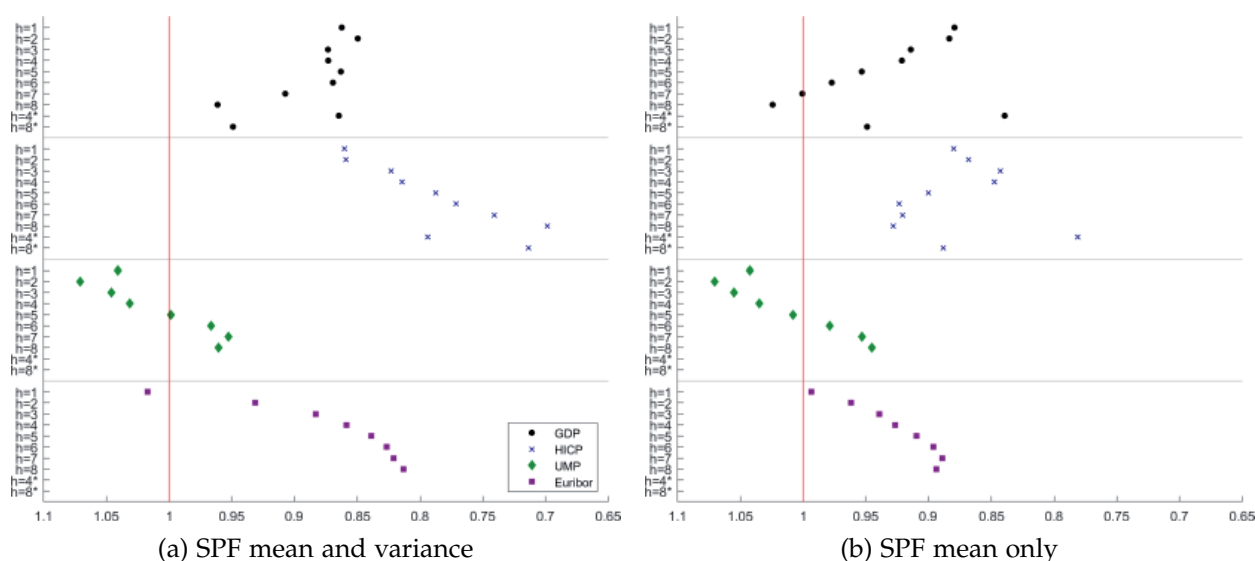
(a) SPF mean and variance   (b) SPF mean only

Note: The figure shows results when tilting the large BVAR predictions jointly towards the one- and two-year-ahead SPF forecasts of real GDP growth, HICP inflation and the unemployment rate. Panels (a) displays the CRPS ratio of the tilted large BVAR and the raw large BVAR, when tilting towards the SPF mean and variance. Panels (b) displays the CRPS ratio of the tilted large BVAR and the raw large BVAR, when tilting towards the SPF mean only while keeping the variance fixed. Numbers smaller than one implies that the tilted large BVAR outperforms the raw large BVAR. The axis label *h* denotes the forecast horizon.

6   Conclusion

In a real-time, out-of-sample forecasting exercise based on euro area macroeconomic aggregates, we incorporated survey expectations into the predictive density of a BVAR with stochastic volatility. The forecasting gains are economically and statistically significant when tilting real GDP growth, HICP inflation, and the unemployment rate, both individually and jointly. The gains are mainly, but not exclusively driven by using the information of the point predictions. In addition, the incorporation of survey information for one variable exhibits spillover effects on other variables. Overall, the results are in line with previous findings regarding the predictive accuracy of surveys of professional forecasters, as well as the usefulness of entropic tilting and soft conditioning. However, different from the existing literature, we impose the restrictions on quarterly year-on-year growth rates, and thereby restrict the possible paths over several horizons.

We documented a bias in real GDP growth forecasts of the BVAR for the period after (but not before) the Great Recession, which we interpreted as a structural change. In turn, the SPF panelists were better than the benchmark macroeconometric model to adapt to the slow GDP growth recovery period after the crisis, which provides evidence that survey expectations can considerably improve model-based forecasts in times of distress and structural change. We consider the tilting procedure as a simple way to correct possible misspecifications of an otherwise useful benchmark model. The results are robust to several alternative specifications, including a time-varying parameter VAR with stochastic volatility, a larger BVAR, estimations in levels and using the hierarchical model of Giannone et al. (2015) with dummy observation priors.

Furthermore, we provided evidence that the recent Great Recession and the following sovereign debt crisis pushed the dynamics of a standard time-varying parameter VAR model towards the unstable region.

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Appendix

Appendix A   Multi-Horizon Forecast Results

The results displayed in Tables 1 to 4 in the main text are based on horizon-by-horizon tests and are consequently subject to a multiple testing problem. Therefore, Tables A.1 and A.2 show the results of the multi-horizon forecast comparison test of Quaedvlieg (2019), which tests for superior predictive ability of the quarter-on-quarter forecasts while controlling the family-wise error rate of the multiple hypothesis tests. We conduct the test for horizon 1 to 4 and 1 to 8 (note that this is different from the year-on-year tests of $h = 4^*$ and $h = 8^*$). Tables A.1 and A.2 show results for tilting different variables (UMP stands for the unemployment rate). Positive (bold) numbers indicate a superior predictive ability of the tilted BVAR relative to the raw BVAR and $^*,^{**},^{***}$ denote statistical significance resulting from the bootstrap procedure of Quaedvlieg (2019). The multi-horizon test confirms the findings in Tables 1 to 4. We interpret these results with some caution as one of the assumptions for the asymptotic theory of the multi-horizon forecast comparison test is a rolling window estimation scheme, i.e. the preservation of parameter estimation error, whereas our BVAR is based on a recursive window estimation scheme because of the small initial sample.

Table A.1: Entropic tilting versus BVAR: Multi-Horizon Test

	Panel A. Tilting GDP							
	RMSFE				*CRPS*			
	GDP	HICP	UMP	Euribor	GDP	HICP	UMP	Euribor
$h = 1\text{-}4$	**1.89****	-0.65	**1.73****	**1.44****	**2.22*****	-0.89	**1.50****	**1.37****
$h = 1\text{-}8$	**1.00**	-0.67	**1.37***	**0.71**	**1.51***	-0.70	**1.29**	**1.19***

	Panel B. Tilting HICP							
	RMSFE				*CRPS*			
	GDP	HICP	UMP	Euribor	GDP	HICP	UMP	Euribor
$h = 1\text{-}4$	**1.02****	**0.81***	**1.15****	**1.56****	**1.19****	**0.92***	**0.98***	**1.26****
$h = 1\text{-}8$	**0.98**	**1.15**	**0.31**	**2.03****	**1.33**	**1.25**	**0.09**	**1.88****

	Panel C. Tilting Unemployment							
	RMSFE				*CRPS*			
	GDP	HICP	UMP	Euribor	GDP	HICP	UMP	Euribor
$h = 1\text{-}4$	**0.49**	-2.00	**1.84*****	**0.22**	-0.24	-1.68	**2.63*****	**0.05**
$h = 1\text{-}8$	-0.78	-1.06	**2.41*****	**0.27**	-1.01	-0.89	**3.17*****	**0.49**

	Panel D. Tilting GDP, HICP and Unemployment							
	RMSFE				*CRPS*			
	GDP	HICP	UMP	Euribor	GDP	HICP	UMP	Euribor
$h = 1\text{-}4$	**1.71****	**0.79***	**1.92*****	**1.65****	**1.95****	**0.81***	**2.86*****	**1.54****
$h = 1\text{-}8$	**0.75**	**1.10**	**2.39*****	**1.82****	**1.22**	**1.15**	**3.16*****	**1.83****

Note: The table shows the results of the "multi-horizon forecast comparison test" by Quaedvlieg (2019). Positive (bold) numbers imply that the tilted BVAR improved over the raw BVAR. Asterisks *, ** and *** imply statistical significance of the one-sided multi-horizon test at the 10%, 5%, 1% level. The evaluation sample size is $P = 72$ quarters. The rows $h = 1\text{-}4$ and $h = 1\text{-}8$ show the results when applying the multi-horizon test to forecast horizons $h = 1$ to 4 and $h = 1$ to 8, respectively.

	Panel A. Tilting GDP							
	RMSFE				*CRPS*			
	GDP	HICP	UMP	Euribor	GDP	HICP	UMP	Euribor
$h = 1\text{-}4$	**2.13*****	−0.41	**1.78****	**1.61****	**2.34*****	−0.74	**1.02***	**1.97****
$h = 1\text{-}8$	**1.27**	−0.50	**1.44***	**1.02**	**1.53***	−0.78	**0.74**	**1.67****

	Panel B. Tilting HICP							
	RMSFE				*CRPS*			
	GDP	HICP	UMP	Euribor	GDP	HICP	UMP	Euribor
$h = 1\text{-}4$	**1.29****	**1.38****	**1.21****	**1.89****	**1.51****	**1.15****	0.32	**1.70****
$h = 1\text{-}8$	**1.13**	**1.79****	**0.31**	**2.38****	**1.64***	**1.64***	−1.11	**2.38****

	Panel C. Tilting Unemployment							
	RMSFE				*CRPS*			
	GDP	HICP	UMP	Euribor	GDP	HICP	UMP	Euribor
$h = 1\text{-}4$	**1.82****	−1.05	**1.75****	−0.75	**1.85****	−1.22	**1.19****	−0.78
$h = 1\text{-}8$	**1.33***	−0.96	**1.79****	−1.02	**1.71***	−1.16	**0.85**	−1.08

	Panel D. Tilting GDP, HICP and Unemployment							
	RMSFE				*CRPS*			
	GDP	HICP	UMP	Euribor	GDP	HICP	UMP	Euribor
$h = 1\text{-}4$	**2.32*****	**1.20****	**2.07*****	**1.97****	**2.64*****	**0.78***	**1.36****	**2.38*****
$h = 1\text{-}8$	**1.34***	**1.60****	**1.82****	**2.29****	**1.65***	**1.17**	**0.73**	**2.88*****

Note: The table shows the results of the "multi-horizon forecast comparison test" by Quaedvlieg (2019). Positive (bold) numbers imply that the tilted BVAR improved over the raw BVAR. Asterisks *, ** and *** imply statistical significance of the one-sided multi-horizon test at the 10%, 5%, 1% level. The evaluation sample size is $P = 72$ quarters. The rows $h = 1\text{-}4$ and $h = 1\text{-}8$ show the results when applying the multi-horizon test to forecast horizons $h = 1$ to 4 and $h = 1$ to 8, respectively.

Appendix B   Tilting Towards One-Year-Ahead SPF Forecasts Only

The results in the main text are based on tilting towards the one- and two-year-ahead forecasts of the SPF jointly. In turn, Figure B.1 shows results for tilting all three variables jointly towards the one-year-ahead SPF predictions only. Results for individually tilting GDP, HICP and the unemployment rate are displayed in Tables B.1 and B.2. The forecasting improvements are strong in the short run for GDP, extend to longer horizons in the case of tilting the inflation rate, the unemployment rate, and the Euribor, and are often economically relevant in size and statistically significant. Similarly to Krüger et al. (2017), we find that improvements are particularly strong at longer horizons for persistent variables (the unemployment rate and the Euribor), as Panel E demonstrates.

Tables B.3 and B.4 show additional results for soft conditioning, which are again qualitatively similar.

Table B.1: Entropic tilting One-Year-Ahead versus BVAR forecasts: RMSFE

Forecast horizon	$h=1$	$h=2$	$h=3$	$h=4$	$h=5$	$h=6$	$h=7$	$h=8$	$h=4^*$	$h=8^*$
					Panel A. BVAR					
GDP	0.55	0.59	0.59	0.58	0.58	0.58	0.57	0.57	1.68	1.93
HICP	0.26	0.27	0.29	0.30	0.31	0.31	0.31	0.31	0.92	1.07
Unemployment	0.29	0.46	0.65	0.83	1.00	1.16	1.30	1.43	*N/A*	*N/A*
Euribor	0.35	0.66	0.94	1.20	1.44	1.64	1.82	1.97	*N/A*	*N/A*
					Panel B. Tilting GDP					
GDP	**0.80****	**0.86***	**0.91**	**0.98**	1.01	1.01	1.01	1.01	**0.81****	1.01
HICP	1.00	1.00	1.01	1.00	1.00	1.00	1.00	1.00	1.01	1.01
Unemployment	**0.95**	**0.92***	**0.91***	**0.92**	**0.94**	**0.95**	**0.96**	**0.97**	*N/A*	*N/A*
Euribor	**0.99**	**0.97**	**0.97**	**0.97**	**0.97***	**0.98**	**0.98**	**0.99**	*N/A*	*N/A*
					Panel C. Tilting HICP					
GDP	**0.99**	**0.99**	**0.99**	1.00	**1.00***	**1.00**	**1.00**	1.00	**0.99**	**1.00**
HICP	**0.94**	**0.98**	**0.93**	**0.93**	**0.93**	**0.92**	**0.92*****	**0.93***	**0.91**	**0.90***
Unemployment	**0.99**	**1.00**	1.00	1.01***	1.02***	1.02***	1.02***	1.02***	*N/A*	*N/A*
Euribor	**0.98**	**0.95***	**0.93***	**0.93****	**0.93****	**0.93****	**0.94****	**0.94****	*N/A*	*N/A*
					Panel D. Tilting Unemployment					
GDP	**0.96**	**0.97**	**0.99**	**0.98**	**0.99**	1.03**	1.04	1.03*	**0.96**	**0.99****
HICP	1.02**	1.02*	1.02	1.02	1.02	1.02	1.01	1.03	1.03**	1.03
Unemployment	**0.93**	**0.88**	**0.86****	**0.86****	**0.87****	**0.88****	**0.89****	**0.91****	*N/A*	*N/A*
Euribor	1.05	1.02	1.01	1.02	1.01	**1.00**	0.98	0.98	*N/A*	*N/A*
					Panel E. Tilting GDP, HICP and Unemployment					
GDP	**0.79****	**0.86***	**0.92**	**1.00**	1.01	1.01	1.03*	1.06	**0.82****	1.00
HICP	**0.95**	**0.97**	**0.94**	**0.93**	**0.94**	**0.94**	**0.95**	**0.97**	**0.91**	**0.93**
Unemployment	**0.89***	**0.84***	**0.83****	**0.86****	**0.88****	**0.89****	**0.90****	**0.91****	*N/A*	*N/A*
Euribor	**0.95**	**0.88****	**0.88****	**0.91***	**0.92***	**0.93***	**0.93***	**0.94**	*N/A*	*N/A*

Note: Panel A displays the raw BVAR RMSFE. Panels B to E show the ratios of the RMSFE of the entropically tilted BVAR to the raw BVAR. Numbers in bold imply that the tilted BVAR improves over the raw BVAR. Asterisks *, ** and *** imply statistical significance of a two-sided Diebold & Mariano (1995) test of equal predictive ability at the 10%, 5%, 1% level. The variance is estimated using Bartlett kernel weights with bandwidth equal to the forecast horizon h. The evaluation sample size is $P = 72$ quarters. The columns $h = 4^*$ and $h = 8^*$ show the results for the one- and two-year-ahead, year-on-year predictions, respectively.

Figure B.1: Entropic Tilting using all three one-year-ahead SPF forecasts vs. BVAR
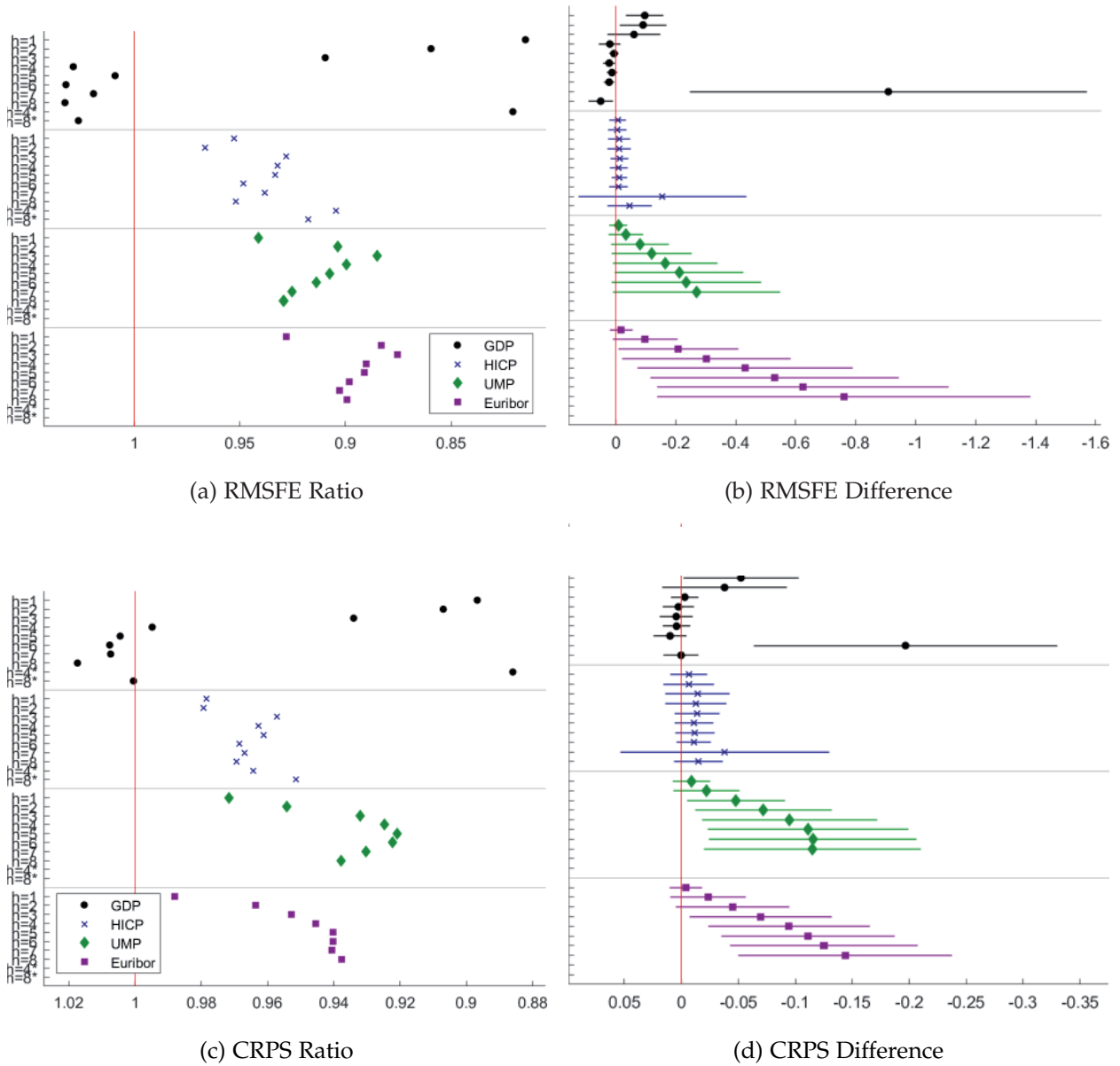
(a) RMSFE Ratio

(b) RMSFE Difference

(c) CRPS Ratio

(d) CRPS Difference

Note: The figure shows results when tilting the BVAR predictions jointly towards the one-year-ahead SPF forecasts of real GDP growth, HICP inflation and the unemployment rate . Panel (a) and Panel (c) display the RMSFE and CRPS ratio of the tilted BVAR and the raw BVAR. A number smaller than one implies that the tilted BVAR outperforms the raw BVAR. Panel (b) and Panel (d) display the RMSFE and CRPS loss differential of the tilted BVAR minus the raw BVAR. A number smaller than zero implies that the tilted BVAR outperforms the raw BVAR. The axis label h denotes the forecast horizon. The horizontal lines centered around a marker denote 90% confidence intervals, for which the variance is estimated using Bartlett kernel weights with bandwidth equal to the forecast horizon h. To improve legibility, all RSMFE loss differentials of the Euribor are normalized by the respective value for $h = 8^*$.

Table B.2: Entropic tilting One-Year-Ahead versus BVAR forecasts: CRPS

Forecast horizon	$h=1$	$h=2$	$h=3$	$h=4$	$h=5$	$h=6$	$h=7$	$h=8$	$h=4^*$	$h=8^*$
					Panel A. BVAR					
GDP	0.27	0.29	0.29	0.29	0.29	0.29	0.28	0.28	0.90	1.08
HICP	0.15	0.16	0.17	0.17	0.18	0.18	0.18	0.18	0.54	0.63
Unemployment	0.18	0.28	0.40	0.54	0.66	0.78	0.89	0.99	*N/A*	*N/A*
Euribor	0.17	0.32	0.49	0.65	0.81	0.95	1.07	1.18	*N/A*	*N/A*
					Panel B. Tilting GDP					
GDP	**0.79****	**0.81***\	**0.86**	**0.96**	**0.99**	**0.99**	1.00	1.00	**0.76****	**0.99**
HICP	1.00	1.01	1.02	1.01	1.00	1.00	1.00	**1.00**	1.01	**1.00**
Unemployment	**0.96**	**0.93**	**0.92**	**0.93**	**0.94**	**0.95**	**0.96**	**0.97**	*N/A*	*N/A*
Euribor	**0.99**	**0.98**	**0.97**	**0.96***	**0.96****	**0.96****	**0.96**	**0.96**	*N/A*	*N/A*
					Panel C. Tilting HICP					
GDP	**0.99**	**0.99**	**0.99**	**1.00**	**0.99***	**1.00***	**1.00**	**1.00**	**0.99**	**0.99***
HICP	**0.93**	**0.98**	**0.92**	**0.92**	**0.92***	**0.92****	**0.92****	**0.93*****	**0.93**	**0.89***
Unemployment	**0.99**	1.00	1.01*	1.02**	1.02**	1.02**	1.03**	1.03**	*N/A*	*N/A*
Euribor	**0.99**	**0.96**	**0.95**	**0.94**	**0.94**	**0.94***	**0.94***	**0.94***	*N/A*	*N/A*
					Panel D. Tilting Unemployment					
GDP	**0.97**	**1.00**	**1.00**	1.00	1.02	1.01	1.07*	1.06**	**0.95****	**0.99**
HICP	1.02*	1.02*	1.01	1.02	1.02	1.02	1.00	1.01	1.04**	1.01
Unemployment	**0.91***	**0.89***	**0.84*****	**0.82*****	**0.82*****	**0.82*****	**0.83*****	**0.85*****	*N/A*	*N/A*
Euribor	1.07	1.03	1.01	1.01	**0.98**	**0.96**	**0.96**	**0.96**	*N/A*	*N/A*
					Panel E. Tilting GDP, HICP and Unemployment					
GDP	**0.78*****	**0.82***	**0.89**	**0.97**	1.01	1.00	1.03	1.06*	**0.76*****	**0.98**
HICP	**0.94**	**0.97**	**0.93**	**0.93**	**0.92**	**0.93**	**0.94**	**0.94**	**0.93**	**0.90**
Unemployment	**0.88****	**0.85****	**0.80*****	**0.80*****	**0.80*****	**0.81*****	**0.83*****	**0.84*****	*N/A*	*N/A*
Euribor	**0.99**	**0.92**	**0.90***	**0.91***	**0.91****	**0.90****	**0.90****	**0.90****	*N/A*	*N/A*

Note: Panel A displays the raw BVAR CRPS. Panels B to E show the ratios of the CRPS of the entropically tilted BVAR to the raw BVAR. Numbers in bold imply that the tilted BVAR improves over the raw BVAR. Asterisks *, ** and *** imply statistical significance of a two-sided Diebold & Mariano (1995) test of equal predictive ability at the 10%, 5%, 1% level. The variance is estimated using Bartlett kernel weights with bandwidth equal to the forecast horizon h. The evaluation sample size is $P = 72$ quarters. The columns $h = 4^*$ and $h = 8^*$ show the results for the one- and two-year-ahead, year-on-year predictions, respectively.

Table B.3: Soft Conditioning versus BVAR forecasts: RMSFE

Forecast horizon	$h=1$	$h=2$	$h=3$	$h=4$	$h=5$	$h=6$	$h=7$	$h=8$	$h=4^*$	$h=8^*$
	Panel A. BVAR									
GDP	0.55	0.59	0.59	0.58	0.58	0.58	0.57	0.57	1.68	1.93
HICP	0.26	0.27	0.29	0.30	0.31	0.31	0.31	0.31	0.92	1.07
Unemployment	0.29	0.46	0.65	0.83	1.00	1.16	1.30	1.43	*N/A*	*N/A*
Euribor	0.35	0.66	0.94	1.20	1.44	1.64	1.82	1.97	*N/A*	*N/A*
	Panel B. Soft Conditioning GDP									
GDP	**0.87****	**0.91*****	**0.93**	**0.99**	1.00	1.01	1.01	1.01	**0.88****	1.00
HICP	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Unemployment	**0.97**	**0.95***	**0.95****	**0.96***	**0.97**	**0.97**	**0.98**	**0.98**	*N/A*	*N/A*
Euribor	**0.99**	**0.98**	**0.98**	**0.98***	**0.98****	**0.99****	**0.99**	**0.99**	*N/A*	*N/A*
	Panel C. Soft Conditioning HICP									
GDP	**1.00**	**1.00**	**1.00**	**1.00**	**1.00****	**1.00**	**1.00**	1.00	**1.00***	**1.00**
HICP	**0.97***	**0.98**	**0.96**	**0.95**	**0.96***	**0.96***	**0.96***	**0.96**	**0.94**	**0.94***
Unemployment	**1.00**	**1.00**	1.00	1.00**	1.00**	1.01**	1.01***	1.01***	*N/A*	*N/A*
Euribor	**0.99**	**0.98***	**0.97***	**0.97***	**0.97****	**0.97****	**0.97****	**0.98****	*N/A*	*N/A*
	Panel D. Soft Conditioning Unemployment									
GDP	**0.99***	**0.99***	**1.00**	1.00	1.00	1.00	1.00	1.01	**1.00**	1.00
HICP	1.00	1.00	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.02
Unemployment	**0.98**	**0.97**	**0.97**	**0.97**	**0.97**	**0.98**	**0.98**	**0.98**	*N/A*	*N/A*
Euribor	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.00	*N/A*	*N/A*
	Panel E. Soft Conditioning GDP, HICP and Unemployment									
GDP	**0.87****	**0.90****	**0.93**	**0.99**	1.00	1.01	1.01	1.01	**0.88****	1.00
HICP	**0.97**	**0.98**	**0.96**	**0.96**	**0.97**	**0.97**	**0.97**	**0.97**	**0.95**	**0.96**
Unemployment	**0.96***	**0.94****	**0.93***	**0.94***	**0.96**	**0.97**	**0.98**	**0.98**	*N/A*	*N/A*
Euribor	**0.99**	**0.96***	**0.95****	**0.95*****	**0.96*****	**0.96*****	**0.97*****	**0.97*****	*N/A*	*N/A*

Note: Panel A displays the raw BVAR RMSFE. Panels B to E show the ratios of the RMSFE of the soft conditioned BVAR to the raw BVAR. Numbers in bold imply that the soft conditioned BVAR improves over the raw BVAR. Asterisks *, ** and *** imply statistical significance of a two-sided Diebold & Mariano (1995) test of equal predictive ability at the 10%, 5%, 1% level. The variance is estimated using Bartlett kernel weights with bandwidth equal to the forecast horizon h. The evaluation sample size is $P = 72$ quarters. The columns $h = 4^*$ and $h = 8^*$ show the results for the one- and two-year-ahead, year-on-year predictions, respectively.

Table B.4: Soft Conditioning versus BVAR forecasts: CRPS

Forecast horizon	$h=1$	$h=2$	$h=3$	$h=4$	$h=5$	$h=6$	$h=7$	$h=8$	$h=4*$	$h=8*$
	Panel A. BVAR									
GDP	0.27	0.29	0.29	0.29	0.29	0.29	0.28	0.28	0.90	1.08
HICP	0.15	0.16	0.17	0.17	0.18	0.18	0.18	0.18	0.54	0.63
Unemployment	0.18	0.28	0.40	0.54	0.66	0.78	0.89	0.99	*N/A*	*N/A*
Euribor	0.17	0.32	0.49	0.65	0.81	0.95	1.07	1.18	*N/A*	*N/A*
	Panel B. Soft Conditioning GDP									
GDP	**0.87****	**0.88****	**0.91***	**0.98**	**0.99**	**1.00**	1.00	1.00	**0.89****	1.00
HICP	1.00	1.00	1.01	1.00	1.00	1.00	1.00	1.00	1.01	1.00
Unemployment	**0.98**	**0.97**	**0.96**	**0.97**	**0.97**	**0.98**	**0.98**	**0.99**	*N/A*	*N/A*
Euribor	**0.99**	**0.98**	**0.97***	**0.97****	**0.97****	**0.98***	**0.98**	**0.98**	*N/A*	*N/A*
	Panel C. Soft Conditioning HICP									
GDP	**1.00**	**0.99**	**0.99**	**1.00****	**1.00****	**1.00*****	**1.00***	**1.00***	0.99	1.00
HICP	**0.97**	**0.99**	**0.96***	**0.96***	**0.96**	**0.96***	**0.96***	**0.97***	**0.97**	**0.95**
Unemployment	**1.00**	1.00	1.00***	1.01***	1.01***	1.01***	1.01***	1.01***	*N/A*	*N/A*
Euribor	**1.00**	**0.98**	**0.97**	**0.97***	**0.97****	**0.97****	**0.97****	**0.98****	*N/A*	*N/A*
	Panel D. Soft Conditioning Unemployment									
GDP	**0.99***	**0.99**	**1.00**	**1.00**	1.00	1.00	1.00	1.01	**1.00**	1.00
HICP	1.00	1.00	1.01	1.01	1.01	1.01	1.01	1.01	1.01*	1.02
Unemployment	**0.99**	**0.98**	**0.97**	**0.98**	**0.98**	**0.98**	**0.98**	**0.99**	*N/A*	*N/A*
Euribor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	*N/A*	*N/A*
	Panel E. Soft Conditioning GDP, HICP and Unemployment									
GDP	**0.87*****	**0.87*****	**0.91***	**0.98***	**0.99**	**1.00**	1.00	1.00	**0.89****	**1.00**
HICP	**0.98**	**0.99**	**0.97**	**0.96**	**0.97**	**0.97**	**0.97**	**0.97**	**0.99**	**0.97**
Unemployment	**0.97**	**0.96**	**0.95**	**0.96**	**0.97**	**0.98**	**0.99**	**0.99**	*N/A*	*N/A*
Euribor	**0.99**	**0.97****	**0.95*****	**0.95*****	**0.95*****	**0.95*****	**0.96*****	**0.96****	*N/A*	*N/A*

Note: Panel A displays the raw BVAR CRPS. Panels B to E show the ratios of the CRPS of the soft conditioned BVAR to the raw BVAR. Numbers in bold imply that the soft conditioned BVAR improves over the raw BVAR. Asterisks *, ** and *** imply statistical significance of a two-sided Diebold & Mariano (1995) test of equal predictive ability at the 10%, 5%, 1% level. The variance is estimated using Bartlett kernel weights with bandwidth equal to the forecast horizon h. The evaluation sample size is $P = 72$ quarters. The columns $h = 4*$ and $h = 8*$ show the results for the one- and two-year-ahead, year-on-year predictions, respectively.

Appendix C TVP-VAR Results

Tables C.1 and C.2 demonstrate that incorporating ECB-SPF information often considerably and significantly improves even the TVP-VAR's forecasts.

Table C.1: Entropic tilting versus TVP-VAR forecasts: RMSFE

Forecast horizon	$h=1$	$h=2$	$h=3$	$h=4$	$h=5$	$h=6$	$h=7$	$h=8$	$h=4^*$	$h=8^*$
					Panel A. TVP-VAR					
GDP	0.51	0.57	0.59	0.60	0.61	0.61	0.62	0.61	1.60	2.11
HICP	0.26	0.28	0.32	0.35	0.37	0.39	0.41	0.43	1.03	1.50
Unemployment	0.26	0.40	0.56	0.73	0.89	1.05	1.20	1.34	N/A	N/A
Euribor	0.38	0.78	1.17	1.55	1.93	2.27	2.60	2.89	N/A	N/A
					Panel B. Tilting GDP					
GDP	**0.86****	**0.89****	**0.92****	**0.93**	**0.94**	**0.94**	**0.93**	**0.95****	**0.86****	**0.91**
HICP	**1.00**	1.00	1.02*	1.01	1.02	1.02	1.01	1.01	1.01	1.02
Unemployment	**0.97***	**0.93**	**0.92**	**0.91**	**0.91**	**0.92**	**0.92**	**0.92**	N/A	N/A
Euribor	**0.99**	**0.98**	**0.98**	**0.97**	**0.97**	**0.97**	**0.97**	**0.97**	N/A	N/A
					Panel C. Tilting HICP					
GDP	**0.99**	**0.98**	**0.98**	**0.99**	**0.99**	1.01	1.01	1.01	**0.97**	**0.99**
HICP	**0.90***	**0.93**	**0.85**	**0.80**	**0.77**	**0.74**	**0.70**	**0.66***	**0.81**	**0.63**
Unemployment	**0.99**	**0.97**	**0.97**	**0.97**	**0.97**	**0.98**	**0.98**	**0.99**	N/A	N/A
Euribor	**0.98**	**0.93***	**0.89****	**0.87****	**0.86****	**0.84****	**0.84****	**0.84****	N/A	N/A
					Panel D. Tilting Unemployment					
GDP	**0.98**	**0.99**	1.01	**0.99**	1.00	1.01	**0.99**	1.01	**0.99**	**0.98**
HICP	1.00	1.01	1.02	1.02	1.01	1.01	1.02	1.01	1.02	1.01
Unemployment	**0.98**	**0.98**	**0.98**	**0.99**	**0.98**	**0.98**	**0.96**	**0.95**	N/A	N/A
Euribor	1.09	1.10	1.06	1.03	1.01	**0.99**	**0.98**	**0.97**	N/A	N/A
					Panel E. Tilting GDP, HICP and Unemployment					
GDP	**0.87****	**0.88****	**0.93***	**0.95**	**0.95**	**0.96**	**0.93**	**0.99**	**0.86****	**0.91**
HICP	**0.89***	**0.93**	**0.86**	**0.79**	**0.76**	**0.73**	**0.69**	**0.67***	**0.81**	**0.63**
Unemployment	**0.98**	**0.97**	**0.98**	**0.99**	**0.98**	**0.97**	**0.96**	**0.95**	N/A	N/A
Euribor	1.06	**0.97**	**0.89***	**0.83****	**0.80****	**0.78***	**0.77***	**0.77****	N/A	N/A

Note: Panel A displays the raw TVP-VAR RMSFE. Panels B to E show the ratios of the RMSFE of the entropically tilted TVP-VAR to the raw TVP-VAR. Numbers in bold imply that the tilted TVP-VAR improves over the raw TVP-VAR. Asterisks *, ** and *** imply statistical significance of a two-sided Diebold & Mariano (1995) test of equal predictive ability at the 10%, 5%, 1% level. The variance is estimated using Bartlett kernel weights with bandwidth equal to the forecast horizon h. The evaluation sample size is $P = 72$ quarters. The columns $h = 4^*$ and $h = 8^*$ show the results for the one- and two-year-ahead, year-on-year predictions, respectively.

Table C.2: Entropic tilting versus TVP-VAR forecasts: CRPS

Forecast horizon	$h=1$	$h=2$	$h=3$	$h=4$	$h=5$	$h=6$	$h=7$	$h=8$	$h=4^*$	$h=8^*$
Panel A. TVP-VAR										
GDP	0.24	0.28	0.29	0.30	0.31	0.31	0.31	0.31	0.83	1.16
HICP	0.15	0.15	0.17	0.19	0.20	0.21	0.23	0.24	0.54	0.80
Unemployment	0.17	0.23	0.31	0.41	0.52	0.62	0.72	0.81	*N/A*	*N/A*
Euribor	0.18	0.38	0.59	0.83	1.06	1.28	1.49	1.69	*N/A*	*N/A*
Panel B. Tilting GDP										
GDP	**0.85*****	**0.86****	**0.88***	**0.88***	**0.88***	**0.88**	**0.87***	**0.90*****	**0.86***	**0.88**
HICP	**1.00**	**1.00**	1.02	1.01	1.02	1.02	1.02	**1.00**	1.02	1.02
Unemployment	**0.98**	**0.96**	**0.95**	**0.94**	**0.94**	**0.94**	**0.94**	**0.94**	*N/A*	*N/A*
Euribor	**0.99**	**0.99**	**0.98**	**0.97**	**0.97**	**0.97**	**0.96**	**0.96**	*N/A*	*N/A*
Panel C. Tilting HICP										
GDP	**0.99**	**0.99**	**0.99**	**0.99**	**1.00**	1.02	1.01	1.02	**0.99**	1.01
HICP	**0.92**	**0.99**	**0.91**	**0.87**	**0.83**	**0.79**	**0.72**	**0.67***	**0.92**	**0.70**
Unemployment	**0.99**	**0.97**	**0.98**	**0.98**	**0.98**	**0.98**	**0.99**	**0.99**	*N/A*	*N/A*
Euribor	**0.98**	**0.94***	**0.90***	**0.88***	**0.86***	**0.85***	**0.84***	**0.84***	*N/A*	*N/A*
Panel D. Tilting Unemployment										
GDP	**0.99**	**1.00**	1.01	**0.97***	**0.98**	**1.00**	**0.98**	**0.99**	1.01	**0.97**
HICP	**1.00**	1.01	1.02	1.01	1.00	1.01	1.01	**1.00**	1.02	1.01
Unemployment	**0.98**	1.01	1.02	1.02	1.01	**0.99**	**0.98**	**0.97**	*N/A*	*N/A*
Euribor	1.07	1.09	1.06*	1.03	**1.00**	**0.97**	**0.96**	**0.95**	*N/A*	*N/A*
Panel E. Tilting GDP, HICP and Unemployment										
GDP	**0.87****	**0.87****	**0.90**	**0.89***	**0.90**	**0.90**	**0.86***	**0.95****	**0.87***	**0.89**
HICP	**0.92**	**1.00**	**0.93**	**0.86**	**0.82**	**0.79**	**0.72**	**0.68***	**0.92**	**0.71**
Unemployment	**0.97**	**1.00**	1.02	1.01	**1.00**	**0.99**	**0.98**	**0.97**	*N/A*	*N/A*
Euribor	1.04	**0.98**	**0.90**	**0.85***	**0.81***	**0.78***	**0.77****	**0.76****	*N/A*	*N/A*

Note: Panel A displays the raw TVP-VAR CRPS. Panels B to E show the ratios of the CRPS of the entropically tilted TVP-VAR to the raw TVP-VAR. Numbers in bold imply that the tilted TVP-VAR improves over the raw TVP-VAR. Asterisks *, ** and *** imply statistical significance of a two-sided Diebold & Mariano (1995) test of equal predictive ability at the 10%, 5%, 1% level. The variance is estimated using Bartlett kernel weights with bandwidth equal to the forecast horizon h. The evaluation sample size is $P = 72$ quarters. The columns $h = 4^*$ and $h = 8^*$ show the results for the one- and two-year-ahead, year-on-year predictions, respectively.

Appendix D   Large BVAR Results

Tables D.1 and D.2 show that even when the base distribution is provided by the large BVAR model, entropic tilting still considerably improves its forecasts not only in the case of variables which are featured in the ECB-SPF, but also for others, through spillover effects. The abbreviations are as follows: PC is real personal consumption, INV is real gross capital formation, EXP and IMP stand for real exports and real imports, respectively, while GOV denotes final government consumption.

Table D.1: Entropic tilting versus large BVAR forecasts: RMSFE

Forecast horizon	$h=1$	$h=2$	$h=3$	$h=4$	$h=5$	$h=6$	$h=7$	$h=8$	$h=4^*$	$h=8^*$
Panel A. Large BVAR										
GDP	0.47	0.55	0.59	0.59	0.58	0.57	0.57	0.55	1.55	1.92
HICP	0.30	0.31	0.33	0.35	0.36	0.36	0.37	0.37	1.12	1.34
Unemployment	0.25	0.38	0.53	0.70	0.86	1.04	1.21	1.37	*N/A*	*N/A*
Euribor	0.38	0.69	1.03	1.38	1.73	2.04	2.33	2.56	*N/A*	*N/A*
PC	0.30	0.34	0.34	0.38	0.41	0.41	0.42	0.43	0.96	1.44
INV	1.31	1.37	1.46	1.52	1.52	1.57	1.59	1.51	2.58	2.65
EXP	1.91	2.14	2.19	2.15	2.12	2.05	2.07	2.08	6.63	6.44
IMP	1.74	1.87	1.92	1.94	1.87	1.90	1.92	1.99	5.27	5.43
GOV	0.30	0.30	0.31	0.34	0.34	0.33	0.35	0.36	5.71	5.80
Panel B. Tilting GDP										
GDP	**0.89****	**0.92****	**0.94**	**0.95**	**0.99**	1.02	1.03	1.04	**0.89****	1.00
HICP	1.01	**1.00**	**0.99**	**0.97**	**0.97**	**0.98**	**0.98**	**0.98**	**0.99**	**0.97**
Unemployment	1.02	1.02	1.03	1.03	1.04	1.05	1.05	1.05	*N/A*	*N/A*
Euribor	**0.98**	**0.96****	**0.93****	**0.92****	**0.91***	**0.92**	**0.93**	**0.95**	*N/A*	*N/A*
PC	1.00	**0.97**	**0.95**	**0.97**	**0.97**	1.04	1.05*	1.06**	**0.97**	1.00
INV	**0.93****	**0.94****	**0.96**	**0.97**	1.00	1.02	1.03	1.03*	**0.84****	**0.81**
EXP	**0.94****	**0.94****	**0.95***	**0.97**	**0.99**	1.00	1.00	1.01	**0.92***	**0.99**
IMP	**0.95****	**0.94****	**0.94****	**0.96***	**1.00**	1.01	1.01	1.02	**0.89****	**0.97**
GOV	1.03**	1.05**	1.05*	1.03	1.03	1.06	1.04	1.05	1.00	1.01
Panel C. Tilting HICP										
GDP	**0.97**	**0.99**	**0.97**	**0.97**	**0.97**	**0.99**	**0.99**	1.01	**0.96**	**0.96**
HICP	**0.83**	**0.84**	**0.82**	**0.81**	**0.80****	**0.79***	**0.77****	**0.76****	**0.74**	**0.72****
Unemployment	**0.98**	**0.99**	**1.00**	1.00	1.01	1.01	1.01	1.01	*N/A*	*N/A*
Euribor	**0.99**	**0.97****	**0.95****	**0.92***	**0.89***	**0.87***	**0.86***	**0.85***	*N/A*	*N/A*
PC	1.03*	1.05	1.03	**0.99**	**0.96**	**0.99**	**1.00**	1.01	1.04	**0.97**
INV	**0.97**	**0.99**	**0.98**	1.00	1.03	1.03	1.03**	1.04**	1.07	1.09
EXP	**0.97**	**0.99**	**0.98**	**0.98**	**0.98**	**0.99**	**0.99**	**1.00**	**0.97**	**0.99**
IMP	**0.98**	**0.99**	**0.98**	**0.97**	**0.99**	1.01	1.02	1.01	**0.96**	**0.97**
GOV	1.00	1.00	1.01	1.01	**1.00**	1.02	1.00	1.02	1.01**	**1.00**
Panel D. Tilting Unemployment										
GDP	**0.98**	**0.98**	**0.99**	**0.97**	**0.98**	**1.00**	**0.99**	1.04***	**0.99**	**0.98**
HICP	1.01	1.01	1.00	**0.99**	**0.99**	1.00	**0.99**	**0.97**	1.00	**0.98**
Unemployment	1.03	1.04	1.03	1.02	1.02	1.01	**0.98**	**0.93**	*N/A*	*N/A*
Euribor	**0.99**	**0.98**	**0.97**	**0.97**	**0.96**	**0.95***	**0.93****	**0.92****	*N/A*	*N/A*
PC	**0.99**	**0.99**	**0.97**	**0.93***	**0.92***	**0.94****	**0.95****	**0.97**	**0.98**	**0.91***
INV	**0.97****	**0.99**	**0.97****	**0.98***	**0.99**	1.02	1.01	1.05***	**0.82****	**0.83***
EXP	**0.99****	**0.97****	**0.99**	**0.98**	**0.98**	1.01	1.01	1.02*	**0.95****	1.03
IMP	**1.00**	**0.97***	**0.99**	**0.97****	**0.98**	1.02*	1.02*	1.04*	**0.98**	**0.99**
GOV	1.02	1.03	1.03	**0.99**	**0.99**	**0.99**	**0.98**	**0.94**	1.01**	1.01
Panel E. Tilting GDP, HICP and Unemployment										
GDP	**0.90****	**0.93****	**0.94**	**0.96**	**0.98**	1.03	1.07	1.10**	**0.89****	1.00
HICP	**0.83**	**0.83**	**0.81***	**0.81***	**0.79****	**0.80****	**0.79****	**0.74****	**0.74**	**0.72****
Unemployment	1.02	1.04	1.03	1.02	1.01	**0.98**	**0.95**	**0.93**	*N/A*	*N/A*
Euribor	1.01	**0.95****	**0.90****	**0.87****	**0.85****	**0.83****	**0.82****	**0.81****	*N/A*	*N/A*
PC	1.04*	1.01	**1.00**	**0.95**	**0.94**	1.02	1.01	1.04	1.02	**0.96**
INV	**0.92****	**0.94****	**0.96**	1.02	1.07	1.08*	1.11***	1.16**	**0.85****	**0.92**
EXP	**0.92****	**0.94***	**0.94**	**0.95**	**0.99**	1.02	1.04	1.04*	**0.90***	1.01
IMP	**0.93****	**0.94***	**0.92****	**0.96**	1.01	1.07*	1.10**	1.10**	**0.87****	1.02
GOV	1.05	1.11***	1.12**	1.07	1.03	1.06	1.03	1.03	1.02**	1.02

Note: Panel A displays the raw large BVAR RMSFE. Panels B to E show the ratios of the RMSFE of the entropically tilted large BVAR to the raw large BVAR. Numbers in bold imply that the tilted large BVAR improves over the raw large BVAR. Asterisks *, ** and *** imply statistical significance of a two-sided Diebold & Mariano (1995) test of equal predictive ability at the 10%, 5%, 1% level. The variance is estimated using Bartlett kernel weights with bandwidth equal to the forecast horizon h. The sample size is $P = 72$ quarters. The columns $h = 4^*$ and $h = 8^*$ show the results for the one- and two-year-ahead, year-on-year predictions.

Table D.2: Entropic tilting versus large BVAR forecasts: CRPS

Forecast horizon	$h=1$	$h=2$	$h=3$	$h=4$	$h=5$	$h=6$	$h=7$	$h=8$	$h=4^*$	$h=8^*$
Panel A. Large BVAR										
GDP	0.24	0.28	0.29	0.31	0.32	0.32	0.32	0.32	0.80	1.11
HICP	0.16	0.17	0.19	0.20	0.21	0.21	0.23	0.23	0.62	0.81
Unemployment	0.15	0.21	0.30	0.40	0.50	0.61	0.71	0.81	*N/A*	*N/A*
Euribor	0.18	0.35	0.54	0.75	0.95	1.13	1.29	1.42	*N/A*	*N/A*
PC	0.17	0.20	0.21	0.24	0.26	0.28	0.30	0.31	0.55	0.90
INV	0.70	0.73	0.80	0.86	0.88	0.91	0.91	0.90	1.42	1.95
EXP	1.00	1.11	1.14	1.15	1.14	1.14	1.15	1.14	3.87	3.83
IMP	0.93	1.00	1.00	1.07	1.05	1.10	1.10	1.14	2.76	3.14
GOV	0.18	0.18	0.20	0.22	0.23	0.25	0.27	0.29	3.97	3.62
Panel B. Tilting GDP										
GDP	**0.85****	**0.85****	**0.87**	**0.86****	**0.87**	**0.86****	**0.87****	**0.92****	**0.87*****	**0.95**
HICP	1.00	**0.99**	**0.98**	**0.96****	**0.95**	**0.95**	**0.95**	**0.95**	**0.98**	**0.93****
Unemployment	1.02	1.02	1.01	1.01	1.00	1.01	1.02	1.03	*N/A*	*N/A*
Euribor	**0.98****	**0.94*****	**0.91*****	**0.90*****	**0.90****	**0.90****	**0.92**	**0.93**	*N/A*	*N/A*
PC	1.00	**0.97**	**0.95**	**0.94**	**0.93**	**0.92**	**0.91**	**0.92**	**0.98**	**0.92**
INV	**0.91*****	**0.91****	**0.92****	**0.93****	**0.94**	**0.94****	**0.97**	**0.98**	**0.84****	**0.69*****
EXP	**0.93*****	**0.91*****	**0.92****	**0.91****	**0.92****	**0.93****	**0.94****	**0.98**	**0.94**	**0.96**
IMP	**0.94*****	**0.92*****	**0.91*****	**0.92*****	**0.94****	**0.94****	**0.95*****	**0.98**	**0.86*****	**0.86****
GOV	1.02	1.02	1.01	**0.99**	**0.97**	**0.95**	**0.93**	**0.94**	1.01	1.04*****
Panel C. Tilting HICP										
GDP	**0.99**	1.00	**0.99**	**0.96**	**0.95**	**0.96**	**0.97**	**0.99**	**0.97**	**0.93**
HICP	**0.86****	**0.86**	**0.83****	**0.81****	**0.80****	**0.77****	**0.73****	**0.71*****	**0.79**	**0.71****
Unemployment	**0.99**	**0.99**	**0.99**	**0.98**	**0.97**	**0.96**	**0.97**	**0.97**	*N/A*	*N/A*
Euribor	**0.99**	**0.97*****	**0.95****	**0.92****	**0.91****	**0.89****	**0.88****	**0.88****	*N/A*	*N/A*
PC	1.02*	1.02	**1.00**	**0.96**	**0.93****	**0.92****	**0.92****	**0.93****	1.03	**0.90**
INV	**0.98**	**0.99**	**0.98**	**0.99**	1.00	1.00	1.01	1.02	1.07*	**0.95**
EXP	**0.99**	**0.99**	**0.99**	**0.97**	**0.97**	**0.98**	**0.99**	**0.99**	1.00	**0.97**
IMP	**1.00**	1.01	**0.99**	**0.97**	**0.98**	**0.99**	**1.00**	1.00	**0.98**	**0.95**
GOV	1.00	**1.00**	**0.99**	**0.98**	**0.94**	**0.93**	**0.92**	**0.93**	1.02*****	1.03*****
Panel D. Tilting Unemployment										
GDP	**0.99**	**0.99**	**0.98**	**0.95****	**0.94*****	**0.96****	**0.96****	**0.99**	1.01	**0.94****
HICP	1.01	1.00	**1.00**	**0.98**	**0.98**	**0.98**	**0.96**	**0.95**	**1.00**	**0.95**
Unemployment	1.05	1.06	1.03	1.02	**0.99**	**0.96**	**0.95**	**0.96**	*N/A*	*N/A*
Euribor	1.01	**0.99**	**0.99**	**0.99**	**0.97**	**0.95****	**0.93****	**0.92*****	*N/A*	*N/A*
PC	**1.00**	**1.00**	**0.97**	**0.94****	**0.91****	**0.90****	**0.89****	**0.90****	**0.99**	**0.87****
INV	**0.97*****	**0.98**	**0.96****	**0.96*****	**0.96*****	**0.99**	**0.99**	1.02	**0.85*****	**0.82*****
EXP	**0.99**	**0.98**	**0.99**	**0.97**	**0.97**	**0.99**	**0.99**	1.01	**0.95****	**1.00**
IMP	**1.00**	**0.98****	**0.99**	**0.96*****	**0.96****	**0.99**	1.01	1.03	**0.99**	**0.96*****
GOV	1.02	1.03	1.02	**0.98**	**0.96**	**0.92****	**0.90****	**0.87*****	1.03*****	1.05****
Panel E. Tilting GDP, HICP and Unemployment										
GDP	**0.86*****	**0.85*****	**0.87**	**0.87****	**0.86****	**0.87****	**0.91**	**0.96**	**0.86****	**0.95**
HICP	**0.86****	**0.86**	**0.82****	**0.81****	**0.79****	**0.77****	**0.74****	**0.70*****	**0.79**	**0.71****
Unemployment	1.04	1.07	1.05	1.03	**1.00**	**0.97**	**0.95**	**0.96**	*N/A*	*N/A*
Euribor	1.02	**0.93*****	**0.88*****	**0.86*****	**0.84*****	**0.83*****	**0.82*****	**0.81*****	*N/A*	*N/A*
PC	1.05**	1.01	**0.98**	**0.92**	**0.90**	**0.89**	**0.87**	**0.87**	1.04	**0.88**
INV	**0.91*****	**0.92****	**0.92****	**0.96**	**0.98**	**0.99**	1.03	1.07	**0.84****	**0.72*****
EXP	**0.92*****	**0.90*****	**0.91****	**0.90****	**0.93****	**0.94**	**0.97**	**0.99**	**0.93**	**0.99**
IMP	**0.93*****	**0.93****	**0.89*****	**0.92****	**0.95**	**0.98**	1.02	1.04	**0.83*****	**0.90**
GOV	1.05	1.07*	1.05	**1.00**	**0.93**	**0.90**	**0.87**	**0.84****	1.04****	1.10*****

Note: Panel A displays the raw large BVAR CRPS. Panels B to E show the ratios of the CRPS of the entropically tilted large BVAR to the raw large BVAR. Numbers in bold imply that the tilted large BVAR improves over the raw large BVAR. Asterisks *, ** and *** imply statistical significance of a two-sided Diebold & Mariano (1995) test of equal predictive ability at the 10%, 5%, 1% level. The variance is estimated using Bartlett kernel weights with bandwidth equal to the forecast horizon h. The evaluation sample size is $P = 72$ quarters. The columns $h = 4^*$ and $h = 8^*$ show the results for the one- and two-year-ahead, year-on-year predictions, respectively.

Table D.3: Entropic tilting using the only the SPF mean vs. large BVAR forecasts: CRPS

Forecast horizon	$h=1$	$h=2$	$h=3$	$h=4$	$h=5$	$h=6$	$h=7$	$h=8$	$h=4^*$	$h=8^*$
	Panel A. Tilting GDP - SPF Mean Only									
GDP	**0.87*****	**0.88****	**0.92**	**0.93***	**0.97**	**0.99**	**1.00**	1.00	**0.84*****	**0.96**
HICP	**1.00**	**0.99**	**0.98**	**0.97**	**0.98**	**0.99**	**0.99**	**0.98**	**0.98**	**0.98**
Unemployment	1.01	1.01	1.01	1.00	**1.00**	1.00	1.00	1.01	*N/A*	*N/A*
Euribor	**0.99**	**0.97****	**0.96***	**0.95**	**0.94**	**0.94**	**0.94**	**0.95**	*N/A*	*N/A*
PC	1.00	**0.99**	**1.00**	**0.99**	**1.00**	1.01	1.01	1.01	**0.99**	**1.00**
INV	**0.92*****	**0.94****	**0.96**	**0.96***	**0.98**	**1.00**	1.01	1.01	**0.89****	**0.97**
EXP	**0.93*****	**0.92*****	**0.93***	**0.95****	**0.99**	**1.00**	1.01*	1.01	**0.90***	**0.99**
IMP	**0.95*****	**0.94****	**0.94*****	**0.95*****	**0.98**	**1.00**	1.01	1.01*	**0.88*****	**0.98**
GOV	1.02*	1.02**	1.01**	1.00	1.01	1.02*	1.01	1.01	**1.00**	**1.00**
	Panel B. Tilting HICP - SPF Mean Only									
GDP	1.00	1.02	1.02	1.00	1.00	**0.99**	**1.00**	1.01	**0.99**	**0.99**
HICP	**0.87***	**0.87**	**0.85**	**0.85**	**0.90**	**0.91**	**0.91***	**0.93**	**0.78***	**0.89***
Unemployment	**0.99**	1.00	1.01	1.02	1.02	1.02	1.02	1.02	*N/A*	*N/A*
Euribor	1.00	**0.98****	**0.97***	**0.97**	**0.97**	**0.97**	**0.98**	**0.98**	*N/A*	*N/A*
PC	1.02**	1.03	1.03	1.02	1.00	1.01	1.01	1.01	1.04*	1.02
INV	**0.99**	1.01	1.01	1.01	1.01	1.01	1.01**	1.01	1.09**	**1.00**
EXP	**0.99**	**1.00**	1.00	1.01	1.01	1.00	1.00	**1.00**	**0.99**	**0.97****
IMP	1.00	1.01	1.01	1.01	1.00	**0.99**	**1.00**	**0.99**	**0.99**	**0.99**
GOV	1.01	1.01	1.02*	1.02**	1.02***	1.03***	1.03***	1.02*	1.01**	1.01
	Panel B. Tilting Unemployment - SPF Mean Only									
GDP	**0.99**	**0.99**	**0.99**	**0.97**	**0.97**	**0.98**	**0.99**	1.01	1.02	**0.97**
HICP	1.00	1.01	1.01	1.01	1.01	1.02	1.01	1.00	1.01	1.01
Unemployment	1.06	1.09	1.06	1.03	**1.00**	**0.96**	**0.93**	**0.92**	*N/A*	*N/A*
Euribor	1.00	**1.00**	**1.00**	1.00	**0.99**	**0.96***	**0.94****	**0.93*****	*N/A*	*N/A*
PC	**1.00**	**1.00**	**0.99**	**0.99**	**0.98***	**0.99**	1.00	1.01	**1.00**	**0.98**
INV	**0.97*****	**0.99**	**0.97**	**0.97****	**0.98****	**0.99***	1.00	1.03	**0.86****	**0.94***
EXP	**0.99**	**0.99**	**0.99**	**0.98**	**0.99**	**1.00**	1.00	1.01*	**0.95****	**0.99**
IMP	**1.00**	**0.99**	**1.00**	**0.98**	**0.99**	1.01*	1.02*	1.03*	**0.99**	**1.00**
GOV	1.02	1.03	1.03	1.00	1.00	**0.99**	**1.00**	**0.98**	1.02**	1.02
	Panel C. Tilting GDP, HICP and Unemployment - SPF Mean Only									
GDP	**0.88*****	**0.88*****	**0.91**	**0.92****	**0.95****	**0.98**	1.00	1.02	**0.84*****	**0.95****
HICP	**0.88***	**0.87**	**0.84***	**0.85**	**0.90***	**0.92**	**0.92***	**0.93**	**0.78***	**0.89***
Unemployment	1.04	1.07	1.05	1.03	1.01	**0.98**	**0.95**	**0.95**	*N/A*	*N/A*
Euribor	**0.99**	**0.96****	**0.94*****	**0.93****	**0.91*****	**0.90*****	**0.89*****	**0.89*****	*N/A*	*N/A*
PC	1.02	1.02	1.03	1.01	**0.99**	1.01	1.02	1.03*	1.04	1.02
INV	**0.92*****	**0.94****	**0.96**	**0.97**	**1.00**	1.01	1.04	1.05**	**0.87****	**0.96**
EXP	**0.93*****	**0.91*****	**0.92*****	**0.95****	**0.98**	1.01	1.01	1.01	**0.89****	**0.96*****
IMP	**0.95*****	**0.93****	**0.92****	**0.94****	**0.98**	1.01	1.02	1.02	**0.86*****	**0.98**
GOV	1.04	1.06	1.06*	1.02	1.03	1.03	1.03	**1.00**	1.03	1.02

Note: Panels A to D show the ratios of the CRPS of the entropically tilted large BVAR to the raw large BVAR, when tilting only towards the SPF mean predictions and keeping the variance fixed. Numbers in bold imply that the tilted large BVAR improves over the raw large BVAR. Asterisks *, ** and *** imply statistical significance of a two-sided Diebold & Mariano (1995) test of equal predictive ability at the 10%, 5%, 1% level. The variance is estimated using Bartlett kernel weights with bandwidth equal to the forecast horizon h. The evaluation sample size is $P = 72$ quarters. The columns $h = 4^*$ and $h = 8^*$ show the results for the one- and two-year-ahead, year-on-year predictions, respectively.

Online Appendix to "Bayesian VAR Forecasts, Survey Information and Structural Change in the Euro Area"

1 ECB Real-Time Database

Starting with the vintage of 2007:Q3 (and once in vintage 2006:Q1), data on real GDP, real gross capital formation, real imports, real exports, real personal consumption expenditures, and real final government consumption prior to 1995:Q1 are not available in the ECB real-time data set.[1] Hence, to be able to use a large sample for the in-sample estimation, starting with the 2007:Q3 vintage we use the 2007:Q2 vintage (for the 2006:Q1 vintage we use the 2006:Q2 vintage respectively) to substitute the missing data points up to 1995:Q1, and from there on the vintage of the respective forecast origin. To deal with the level shift, caused by a change in the inflation base index, for the observations from 1994:Q4 to 1995:Q1 we impute 1995:Q1 growth rates from the 2007:Q2 (or 2006:Q2 respectively) vintage using data up to and including 1995:Q1.

For a few releases (depending on the time series considered) the publication of the latest data was delayed. To avoid errors in the model estimation, we substituted these missing data points backwards, i.e. we substituted the missing data point by the estimate of the next vintage.

Furthermore, the unemployment rate, as well as the real personal consumption expenditure data, exhibit missing data points with a less regular pattern. To be able to use the data, we backward substituted, i.e. using the closest future release whenever we encountered a missing data point.

2 BVAR without GDP jumping-off

To ensure that our results are not driven by the properties of the ECB nowcasts, we also produce forecasts of the BVAR without a jumping-off procedure. To accommodate the timing of the GDP releases (see the Data section of the main paper for details), the timing of the BVAR predictions has to change. As before, for the first forecast, the *in-sample estimation* of the BVAR is based on the 1999:Q1 vintage (before the release of 1998:Q4 real GDP data), which is aligned with the SPF 1999:Q1 predictions, and the in-sample estimation ranges from 1991:Q1 to 1998:Q3. Different from the jumping-off approach, the first prediction of the BVAR, denoted by $h = 0$, is for 1998:Q4 and based on GDP, HICP, unemployment and Euribor realizations of 1998:Q3. We then substitute the released values of HICP, the unemployment rate and the Euribor for their forecasts for 1998:Q4 and retain the GDP forecast for which there is no realized data available. In other words, we use a jumping-off approach for all variables but GDP growth. An alternative would be to use a Kalman filter to impute the missing values of real GDP growth at the end of the sample (see Bańbura et al. (2015) for an example). While using the Kalman filter would be the most efficient approach as it uses the information of the most recent HICP and unemployment releases to impute the missing GDP value, we would expect that the differences to the results presented here are small.

As before, the horizon $h = 1$ corresponds to a nowcast, that is predictions for the quarter of the survey round. The horizon $h = 0$ corresponds to a backcast, but only for GDP which we subsequently do not evaluate. The total out-of-sample forecast errors we evaluate range from 1999:Q1 to 2016:Q4 for the $h = 1$ predictions, and from 2000:Q1 to 2018:Q3 for $h = 8$ predictions, i.e. the total out-of-sample size is again $P = 72$ for all horizons.

Table 1 summarizes and illustrates the timing of the data available to SPF panelists and the BVAR model, along with the forecast targets through the example of the 2007:Q4 survey round.

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[1] In 1995, new rules for the "European System of Accounts" (ESA) were introduced.

Tables 2 to 5 display the results for entropic tilting and soft conditioning the BVAR without jumping-off.

Table 1: Timing of the ECB-SPF and the BVAR model, without GDP jumping-off, for the 2007:Q4 round

	Last observation			Targets							
					BVAR						
	SPF	BVAR	SPF	Tilting	$h=0$	$h=1$	$h=2$	$h=3$	$h=4$	$h=5$
GDP	2007:Q2	2007:Q2	$\frac{2008:Q2}{2007:Q2}$	$\frac{2008:Q2}{2007:Q2}$	$\frac{2007:Q3}{2007:Q2}$	$\frac{2007:Q4}{2007:Q3}$	$\frac{2008:Q1}{2007:Q4}$	$\frac{2008:Q2}{2008:Q1}$	$\frac{2008:Q3}{2008:Q2}$	$\frac{2008:Q4}{2008:Q3}$
HICP	2007:M9	2007:Q3	$\frac{2008:M9}{2007:M9}$	$\frac{2008:Q3}{2007:Q3}$	NA	$\frac{2007:Q4}{2007:Q3}$	$\frac{2008:Q1}{2007:Q4}$	$\frac{2008:Q2}{2008:Q1}$	$\frac{2008:Q3}{2008:Q2}$	$\frac{2008:Q4}{2008:Q3}$
Unemployment	2007:M8	2007:Q3*	2008:M8	2008:Q3	NA	2007:Q4	2008:Q1	2008:Q2	2008:Q3	2008:Q4
Euribor	NA	2007:Q3	NA	NA	NA	2007:Q4	2008:Q1	2008:Q2	2008:Q3	2008:Q4

Note: The table illustrates the timing of the SPF forecasts and the BVAR (without GDP jumping-off) predictions through the example of the 2007:Q4 SPF survey round. For each of the four variables, the column "Last observation" shows the dates of the last observations available to SPF panelists and the one used in the BVAR. The columns labeled "Targets" shows the forecast targets of the SPF panelists, the corresponding *quarterly* targets used in the entropic tilting and soft conditioning procedures, and the BVAR's quarterly forecast targets for horizons $h = 1, \ldots 5$ (for simplicity). The fractions of dates correspond to growth rates, e.g. $\frac{2008:Q2}{2007:Q2}$ means the growth rate of the given variable between 2007:Q2 and 2008:Q2. "NA" denotes "not applicable", as the ECB SPF does not contain a survey question on the Euribor interest rate. 2007:Q3* denotes the quarterly average of unemployment taken only over the first two month of the quarter, which are available at the forecasting round of the SPF.

Table 2: Entropic tilting versus BVAR without jumping-off forecasts: RMSFE

Forecast horizon	$h=1$	$h=2$	$h=3$	$h=4$	$h=5$	$h=6$	$h=7$	$h=8$	$h=4^*$	$h=8^*$
					Panel A. BVAR					
GDP	0.57	0.59	0.59	0.58	0.58	0.58	0.57	0.57	1.93	1.92
HICP	0.26	0.27	0.29	0.30	0.31	0.31	0.31	0.31	0.92	1.07
Unemployment	0.29	0.47	0.65	0.84	1.01	1.16	1.31	1.43	*N/A*	*N/A*
Euribor	0.36	0.68	0.96	1.22	1.46	1.66	1.84	1.99	*N/A*	*N/A*
					Panel B. Tilting GDP					
GDP	**0.75****	**0.85****	**0.89**	**0.97**	**1.00**	1.01	1.01	1.02	**0.71****	**1.00**
HICP	**1.00**	1.00	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.02
Unemployment	**0.95***	**0.91***	**0.90****	**0.91***	0.92	0.93	0.95	0.96	*N/A*	*N/A*
Euribor	**0.94****	**0.91*****	**0.89*****	**0.91*****	**0.93****	**0.95***	0.97	0.97	*N/A*	*N/A*
					Panel C. Tilting HICP					
GDP	**0.98**	**0.98**	**0.98**	**0.99**	**0.99**	1.00	**1.00**	1.00	**0.98**	**0.99**
HICP	**0.93**	**0.98**	**0.93**	**0.93**	**0.92**	**0.92**	**0.91**	**0.91**	**0.91**	**0.88**
Unemployment	**0.98**	**0.97**	**0.98**	**0.98**	**0.99**	**0.99**	1.00	1.01	*N/A*	*N/A*
Euribor	**0.96**	**0.92**	**0.88***	**0.86***	**0.85***	**0.84****	**0.84****	**0.85****	*N/A*	*N/A*
					Panel D. Tilting Unemployment					
GDP	**0.97**	**0.97**	**0.99**	**0.98**	1.02***	1.09*	1.06*	1.04**	**0.93****	**1.00**
HICP	1.04**	1.02**	1.02	1.02	1.02	1.02	1.02	1.03	1.03**	1.04
Unemployment	**0.92**	**0.88**	**0.85****	**0.85****	**0.86*****	**0.87*****	**0.88*****	**0.89*****	*N/A*	*N/A*
Euribor	1.02	**0.95***	0.95	0.98	0.98	0.97	0.97	0.98	*N/A*	*N/A*
					Panel E. Tilting GDP, HICP and Unemployment					
GDP	**0.77****	**0.86***	**0.91**	1.01	1.00	1.01	1.01	1.06***	**0.71****	**1.00**
HICP	**0.94**	**0.96**	**0.94**	**0.95**	**0.91**	**0.92**	**0.92**	**0.93**	**0.91**	**0.88**
Unemployment	**0.91***	**0.85***	**0.84****	**0.85****	**0.87*****	**0.87*****	**0.89*****	**0.90*****	*N/A*	*N/A*
Euribor	**0.90***	**0.82****	**0.80****	**0.82****	**0.83****	**0.85****	**0.85****	**0.86****	*N/A*	*N/A*

Note: Panel A displays the raw BVAR without jumping-off RMSFE. Panels B to E show the ratios of the RMSFE of the entropically tilted BVAR without jumping-off to the raw BVAR without jumping-off. Numbers in bold imply that the tilted BVAR without jumping-off improves over the raw BVAR without jumping-off. Asterisks *, ** and *** imply statistical significance of a two-sided Diebold and Mariano (1995) test of equal predictive ability at the 10%, 5%, 1% level. The variance is estimated using Bartlett kernel weights with bandwidth equal to the forecast horizon h. The evaluation sample size is $P = 72$ quarters. The columns $h = 4^*$ and $h = 8^*$ show the results for the one- and two-year-ahead, year-on-year predictions, respectively.

Table 3: Entropic tilting versus BVAR without jumping-off forecasts: CRPS

Forecast horizon	$h=1$	$h=2$	$h=3$	$h=4$	$h=5$	$h=6$	$h=7$	$h=8$	$h=4^*$	$h=8^*$
	Panel A. BVAR									
GDP	0.28	0.29	0.29	0.29	0.29	0.29	0.28	0.28	1.06	1.08
HICP	0.15	0.16	0.17	0.17	0.18	0.18	0.18	0.18	0.54	0.63
Unemployment	0.18	0.28	0.41	0.54	0.67	0.78	0.89	0.99	*N/A*	*N/A*
Euribor	0.17	0.34	0.50	0.67	0.83	0.97	1.09	1.19	*N/A*	*N/A*
	Panel B. Tilting GDP									
GDP	**0.74******	**0.79******	**0.84**	**0.93**	**0.95**	**0.96**	**0.97**	1.00	**0.66******	**0.97**
HICP	1.00	1.01	1.02	1.02	1.02	1.01	1.01	1.00	1.02	1.02
Unemployment	**0.95******	**0.93**	**0.91**	**0.91**	**0.92**	**0.93**	**0.94**	**0.95**	*N/A*	*N/A*
Euribor	**0.94******	**0.91*******	**0.89*******	**0.90*******	**0.91*******	**0.93*******	**0.94*****	**0.94**	*N/A*	*N/A*
	Panel C. Tilting HICP									
GDP	**0.98**	**0.98**	**0.98**	**0.99**	**0.99**	**0.99**	**0.99**	**1.00**	**0.98**	**0.99**
HICP	**0.93*****	**0.97**	**0.92**	**0.92**	**0.92**	**0.91**	**0.90**	**0.90**	**0.93**	**0.88**
Unemployment	**0.98**	**0.98**	**0.98**	**0.99**	**0.99**	**1.00**	1.01	1.01	*N/A*	*N/A*
Euribor	**0.98**	**0.95**	**0.91**	**0.89**	**0.87**	**0.86*****	**0.86*****	**0.86*****	*N/A*	*N/A*
	Panel D. Tilting Unemployment									
GDP	**0.99**	1.01	1.01	**0.99**	1.04**	1.06**	1.09*	1.06**	**0.91*******	**0.99**
HICP	1.04	1.02**	1.01	1.02	1.01	1.02	1.01	1.01	1.04*	1.01
Unemployment	**0.91******	**0.87******	**0.83*******	**0.81*******	**0.80*******	**0.80*******	**0.81*******	**0.82*******	*N/A*	*N/A*
Euribor	1.05	**0.97**	**0.96**	**0.97**	**0.96**	**0.95**	**0.95**	**0.96**	*N/A*	*N/A*
	Panel E. Tilting GDP, HICP and Unemployment									
GDP	**0.76*******	**0.82*****	**0.88**	**0.96**	**0.96**	**0.97**	1.00	1.04	**0.67******	**0.97**
HICP	**0.94**	**0.95**	**0.94**	**0.96**	**0.92**	**0.91**	**0.91**	**0.92**	**0.93**	**0.89**
Unemployment	**0.88*******	**0.84******	**0.79*******	**0.78*******	**0.78*******	**0.79*******	**0.80*******	**0.82*******	*N/A*	*N/A*
Euribor	**0.94**	**0.86*****	**0.82******	**0.83******	**0.83******	**0.84******	**0.83******	**0.84******	*N/A*	*N/A*

Note: Panel A displays the raw BVAR without jumping-off CRPS. Panels B to E show the ratios of the CRPS of the entropically tilted BVAR without jumping-off to the raw BVAR without jumping-off. Numbers in bold imply that the tilted BVAR without jumping-off improves over the raw BVAR without jumping-off. Asterisks *, ** and *** imply statistical significance of a two-sided Diebold and Mariano (1995) test of equal predictive ability at the 10%, 5%, 1% level. The variance is estimated using Bartlett kernel weights with bandwidth equal to the forecast horizon h. The evaluation sample size is $P = 72$ quarters. The columns $h = 4^*$ and $h = 8^*$ show the results for the one- and two-year-ahead, year-on-year predictions, respectively.

Table 4: Soft Conditioning versus BVAR without jumping-off forecasts: RMSFE

Forecast horizon	$h=1$	$h=2$	$h=3$	$h=4$	$h=5$	$h=6$	$h=7$	$h=8$	$h=4^*$	$h=8^*$
	Panel A. BVAR									
GDP	0.57	0.59	0.59	0.58	0.58	0.58	0.57	0.57	1.93	1.92
HICP	0.26	0.27	0.29	0.30	0.31	0.31	0.31	0.31	0.92	1.07
Unemployment	0.29	0.47	0.65	0.84	1.01	1.16	1.31	1.43	*N/A*	*N/A*
Euribor	0.36	0.68	0.96	1.22	1.46	1.66	1.84	1.99	*N/A*	*N/A*
	Panel B. Soft Conditioning GDP									
GDP	**0.82****	**0.88*****	**0.91**	**0.97**	**0.99**	**0.99**	**1.00**	1.01	**0.79****	**0.98**
HICP	**1.00**	1.00	1.01	1.00	1.01	1.01	1.00	1.01	1.00	1.01
Unemployment	**0.96***	**0.94***	**0.93****	**0.94***	**0.95**	**0.96**	**0.96**	**0.97**	*N/A*	*N/A*
Euribor	**0.96****	**0.94****	**0.93*****	**0.94*****	**0.95*****	**0.96*****	**0.97**	**0.98**	*N/A*	*N/A*
	Panel C. Soft Conditioning HICP									
GDP	**0.99**	**0.99**	**0.99**	**0.99**	**1.00**	1.00	1.00	**1.00****	**0.99**	**1.00**
HICP	**0.96***	**0.98**	**0.95**	**0.94**	**0.93**	**0.93**	**0.92***	**0.93***	**0.94**	**0.90***
Unemployment	**0.99**	**0.99**	**0.99**	**0.99**	**0.99**	**1.00**	1.00	1.00	*N/A*	*N/A*
Euribor	**0.98**	**0.96***	**0.94***	**0.93***	**0.92***	**0.92****	**0.92****	**0.92****	*N/A*	*N/A*
	Panel D. Soft Conditioning Unemployment									
GDP	**0.99***	**0.99***	**1.00**	1.00	**1.00**	**1.00**	**1.00**	1.01	**0.99****	**1.00**
HICP	1.00	1.00	1.00	1.00	1.01	1.01	1.01	1.01	1.00	1.02
Unemployment	**0.98**	**0.97**	**0.96***	**0.96***	**0.97***	**0.97***	**0.97***	**0.97***	*N/A*	*N/A*
Euribor	1.01	1.00	1.00	1.01	1.01	1.01	1.01	1.01*	*N/A*	*N/A*
	Panel E. Soft Conditioning GDP, HICP and Unemployment									
GDP	**0.81****	**0.88****	**0.91**	**0.97**	**0.99**	**0.99**	**1.00**	1.02	**0.79****	**0.98**
HICP	**0.97**	**0.98**	**0.96**	**0.95**	**0.94**	**0.93**	**0.93***	**0.94***	**0.94**	**0.91***
Unemployment	**0.95***	**0.92****	**0.91****	**0.92****	**0.93***	**0.94**	**0.95**	**0.96**	*N/A*	*N/A*
Euribor	**0.95***	**0.91****	**0.88*****	**0.88*****	**0.89*****	**0.89*****	**0.91*****	**0.92*****	*N/A*	*N/A*

Note: Panel A displays the raw BVAR without jumping-off RMSFE. Panels B to E show the ratios of the RMSFE of the soft conditioned BVAR without jumping-off to the raw BVAR without jumping-off. Numbers in bold imply that the soft conditioned BVAR without jumping-off improves over the raw BVAR without jumping-off. Asterisks *, ** and *** imply statistical significance of a two-sided Diebold and Mariano (1995) test of equal predictive ability at the 10%, 5%, 1% level. The variance is estimated using Bartlett kernel weights with bandwidth equal to the forecast horizon h. The evaluation sample size is $P = 72$ quarters. The columns $h=4^*$ and $h=8^*$ show the results for the one- and two-year-ahead, year-on-year predictions, respectively.

Table 5: Soft Conditioning versus BVAR without jumping-off forecasts: CRPS

Forecast horizon	$h=1$	$h=2$	$h=3$	$h=4$	$h=5$	$h=6$	$h=7$	$h=8$	$h=4^*$	$h=8^*$
				Panel A. BVAR						
GDP	0.28	0.29	0.29	0.29	0.29	0.29	0.28	0.28	1.06	1.08
HICP	0.15	0.16	0.17	0.17	0.18	0.18	0.18	0.18	0.54	0.63
Unemployment	0.18	0.28	0.41	0.54	0.67	0.78	0.89	0.99	*N/A*	*N/A*
Euribor	0.17	0.34	0.50	0.67	0.83	0.97	1.09	1.19	*N/A*	*N/A*
				Panel B. Soft Conditioning GDP						
GDP	**0.81*****	**0.84*****	**0.88***	**0.94**	**0.96**	**0.97**	**0.97**	1.00	**0.79****	1.00
HICP	1.00	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.02	1.02
Unemployment	**0.98**	**0.96**	**0.95**	**0.95**	**0.96**	**0.97**	**0.97**	**0.98**	*N/A*	*N/A*
Euribor	**0.95*****	**0.93*****	**0.92*****	**0.93*****	**0.94*****	**0.95*****	**0.96**	**0.96**	*N/A*	*N/A*
				Panel C. Soft Conditioning HICP						
GDP	**0.99**	**0.99**	**0.99**	**0.99**	**0.99***	**0.99****	**1.00****	1.00	**0.99**	**1.00**
HICP	**0.97**	**0.98**	**0.96***	**0.95**	**0.94***	**0.94***	**0.93***	**0.93***	**0.97**	**0.93**
Unemployment	**1.00**	**0.99**	**1.00**	1.00	1.00	1.01	1.01*	1.02**	*N/A*	*N/A*
Euribor	**0.99**	**0.97**	**0.95**	**0.94**	**0.93***	**0.93***	**0.93****	**0.93****	*N/A*	*N/A*
				Panel D. Soft Conditioning Unemployment						
GDP	**0.99***	**0.99****	**1.00**	**1.00**	**1.00***	**1.00**	**1.00**	1.00	**0.99**	**1.00**
HICP	1.00	1.00*	1.00	1.01	1.01	1.01	1.01	1.01	1.01*	1.02
Unemployment	**0.99**	**0.97**	**0.97**	**0.97**	**0.98**	**0.98**	**0.99**	**0.99**	*N/A*	*N/A*
Euribor	1.00	1.00	1.00	1.01	1.01	1.01	1.01	1.01	*N/A*	*N/A*
				Panel E. Soft Conditioning GDP, HICP and Unemployment						
GDP	**0.80*****	**0.84*****	**0.88***	**0.94**	**0.96**	**0.97**	**0.97**	1.00	**0.80****	1.01
HICP	**0.98**	**0.99**	**0.97**	**0.97**	**0.96**	**0.95**	**0.95**	**0.95**	**0.99**	**0.96**
Unemployment	**0.97***	**0.94**	**0.93**	**0.94**	**0.95**	**0.97**	**0.98**	**0.99**	*N/A*	*N/A*
Euribor	**0.95****	**0.91*****	**0.89*****	**0.88*****	**0.89*****	**0.89*****	**0.90*****	**0.91****	*N/A*	*N/A*

Note: Panel A displays the raw BVAR without jumping-off CRPS. Panels B to E show the ratios of the CRPS of the soft conditioned BVAR without jumping-off to the raw BVAR without jumping-off. Numbers in bold imply that the soft conditioned BVAR without jumping-off improves over the raw BVAR without jumping-off. Asterisks *, ** and *** imply statistical significance of a two-sided Diebold and Mariano (1995) test of equal predictive ability at the 10%, 5%, 1% level. The variance is estimated using Bartlett kernel weights with bandwidth equal to the forecast horizon h. The evaluation sample size is $P = 72$ quarters. The columns $h = 4^*$ and $h = 8^*$ show the results for the one- and two-year-ahead, year-on-year predictions, respectively.

3 Soft Conditioning TVP-VAR Results

Tables 6 and 7 display the results for soft conditioning the TVP-VAR.

Table 6: Soft Conditioning versus TVP-VAR forecasts: RMSFE

Forecast horizon	$h=1$	$h=2$	$h=3$	$h=4$	$h=5$	$h=6$	$h=7$	$h=8$	$h=4^*$	$h=8^*$
					Panel A. TVP-VAR					
GDP	0.51	0.57	0.59	0.60	0.61	0.61	0.62	0.61	1.60	2.11
HICP	0.26	0.28	0.32	0.35	0.37	0.39	0.41	0.43	1.03	1.50
Unemployment	0.26	0.40	0.56	0.73	0.89	1.05	1.20	1.34	*N/A*	*N/A*
Euribor	0.38	0.78	1.17	1.55	1.93	2.27	2.60	2.89	*N/A*	*N/A*
					Panel B. Soft Conditioning GDP					
GDP	**0.92****	**0.94*****	**0.95****	**0.96***	**0.96**	**0.96**	**0.95**	**0.96****	**0.92*****	**0.93**
HICP	**1.00**	**1.00**	1.00	1.00	1.01	1.01	1.01	1.01	1.00	1.01
Unemployment	**0.98**	**0.97**	**0.96**	**0.96**	**0.96**	**0.96**	**0.96**	**0.96**	*N/A*	*N/A*
Euribor	**1.00**	**0.99**	**0.99**	**0.98**	**0.98**	**0.98**	**0.98**	**0.98**	*N/A*	*N/A*
					Panel C. Soft Conditioning HICP					
GDP	**0.99**	**0.98**	**0.98**	**0.98**	**0.99**	**1.00**	1.00	1.01	**0.98**	**0.99**
HICP	**0.93***	**0.92**	**0.85**	**0.78**	**0.74**	**0.70***	**0.67***	**0.65****	**0.81**	**0.60***
Unemployment	**0.99**	**0.98**	**0.97**	**0.97**	**0.97**	**0.98**	**0.98**	**0.99**	*N/A*	*N/A*
Euribor	**0.98**	**0.94****	**0.91****	**0.88****	**0.87****	**0.86****	**0.85****	**0.85****	*N/A*	*N/A*
					Panel D. Soft Conditioning Unemployment					
GDP	**0.99**	**1.00**	1.00	**0.99**	**0.99***	**0.99**	**0.98***	**0.98***	1.00	**0.98***
HICP	1.00	1.00	1.01	1.01	1.01	1.02	1.02	1.02	1.01	1.02
Unemployment	**0.99**	**0.99**	**0.99**	**0.99**	**0.99**	**0.99**	**0.99**	**0.99**	*N/A*	*N/A*
Euribor	1.04	1.05	1.04*	1.03*	1.02**	1.01	1.01	**1.00**	*N/A*	*N/A*
					Panel E. Soft Conditioning GDP, HICP and Unemployment					
GDP	**0.91****	**0.92*****	**0.95*****	**0.94*****	**0.95****	**0.96**	**0.95***	**0.97*****	**0.91****	**0.93****
HICP	**0.93***	**0.92**	**0.85**	**0.78**	**0.73***	**0.70***	**0.68***	**0.66****	**0.81**	**0.61***
Unemployment	**0.98**	**0.95**	**0.95**	**0.95**	**0.95**	**0.96**	**0.96**	**0.96**	*N/A*	*N/A*
Euribor	**1.00**	**0.96**	**0.92****	**0.88****	**0.86****	**0.85****	**0.84****	**0.83****	*N/A*	*N/A*

Note: Panel A displays the raw TVP-VAR RMSFE. Panels B to E show the ratios of the RMSFE of the soft conditioned TVP-VAR to the raw TVP-VAR. Numbers in bold imply that the soft conditioned TVP-VAR improves over the raw TVP-VAR. Asterisks *, ** and *** imply statistical significance of a two-sided Diebold and Mariano (1995) test of equal predictive ability at the 10%, 5%, 1% level. The variance is estimated using Bartlett kernel weights with bandwidth equal to the forecast horizon *h*. The evaluation sample size is $P = 72$ quarters. The columns $h = 4^*$ and $h = 8^*$ show the results for the one- and two-year-ahead, year-on-year predictions, respectively.

Table 7: Soft Conditioning versus TVP-VAR forecasts: CRPS

Forecast horizon	$h=1$	$h=2$	$h=3$	$h=4$	$h=5$	$h=6$	$h=7$	$h=8$	$h=4^*$	$h=8^*$
					Panel A. TVP-VAR					
GDP	0.24	0.28	0.29	0.30	0.31	0.31	0.31	0.31	0.83	1.16
HICP	0.15	0.15	0.17	0.19	0.20	0.21	0.23	0.24	0.54	0.80
Unemployment	0.17	0.23	0.31	0.41	0.52	0.62	0.72	0.81	*N/A*	*N/A*
Euribor	0.18	0.38	0.59	0.83	1.06	1.28	1.49	1.69	*N/A*	*N/A*
					Panel B. Soft Conditioning GDP					
GDP	**0.91****	**0.92****	**0.93****	**0.93****	**0.93***	**0.92***	**0.91****	**0.94****	**0.94***	**0.94**
HICP	**1.00**	**1.00**	1.00	1.01	1.01	1.02	1.02	1.01	1.00	1.02
Unemployment	1.00	**1.00**	**0.99**	**0.99**	**0.99**	**0.99**	**0.99**	**0.99**	*N/A*	*N/A*
Euribor	**0.99**	**1.00**	**0.99**	**0.98**	**0.98**	**0.98**	**0.97**	**0.97**	*N/A*	*N/A*
					Panel C. Soft Conditioning HICP					
GDP	**0.99**	**0.98**	**0.99**	**0.99**	**0.99**	1.00	1.00	1.01	**0.99**	1.00
HICP	**0.96**	**0.98**	**0.90**	**0.84**	**0.78**	**0.75***	**0.70***	**0.67****	**0.89**	**0.65***
Unemployment	**0.99**	**0.98**	**0.98**	**0.98**	**0.98**	**0.98**	**0.99**	**0.99**	*N/A*	*N/A*
Euribor	**0.98**	**0.94****	**0.90****	**0.89****	**0.87****	**0.86****	**0.85****	**0.85****	*N/A*	*N/A*
					Panel D. Soft Conditioning Unemployment					
GDP	**0.99***	**0.99**	1.00	**0.98****	**0.97****	**0.98***	**0.97****	**0.97****	1.01	**0.97***
HICP	**1.00**	1.00	1.00	1.00	1.01	1.01	1.02	1.02	1.00	1.02
Unemployment	1.01*	1.01*	1.01	1.01	1.02	1.03	1.03	1.03	*N/A*	*N/A*
Euribor	1.03	1.05	1.04	1.03**	1.02	1.01	1.00	**0.99**	*N/A*	*N/A*
					Panel E. Soft Conditioning GDP, HICP and Unemployment					
GDP	**0.91****	**0.91****	**0.93****	**0.92****	**0.93****	**0.93****	**0.92****	**0.94****	**0.94***	**0.95**
HICP	**0.96**	**0.98**	**0.91**	**0.84**	**0.78***	**0.75***	**0.72***	**0.68****	**0.89**	**0.67***
Unemployment	1.00	**0.99**	**0.99**	**1.00**	1.01	1.01	1.02	1.02	*N/A*	*N/A*
Euribor	**0.99**	**0.96**	**0.92****	**0.89****	**0.87****	**0.85****	**0.84****	**0.83****	*N/A*	*N/A*

Note: Panel A displays the raw TVP-VAR CRPS. Panels B to E show the ratios of the CRPS of the soft conditioned TVP-VAR to the raw TVP-VAR. Numbers in bold imply that the soft conditioned TVP-VAR improves over the raw TVP-VAR. Asterisks *, ** and *** imply statistical significance of a two-sided Diebold and Mariano (1995) test of equal predictive ability at the 10%, 5%, 1% level. The variance is estimated using Bartlett kernel weights with bandwidth equal to the forecast horizon h. The evaluation sample size is $P = 72$ quarters. The columns $h = 4^*$ and $h = 8^*$ show the results for the one- and two-year-ahead, year-on-year predictions, respectively.

4 Soft Conditioning Large BVAR Results

Tables 8 and 9 display the results for soft conditioning the large BVAR. The abbreviations are as follows: PC is real personal consumption, INV is real gross capital formation, EXP and IMP stand for real exports and real imports, respectively, while GOV denotes final government consumption.

Table 8: Soft Conditioning versus large BVAR forecasts: RMSFE

Forecast horizon	$h=1$	$h=2$	$h=3$	$h=4$	$h=5$	$h=6$	$h=7$	$h=8$	$h=4^*$	$h=8^*$
					Panel A. Large BVAR					
GDP	0.47	0.55	0.59	0.59	0.58	0.57	0.57	0.55	1.55	1.92
HICP	0.30	0.31	0.33	0.35	0.36	0.36	0.37	0.37	1.12	1.34
Unemployment	0.25	0.38	0.53	0.70	0.86	1.04	1.21	1.37	*N/A*	*N/A*
Euribor	0.38	0.69	1.03	1.38	1.73	2.04	2.33	2.56	*N/A*	*N/A*
PC	0.30	0.34	0.34	0.38	0.41	0.41	0.42	0.43	0.96	1.44
INV	1.31	1.37	1.46	1.52	1.52	1.57	1.59	1.51	2.58	2.65
EXP	1.91	2.14	2.19	2.15	2.12	2.05	2.07	2.08	6.63	6.44
IMP	1.74	1.87	1.92	1.94	1.87	1.90	1.92	1.99	5.27	5.43
GOV	0.30	0.30	0.31	0.34	0.34	0.33	0.35	0.36	5.71	5.80
					Panel B. Soft Conditioning GDP					
GDP	**0.92*****	**0.93*****	**0.93**	**0.94**	**0.98**	1.01	1.01	1.02	**0.90*****	**0.98**
HICP	1.01	**1.00**	**0.99**	**0.98***	**0.98**	**0.98**	**0.98**	**0.98**	**0.99**	**0.97**
Unemployment	1.01	1.01	1.01	1.02	1.02	1.03	1.03	1.03	*N/A*	*N/A*
Euribor	**0.99**	**0.96*****	**0.94*****	**0.92****	**0.92****	**0.92**	**0.93**	**0.94**	*N/A*	*N/A*
PC	**1.00**	**0.97**	**0.94**	**0.96**	**0.96**	1.03	1.04	1.04**	**0.96**	**0.99**
INV	**0.95*****	**0.95****	**0.96**	**0.97***	**0.99**	1.01	1.02	1.02	**0.85*****	**0.82**
EXP	**0.96*****	**0.96*****	**0.96****	**0.97**	**0.99**	**1.00**	**1.00**	1.01	**0.94***	**0.98**
IMP	**0.96*****	**0.95*****	**0.94****	**0.96****	**0.99**	1.00	1.01	1.01	**0.92*****	**0.97**
GOV	1.02*	1.03***	1.04	1.03	1.02	1.04	1.03	1.03	**1.00**	**1.00**
					Panel C. Soft Conditioning HICP					
GDP	**0.98**	**0.97**	**0.96***	**0.96**	**0.97**	**0.99**	**0.99**	1.01	**0.96***	**0.96**
HICP	**0.90***	**0.90***	**0.86****	**0.83****	**0.82****	**0.80****	**0.78****	**0.77****	**0.82****	**0.74****
Unemployment	**0.99**	**0.99**	**0.98**	**0.98**	**0.99**	**0.99**	**0.99**	**0.99**	*N/A*	*N/A*
Euribor	**0.99**	**0.97****	**0.94*****	**0.91****	**0.89****	**0.87****	**0.86****	**0.86****	*N/A*	*N/A*
PC	1.02	1.03	1.01	**0.99**	**0.96**	**0.99**	1.00	1.01	1.02	**0.97**
INV	**0.98**	**0.97**	**0.98**	**0.99**	1.02	1.02	1.02	1.03*	1.02	1.08
EXP	**0.97***	**0.98**	**0.97**	**0.97**	**0.98**	**0.99**	**0.99**	**1.00**	**0.97**	**0.99**
IMP	**0.98***	**0.98**	**0.96**	**0.97**	**0.99**	1.01	1.02	1.01	**0.96***	**0.97**
GOV	**1.00**	1.00	1.00	**0.99**	**0.98**	1.01	**0.99**	1.01	**1.00****	**0.99**
					Panel D. Soft Conditioning Unemployment					
GDP	**0.99**	**0.99**	**0.98**	**0.97****	**0.96*****	**0.95****	**0.96***	**0.99**	**0.99**	**0.94*****
HICP	1.00	1.00	**1.00**	**1.00**	**0.99**	**1.00**	**0.99**	**0.98**	1.00	**0.99**
Unemployment	1.01	1.01	**0.99**	**0.98**	**0.98**	**0.97**	**0.95**	**0.91****	*N/A*	*N/A*
Euribor	**1.00**	**0.99***	**0.98****	**0.98**	**0.97**	**0.96***	**0.94****	**0.93*****	*N/A*	*N/A*
PC	**0.99**	**0.99**	**0.97***	**0.93***	**0.91***	**0.93****	**0.95****	**0.95****	**0.97**	**0.89***
INV	**0.99*****	**0.98****	**0.98****	**0.97*****	**0.97****	**0.97**	**0.97**	1.00	**0.90*****	**0.86****
EXP	**1.00****	**0.99**	**0.99**	**0.98**	**0.97**	**0.98**	**0.99**	1.00	**0.98***	**0.99**
IMP	1.00	**0.99***	**0.99**	**0.97*****	**0.98****	**0.99**	1.00	1.02*	**0.99****	**0.96*****
GOV	1.00	1.01	1.02	**0.98**	**0.98**	**0.99**	**0.97**	**0.96**	1.01**	1.01
					Panel E. Soft Conditioning GDP, HICP and Unemployment					
GDP	**0.92*****	**0.92*****	**0.92***	**0.95**	**0.97**	1.00	1.01	1.03	**0.89*****	**0.97**
HICP	**0.90***	**0.90***	**0.87****	**0.85****	**0.84****	**0.81****	**0.82*****	**0.76*****	**0.83****	**0.75*****
Unemployment	**1.00**	**1.00**	**0.98**	**0.97**	**0.97**	**0.96**	**0.95**	**0.94**	*N/A*	*N/A*
Euribor	**0.99**	**0.93*****	**0.89*****	**0.86*****	**0.84****	**0.83****	**0.82****	**0.82****	*N/A*	*N/A*
PC	1.01	**0.98**	**0.96**	**0.96**	**0.91**	**0.98**	**0.99**	**0.98**	**0.96**	**0.93**
INV	**0.95*****	**0.93*****	**0.95****	**0.98**	1.01	1.02	1.03	1.04***	**0.85*****	**0.81****
EXP	**0.94*****	**0.94*****	**0.94****	**0.96**	**0.96**	**1.00**	**0.99**	1.01	**0.92****	**0.97**
IMP	**0.95****	**0.93*****	**0.92****	**0.95****	**0.98**	1.02	1.03	1.04	**0.89*****	**0.95**
GOV	1.02	1.05**	1.06*	1.03	**1.00**	1.04	1.01	1.04	1.01*	1.01

Note: Panel A displays the raw large BVAR RMSFE. Panels B to E show the ratios of the RMSFE of the soft conditioned large BVAR to the raw large BVAR. Numbers in bold imply that the soft conditioned large BVAR improves over the raw large BVAR. Asterisks *, ** and *** imply statistical significance of a two-sided Diebold and Mariano (1995) test of equal predictive ability at the 10%, 5%, 1% level. The variance is estimated using Bartlett kernel weights with bandwidth equal to the forecast horizon h. The evaluation sample size is $P = 72$ quarters. The columns $h = 4^*$ and $h = 8^*$ show the results for the one- and two-year-ahead, year-on-year predictions, respectively.

Table 9: Soft Conditioning versus large BVAR forecasts: CRPS

Forecast horizon	$h=1$	$h=2$	$h=3$	$h=4$	$h=5$	$h=6$	$h=7$	$h=8$	$h=4^*$	$h=8^*$
Panel A. Large BVAR										
GDP	0.24	0.28	0.29	0.31	0.32	0.32	0.32	0.32	0.80	1.11
HICP	0.16	0.17	0.19	0.20	0.21	0.21	0.23	0.23	0.62	0.81
Unemployment	0.15	0.21	0.30	0.40	0.50	0.61	0.71	0.81	*N/A*	*N/A*
Euribor	0.18	0.35	0.54	0.75	0.95	1.13	1.29	1.42	*N/A*	*N/A*
PC	0.17	0.20	0.21	0.24	0.26	0.28	0.30	0.31	0.55	0.90
INV	0.70	0.73	0.80	0.86	0.88	0.91	0.91	0.90	1.42	1.95
EXP	1.00	1.11	1.14	1.15	1.14	1.14	1.15	1.14	3.87	3.83
IMP	0.93	1.00	1.00	1.07	1.05	1.10	1.10	1.14	2.76	3.14
GOV	0.18	0.18	0.20	0.22	0.23	0.25	0.27	0.29	3.97	3.62
Panel B. Soft Conditioning GDP										
GDP	**0.89****	**0.87****	**0.87****	**0.86****	**0.85***	**0.84****	**0.85****	**0.91****	**0.90****	**0.91**
HICP	1.01	**1.00**	**0.98***	**0.97***	**0.96****	**0.95**	**0.95**	**0.94**	**0.99**	**0.93**
Unemployment	1.02	1.02	**1.00**	**0.99**	**0.99**	**0.99**	**1.00**	1.01	*N/A*	*N/A*
Euribor	**0.98****	**0.95****	**0.92****	**0.91****	**0.91****	**0.91****	**0.92***	**0.93**	*N/A*	*N/A*
PC	**0.99**	**0.97**	**0.94**	**0.93**	**0.92**	**0.92**	**0.91**	**0.92***	**0.96**	**0.90**
INV	**0.94****	**0.92****	**0.92****	**0.93****	**0.94***	**0.94****	**0.96**	**0.98**	**0.85****	**0.70****
EXP	**0.95****	**0.93****	**0.93****	**0.92****	**0.92****	**0.92****	**0.94****	**0.98**	**0.97**	**0.96**
IMP	**0.96****	**0.93****	**0.92****	**0.93****	**0.94****	**0.94****	**0.95****	**0.98**	**0.90****	**0.86****
GOV	1.01	1.01	**1.00**	**0.98**	**0.96**	**0.94**	**0.92**	**0.93**	1.01*	1.04****
Panel C. Soft Conditioning HICP										
GDP	**0.99**	**0.98**	**0.96**	**0.95**	**0.95**	**0.95***	**0.96***	**0.98**	**0.97**	**0.93**
HICP	**0.92****	**0.92****	**0.87****	**0.84****	**0.82****	**0.79****	**0.74****	**0.73****	**0.86****	**0.74****
Unemployment	**1.00**	**0.99**	**0.98**	**0.97**	**0.96**	**0.95**	**0.95**	**0.96**	*N/A*	*N/A*
Euribor	**0.99**	**0.97****	**0.95****	**0.92****	**0.90****	**0.89****	**0.88****	**0.88****	*N/A*	*N/A*
PC	1.01	**1.00**	**0.98**	**0.96***	**0.93***	**0.91***	**0.91***	**0.92****	1.01	**0.90***
INV	**0.99**	**0.98**	**0.98**	**0.98**	**0.99**	**0.99**	**1.00**	1.01	1.02	**0.94**
EXP	**0.98**	**0.98**	**0.97**	**0.96**	**0.97**	**0.98***	**0.98**	**0.99**	**0.99**	**0.98**
IMP	**0.99**	**0.99**	**0.97**	**0.97**	**0.98**	**0.99**	**1.00**	**1.00**	**0.97**	**0.95**
GOV	**0.99**	**0.99**	**0.98**	**0.96**	**0.93***	**0.92**	**0.91***	**0.92***	1.01****	1.02****
Panel D. Soft Conditioning Unemployment										
GDP	**1.00**	**0.99**	**0.97**	**0.94****	**0.92****	**0.92****	**0.92****	**0.95****	**1.00**	**0.90****
HICP	1.01*	**1.00**	**1.00**	**0.99**	**0.98**	**0.97**	**0.96**	**0.95**	1.00	**0.95**
Unemployment	1.02	1.01	**0.98**	**0.96**	**0.94**	**0.92****	**0.90***	**0.90***	*N/A*	*N/A*
Euribor	1.00	**0.99****	**0.99****	**0.98**	**0.97***	**0.95****	**0.94****	**0.93****	*N/A*	*N/A*
PC	**0.99**	**0.98**	**0.96****	**0.93****	**0.90****	**0.89****	**0.88****	**0.89****	**0.98**	**0.86****
INV	**0.99****	**0.98****	**0.96****	**0.95****	**0.95****	**0.95****	**0.96****	**0.98***	**0.90****	**0.83****
EXP	**1.00**	**0.99**	**0.99**	**0.96****	**0.95****	**0.96****	**0.97****	**0.99**	**0.99**	**0.97****
IMP	**1.00**	**0.99***	**0.99**	**0.96****	**0.96****	**0.97****	**0.98****	**1.00**	**0.99**	**0.93****
GOV	**1.00**	**1.00**	**0.99**	**0.96**	**0.94**	**0.91***	**0.89****	**0.88****	1.02****	1.05****
Panel E. Soft Conditioning GDP, HICP and Unemployment										
GDP	**0.90****	**0.88****	**0.87****	**0.87****	**0.85****	**0.84****	**0.84****	**0.89****	**0.91****	**0.91**
HICP	**0.93****	**0.92****	**0.89****	**0.87****	**0.84****	**0.80****	**0.78****	**0.72****	**0.88****	**0.76****
Unemployment	1.02	1.02	**0.98**	**0.96**	**0.94**	**0.93**	**0.92**	**0.94**	*N/A*	*N/A*
Euribor	**0.98**	**0.93****	**0.88****	**0.86****	**0.84****	**0.84****	**0.83****	**0.83****	*N/A*	*N/A*
PC	1.01	**0.96**	**0.94**	**0.91***	**0.86***	**0.87**	**0.84***	**0.84***	**0.97**	**0.85**
INV	**0.94****	**0.92****	**0.91****	**0.94***	**0.94**	**0.93***	**0.97**	**0.98**	**0.84****	**0.65****
EXP	**0.94****	**0.92****	**0.91****	**0.90****	**0.89****	**0.91****	**0.92****	**0.97**	**0.97**	**0.96**
IMP	**0.96****	**0.93****	**0.91****	**0.92****	**0.92****	**0.94**	**0.96**	**0.99**	**0.89****	**0.85****
GOV	1.01	1.01	**0.99**	**0.96**	**0.91**	**0.88**	**0.85**	**0.84***	1.03****	1.09****

Note: Panel A displays the raw large BVAR CRPS. Panels B to E show the ratios of the CRPS of the soft conditioned large BVAR to the raw large BVAR. Numbers in bold imply that the soft conditioned large BVAR improves over the raw large BVAR. Asterisks *, ** and *** imply statistical significance of a two-sided Diebold and Mariano (1995) test of equal predictive ability at the 10%, 5%, 1% level. The variance is estimated using Bartlett kernel weights with bandwidth equal to the forecast horizon h. The evaluation sample size is $P = 72$ quarters. The columns $h = 4^*$ and $h = 8^*$ show the results for the one- and two-year-ahead, year-on-year predictions, respectively.

5 Hierarchical BVAR

Tables 10 to 13 show results for a BVAR (GLP-BVAR) estimated following Giannone et al. (2015).[2] The BVAR is estimated using a Minnesota prior with additional "dummy-initial-observation" and "sum-of-coefficients" priors, where the hyperparameters that control the tightness of the prior are treated as random variables instead of being fixed *a priori*. The hierarchical BVAR of Giannone et al. (2015) helps to rule out some alternative explanations of why the SPF information helps to improve the forecasting performance. First, the "dummy-initial-observation" and the "sum-of-coefficient" priors, implemented via dummy observations address the potential problem of fitting the low-frequency variation in the data via the deterministic component of the VAR (see Giannone et al. (2019) for more details). Second, treating the hyperparameter that controls the tightness of the prior as an additional parameter serves as a robustness check against our hyperparameter choices in the previously discussed models.

Results are qualitatively the same, although the improvements for GDP are statistically significant at fewer horizons, whereas the improvements for HICP are larger and more often significant. However, Tables 14 and 15 show results when using the multi-horizon forecast comparison test of Quaedvlieg (2019), and results are very similar to the baseline model, including for GDP (UMP stands for the unemployment rate). Importantly, the upward bias in GDP remains, as shown in Table 16.

Table 10: Entropic tilting versus GLP-BVAR: RMSFE

Forecast horizon	$h=1$	$h=2$	$h=3$	$h=4$	$h=5$	$h=6$	$h=7$	$h=8$	$h=4^*$	$h=8^*$
					Panel A. GLP-BVAR					
GDP	0.51	0.55	0.59	0.60	0.62	0.62	0.62	0.62	1.58	2.11
HICP	0.26	0.29	0.31	0.32	0.32	0.33	0.33	0.33	1.00	1.15
Unemployment	0.26	0.39	0.54	0.69	0.84	0.99	1.14	1.28	*N/A*	*N/A*
Euribor	0.38	0.71	1.00	1.24	1.43	1.57	1.69	1.79	*N/A*	*N/A*
					Panel B. Tilting GDP					
GDP	**0.84*****	**0.92**	**0.93**	**0.93**	**0.94**	**0.93**	**0.93**	**0.97**	**0.87***	**0.91**
HICP	1.00	**0.99*****	0.99	1.00	1.00	1.00	1.00	1.00	**0.99**	1.01
Unemployment	**0.98**	**0.97**	**0.97**	**0.96**	**0.96**	**0.96**	**0.96**	**0.96**	*N/A*	*N/A*
Euribor	**0.97**	**0.94**	**0.93***	**0.94***	**0.97**	1.01	1.05	1.07	*N/A*	*N/A*
					Panel C. Tilting HICP					
GDP	**0.97***	**0.97****	**0.97*****	**0.98**	**0.99**	**1.00**	**0.99**	1.00	**0.96****	**0.99**
HICP	**0.89*****	**0.92***	**0.87****	**0.86****	**0.87****	**0.87****	**0.87****	**0.87****	**0.84****	**0.82****
Unemployment	**1.00**	**1.00**	1.00	1.01	1.01	1.02	1.03	1.03*	*N/A*	*N/A*
Euribor	**0.98**	**0.96***	**0.94***	**0.92***	**0.92***	**0.92****	**0.92****	**0.93*****	*N/A*	*N/A*
					Panel D. Tilting Unemployment					
GDP	**0.97**	1.05	1.07	1.01	**0.99**	1.01	1.00	1.06***	1.05	**0.99**
HICP	1.00	**1.00**	0.98	0.97	0.99	0.98	0.99	0.98	0.98	0.98
Unemployment	**0.99**	1.00	1.02	1.04	1.05	1.03	1.01	**1.00**	*N/A*	*N/A*
Euribor	**0.97**	**0.98**	1.02	1.08	1.13	1.15	1.16	1.14	*N/A*	*N/A*
					Panel E. Tilting GDP, HICP and Unemployment					
GDP	**0.86****	**0.92**	**0.92**	**0.93**	**0.93**	**0.94**	**0.95**	1.02	**0.87***	**0.91**
HICP	**0.91*****	**0.92***	**0.88****	**0.87****	**0.88****	**0.86****	**0.86****	**0.89****	**0.84****	**0.82****
Unemployment	**0.99**	1.00	1.02	1.04	1.03	1.02	1.01	**1.00**	*N/A*	*N/A*
Euribor	**0.98**	**0.90****	**0.89****	**0.91***	0.95	0.99	1.01	1.01	*N/A*	*N/A*

Note: Panel A displays the raw GLP-BVAR RMSFE. Panels B to E show the ratios of the RMSFE of the entropically tilted GLP-BVAR to the raw GLP-BVAR. Numbers in bold imply that the tilted GLP-BVAR improves over the raw GLP-BVAR. Asterisks *, ** and *** imply statistical significance of a two-sided Diebold and Mariano (1995) test of equal predictive ability at the 10%, 5%, 1% level. The variance is estimated using Bartlett kernel weights with bandwidth equal to the forecast horizon h. The evaluation sample size is $P = 72$ quarters. The columns $h = 4^*$ and $h = 8^*$ show the results for the one- and two-year-ahead, year-on-year predictions, respectively.

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[2]The BVAR has constant volatilities and is estimated in levels (log-levels respectively). The number of lags is equal to four.

Table 11: Entropic tilting versus GLP-BVAR: CRPS

Forecast horizon	$h=1$	$h=2$	$h=3$	$h=4$	$h=5$	$h=6$	$h=7$	$h=8$	$h=4^*$	$h=8^*$
	Panel A. GLP-BVAR									
GDP	0.32	0.33	0.34	0.36	0.36	0.37	0.38	0.37	0.88	1.22
HICP	0.15	0.16	0.17	0.18	0.18	0.18	0.19	0.18	0.57	0.65
Unemployment	0.16	0.22	0.30	0.39	0.49	0.58	0.67	0.76	*N/A*	*N/A*
Euribor	0.19	0.37	0.53	0.67	0.79	0.89	0.97	1.05	*N/A*	*N/A*
	Panel B. Tilting GDP									
GDP	**0.84****	**0.89**	**0.91**	**0.91**	**0.91**	**0.91**	**0.90**	**0.97**	**0.80**	**0.86**
HICP	1.00	**0.99****	1.00	1.01	1.01	1.01	1.02	1.01	**1.00**	1.02
Unemployment	**0.99**	**0.97**	**0.96**	**0.95**	**0.95**	**0.95**	**0.95**	**0.96**	*N/A*	*N/A*
Euribor	**0.98**	**0.96***	**0.95****	**0.95****	**0.98**	1.00	1.03	1.04	*N/A*	*N/A*
	Panel C. Tilting HICP									
GDP	**0.98****	**0.98****	**0.98*****	**0.99**	**0.99**	**1.00**	**0.99**	**1.00**	**0.96****	**0.99**
HICP	**0.89*****	**0.93***	**0.88****	**0.86****	**0.88****	**0.88****	**0.88****	**0.89*****	**0.86****	**0.86****
Unemployment	**1.00**	**1.00**	1.00	1.01	1.02	1.03*	1.03*	1.04*	*N/A*	*N/A*
Euribor	**0.98**	**0.97***	**0.96***	**0.94***	**0.93****	**0.93****	**0.93*****	**0.93*****	*N/A*	*N/A*
	Panel D. Tilting Unemployment									
GDP	1.02	1.10*	1.08	1.01	**0.98**	1.01	1.00	1.05***	1.08	**0.98**
HICP	**1.00**	**1.00**	**0.98**	**0.97**	**0.98**	**0.98**	**1.00**	1.00	**0.98**	**0.99**
Unemployment	**0.99**	1.01	1.03	1.03	1.04	1.03	1.02	1.02	*N/A*	*N/A*
Euribor	**0.98**	**0.97**	1.02	1.08	1.12	1.13	1.12	1.10	*N/A*	*N/A*
	Panel E. Tilting GDP, HICP and Unemployment									
GDP	**0.87***	**0.91**	**0.90**	**0.92**	**0.91**	**0.92**	**0.93**	1.03	**0.80**	**0.86**
HICP	**0.92*****	**0.94**	**0.89****	**0.89****	**0.90****	**0.87****	**0.89*****	**0.91****	**0.87****	**0.87****
Unemployment	**0.99**	1.04	1.07	1.08	1.06	1.04	1.02	1.02	*N/A*	*N/A*
Euribor	1.00	**0.93**	**0.93***	**0.95**	**0.97**	**0.99**	**1.00**	**0.99**	*N/A*	*N/A*

Note: Panel A displays the raw GLP-BVAR CRPS. Panels B to E show the ratios of the CRPS of the entropically tilted GLP-BVAR to the raw GLP-BVAR. Numbers in bold imply that the tilted GLP-BVAR improves over the raw GLP-BVAR. Asterisks *, ** and *** imply statistical significance of a two-sided Diebold and Mariano (1995) test of equal predictive ability at the 10%, 5%, 1% level. The variance is estimated using Bartlett kernel weights with bandwidth equal to the forecast horizon h. The evaluation sample size is $P = 72$ quarters. The columns $h = 4^*$ and $h = 8^*$ show the results for the one- and two-year-ahead, year-on-year predictions, respectively.

Table 12: Soft Conditioning versus GLP-BVAR: RMSFE

Forecast horizon	$h=1$	$h=2$	$h=3$	$h=4$	$h=5$	$h=6$	$h=7$	$h=8$	$h=4^*$	$h=8^*$
	Panel A. GLP-BVAR									
GDP	0.51	0.55	0.59	0.60	0.62	0.62	0.62	0.62	1.58	2.11
HICP	0.26	0.29	0.31	0.32	0.32	0.33	0.33	0.33	1.00	1.15
Unemployment	0.26	0.39	0.54	0.69	0.84	0.99	1.14	1.28	*N/A*	*N/A*
Euribor	0.38	0.71	1.00	1.24	1.43	1.57	1.69	1.79	*N/A*	*N/A*
	Panel B. Soft Conditioning GDP									
GDP	**0.86****	**0.91**	**0.92**	**0.91**	**0.92**	**0.92**	**0.92**	**0.97**	**0.87***	**0.89**
HICP	1.00	**0.99****	**0.99**	**0.99**	**0.99**	1.00	1.00	**0.99**	**0.99**	**1.00**
Unemployment	**0.99**	**0.98**	**0.98**	**0.97**	**0.97**	**0.97**	**0.97**	**0.97**	*N/A*	*N/A*
Euribor	**0.97**	**0.95**	**0.94**	**0.94***	**0.97***	**1.00**	1.02	1.04	*N/A*	*N/A*
	Panel C. Soft Conditioning HICP									
GDP	**0.98***	**0.99****	**0.99****	**0.99**	**1.00**	1.00	**1.00**	1.00	**0.98****	**1.00**
HICP	**0.95*****	**0.95****	**0.92****	**0.90****	**0.91****	**0.90****	**0.89****	**0.90****	**0.90*****	**0.86****
Unemployment	1.00	1.00	1.00	1.00	1.01	1.01*	1.01**	1.02**	*N/A*	*N/A*
Euribor	**0.98***	**0.97***	**0.96***	**0.94***	**0.94****	**0.95****	**0.95****	**0.95*****	*N/A*	*N/A*
	Panel D. Soft Conditioning Unemployment									
GDP	1.00	1.01	1.02	1.01	**0.99**	**0.99**	**0.99**	**0.99**	1.02	**0.99**
HICP	**0.99**	**0.99**	**0.98**	**0.98**	**0.98**	**0.97**	**0.97**	**0.97**	**0.98**	**0.97**
Unemployment	**1.00**	**0.99**	**0.99**	**0.99**	**1.00**	**1.00**	**0.99**	**0.98**	*N/A*	*N/A*
Euribor	**1.00**	**1.00**	**1.00**	1.01	1.03	1.05	1.06	1.06	*N/A*	*N/A*
	Panel E. Soft Conditioning GDP, HICP and Unemployment									
GDP	**0.86****	**0.91**	**0.92**	**0.91**	**0.92**	**0.92**	**0.92**	**0.97**	**0.87***	**0.89**
HICP	**0.95*****	**0.95****	**0.92****	**0.90****	**0.91****	**0.90***	**0.90***	**0.90***	**0.90*****	**0.87***
Unemployment	**0.99**	**0.98**	**0.98**	**0.98**	**0.98**	**0.99**	**0.99**	**0.98**	*N/A*	*N/A*
Euribor	**0.96**	**0.93***	**0.91****	**0.91****	**0.93*****	**0.96*****	**0.98**	**1.00**	*N/A*	*N/A*

Note: Panel A displays the raw GLP-BVAR RMSFE. Panels B to E show the ratios of the RMSFE of the soft conditioned GLP-BVAR to the raw GLP-BVAR. Numbers in bold imply that the soft conditioned GLP-BVAR improves over the raw GLP-BVAR. Asterisks *, ** and *** imply statistical significance of a two-sided Diebold and Mariano (1995) test of equal predictive ability at the 10%, 5%, 1% level. The variance is estimated using Bartlett kernel weights with bandwidth equal to the forecast horizon h. The evaluation sample size is $P = 72$ quarters. The columns $h = 4^*$ and $h = 8^*$ show the results for the one- and two-year-ahead, year-on-year predictions, respectively.

Table 13: Soft Conditioning versus GLP-BVAR: CRPS

Forecast horizon	$h=1$	$h=2$	$h=3$	$h=4$	$h=5$	$h=6$	$h=7$	$h=8$	$h=4^*$	$h=8^*$
	Panel A. GLP-BVAR									
GDP	0.32	0.33	0.34	0.36	0.36	0.37	0.38	0.37	0.88	1.22
HICP	0.15	0.16	0.17	0.18	0.18	0.18	0.19	0.18	0.57	0.65
Unemployment	0.16	0.22	0.30	0.39	0.49	0.58	0.67	0.76	*N/A*	*N/A*
Euribor	0.19	0.37	0.53	0.67	0.79	0.89	0.97	1.05	*N/A*	*N/A*
	Panel B. Soft Conditioning GDP									
GDP	**0.85****	**0.88***	**0.89**	**0.90**	**0.90**	**0.90**	**0.90**	**0.97**	**0.80**	**0.84**
HICP	1.00	**1.00**	**1.00**	1.00	1.00	1.01	1.01	1.00	**1.00**	1.01
Unemployment	**0.99**	**0.99**	**0.98**	**0.97**	**0.97**	**0.97**	**0.97**	**0.98**	*N/A*	*N/A*
Euribor	**0.98**	**0.97***	**0.96****	**0.96****	**0.98**	**1.00**	1.01	1.02	*N/A*	*N/A*
	Panel C. Soft Conditioning HICP									
GDP	**0.99****	**0.99*****	**0.99*****	**0.99***	**1.00**	**1.00**	**1.00**	**1.00**	**0.98****	**1.00**
HICP	**0.95*****	**0.96***	**0.93****	**0.92****	**0.92****	**0.92****	**0.91****	**0.92****	**0.94****	**0.91****
Unemployment	1.00	1.00	1.00	1.01	1.01**	1.02**	1.02**	1.02**	*N/A*	*N/A*
Euribor	**0.99***	**0.98****	**0.97****	**0.96****	**0.96****	**0.95*****	**0.95*****	**0.96*****	*N/A*	*N/A*
	Panel D. Soft Conditioning Unemployment									
GDP	1.00	1.01	1.02	1.00	**0.99**	**0.99**	**0.98*****	**0.99****	1.03	**0.99**
HICP	**0.99**	**0.99**	**0.99**	**0.98**	**0.98**	**0.98**	**0.99**	**0.99**	**0.98**	**0.98**
Unemployment	1.00	1.00	**1.00**	1.00	1.01	1.02	1.02	1.01	*N/A*	*N/A*
Euribor	1.00	**0.99**	**0.99**	1.00	1.02	1.03	1.03	1.03	*N/A*	*N/A*
	Panel E. Soft Conditioning GDP, HICP and Unemployment									
GDP	**0.85****	**0.88***	**0.89**	**0.90**	**0.90**	**0.90**	**0.90**	**0.97**	**0.80**	**0.83**
HICP	**0.95****	**0.96***	**0.93****	**0.92****	**0.93***	**0.93****	**0.93**	**0.93***	**0.93***	**0.93**
Unemployment	1.00	**1.00**	**1.00**	**1.00**	1.01	1.02	1.02	1.03	*N/A*	*N/A*
Euribor	**0.97**	**0.95****	**0.93*****	**0.93*****	**0.95****	**0.96**	**0.98**	**0.98**	*N/A*	*N/A*

Note: Panel A displays the raw GLP-BVAR CRPS. Panels B to E show the ratios of the CRPS of the soft conditioned GLP-BVAR to the raw GLP-BVAR. Numbers in bold imply that the soft conditioned GLP-BVAR improves over the raw GLP-BVAR. Asterisks *, ** and *** imply statistical significance of a two-sided Diebold and Mariano (1995) test of equal predictive ability at the 10%, 5%, 1% level. The variance is estimated using Bartlett kernel weights with bandwidth equal to the forecast horizon h. The evaluation sample size is $P = 72$ quarters. The columns $h = 4^*$ and $h = 8^*$ show the results for the one- and two-year-ahead, year-on-year predictions, respectively.

Table 14: Entropic tilting versus GLP-BVAR: Multi-Horizon Test

	Panel A. Tilting GDP							
	RMSFE				*CRPS*			
	GDP	HICP	UMP	Euribor	GDP	HICP	UMP	Euribor
$h = 1\text{-}4$	**1.82****	0.67	**1.35****	**1.44*****	**2.35*****	0.03	**1.17****	**1.72*****
$h = 1\text{-}8$	**1.63***	0.09	1.11	−0.38	**2.14****	−0.30	**1.06**	0.13

	Panel B. Tilting HICP							
	RMSFE				*CRPS*			
	GDP	HICP	UMP	Euribor	GDP	HICP	UMP	Euribor
$h = 1\text{-}4$	**2.33*****	**2.29*****	−0.23	**1.83****	**2.75*****	**2.34*****	−0.37	**1.90****
$h = 1\text{-}8$	**2.03****	**2.44****	−1.26	**2.21****	**2.56****	**2.54*****	−1.42	**2.32****

	Panel C. Tilting Unemployment							
	RMSFE				*CRPS*			
	GDP	HICP	UMP	Euribor	GDP	HICP	UMP	Euribor
$h = 1\text{-}4$	−0.76	**0.38**	−0.59	−0.61	−1.46	**0.34**	−0.31	−0.48
$h = 1\text{-}8$	−1.04	**0.30**	−0.38	−1.25	−1.70	**0.27**	−0.32	−1.09

	Panel D. Tilting GDP, HICP and Unemployment							
	RMSFE				*CRPS*			
	GDP	HICP	UMP	Euribor	GDP	HICP	UMP	Euribor
$h = 1\text{-}4$	**1.84****	**2.17*****	−0.50	**1.58****	**2.17****	**2.08****	−0.77	**1.12****
$h = 1\text{-}8$	**1.42***	**2.36****	−0.28	**0.55**	**1.79***	**2.31****	−0.52	**0.52**

Note: The table shows the results of the "multi-horizon forecast comparison test" by Quaedvlieg (2019). Positive (bold) numbers imply that the tilted GLP-BVAR improved over the raw GLP-BVAR. Asterisks *, ** and *** imply statistical significance of the one-sided multi-horizon test at the 10%, 5%, 1% level. The evaluation sample size is $P = 72$ quarters. The rows $h = 1\text{-}4$ and $h = 1\text{-}8$ show the results when applying the multi-horizon test to forecast horizons $h = 1$ to 4 and $h = 1$ to 8, respectively.

Table 15: Soft Conditioning versus GLP-BVAR: Multi-Horizon Test

	Panel A. Soft Conditioning GDP							
	RMSFE				*CRPS*			
	GDP	HICP	UMP	Euribor	GDP	HICP	UMP	Euribor
$h = 1\text{-}4$	**2.09****	0.75	**1.41****	**1.38*****	**2.87*****	0.00	**1.02***	**1.69*****
$h = 1\text{-}8$	**1.97****	0.36	1.19	0.21	**2.64****	−0.15	0.84	0.46

	Panel B. Soft Conditioning HICP							
	RMSFE				*CRPS*			
	GDP	HICP	UMP	Euribor	GDP	HICP	UMP	Euribor
$h = 1\text{-}4$	**2.58*****	**2.36*****	−0.62	**1.81*****	**3.28*****	**2.14*****	−0.98	**2.25*****
$h = 1\text{-}8$	**1.82****	**2.26****	−1.68	**2.27*****	**2.94*****	**2.29*****	−2.01	**2.68*****

	Panel C. Soft Conditioning Unemployment							
	RMSFE				*CRPS*			
	GDP	HICP	UMP	Euribor	GDP	HICP	UMP	Euribor
$h = 1\text{-}4$	−0.91	**0.79****	0.50	−0.34	−0.80	**0.69***	−0.05	**0.16**
$h = 1\text{-}8$	**0.05**	**0.69**	0.37	−1.14	**0.12**	**0.54**	−0.35	−0.70

	Panel D. Soft Conditioning GDP, HICP and Unemployment							
	RMSFE				*CRPS*			
	GDP	HICP	UMP	Euribor	GDP	HICP	UMP	Euribor
$h = 1\text{-}4$	**2.12****	**2.30*****	**0.96***	**1.81*****	**2.87*****	**1.97*****	0.09	**2.58*****
$h = 1\text{-}8$	**2.04****	**2.12*****	0.53	**2.07****	**2.68****	**1.93****	−0.34	**1.78***

Note: The table shows the results of the "multi-horizon forecast comparison test" by Quaedvlieg (2019). Positive (bold) numbers imply that the tilted GLP-BVAR improved over the raw GLP-BVAR. Asterisks *, ** and *** imply statistical significance of the one-sided multi-horizon test at the 10%, 5%, 1% level. The evaluation sample size is $P = 72$ quarters. The rows $h = 1\text{-}4$ and $h = 1\text{-}8$ show the results when applying the multi-horizon test to forecast horizons $h = 1$ to 4 and $h = 1$ to 8, respectively.

Table 16: GLP-BVAR Forecast bias — before and after the Great Recession

Forecast horizon	$h=1$	$h=2$	$h=3$	$h=4$	$h=5$	$h=6$	$h=7$	$h=8$	$h=4^*$	$h=8^*$
Panel A. GLP-BVAR - Before Great Recession										
GDP	−0.01	−0.01	−0.03	−0.06	−0.07	−0.09	−0.11	−0.11	−0.21	−0.46
HICP	0.08**	0.10**	0.11*	0.11*	0.12	0.12	0.12	0.12	0.34	0.37
Unemployment	−0.04	−0.05	−0.08	−0.11	−0.13	−0.13	−0.11	−0.09	N/A	N/A
Euribor	0.07	0.19	0.33	0.46	0.55	0.63	0.67	0.69	N/A	N/A
Panel B. Tilting GDP One- and Two-Year-Ahead - Before Great Recession										
GDP	−0.05	−0.06	−0.09	−0.13	−0.14	−0.15	−0.15	−0.13	−0.37	−0.72
HICP	0.08**	0.10**	0.11*	0.11*	0.11	0.11	0.12	0.11	0.34	0.36
Unemployment	−0.03	−0.04	−0.06	−0.07	−0.07	−0.05	−0.02	0.03	N/A	N/A
Euribor	0.09	0.21	0.34	0.44	0.49	0.51	0.49	0.45	N/A	N/A
Panel C. GLP-BVAR - After Great Recession										
GDP	−0.24***	−0.32***	−0.39***	−0.43***	−0.45***	−0.45***	−0.43***	−0.43***	−0.86**	−1.73***
HICP	−0.01	−0.02	−0.05	−0.07	−0.09	−0.10	−0.11	−0.13	−0.12	−0.42
Unemployment	0.03	0.08	0.13	0.20	0.27	0.34	0.40	0.46	N/A	N/A
Euribor	0.06	0.08	0.06	−0.01	−0.12	−0.27	−0.43	−0.59*	N/A	N/A
Panel D. Tilting GDP One- and Two-Year-Ahead - After Great Recession										
GDP	−0.01	−0.08	−0.12	−0.12	−0.10	−0.12	−0.12	−0.32**	−0.09	−0.36
HICP	−0.02	−0.02	−0.04	−0.05	−0.06	−0.06	−0.07	−0.09	−0.10	−0.27
Unemployment	0.02	0.05	0.09	0.12	0.15	0.17	0.19	0.22	N/A	N/A
Euribor	0.06	0.08	0.08	0.05	0.02	−0.02	−0.06	−0.13	N/A	N/A

Note: Panels A to D display the means of the forecast errors of the GLP-BVAR and tilted GLP-BVAR, before and after the Great Recession. Asterisks *, ** and *** imply statistical significance of a two-sided *t*-test of unbiasedness at the 10%, 5%, 1% level. The variance is estimated using Bartlett kernel weights with bandwidth equal to the forecast horizon h. The evaluation sample size is $38 - h$ quarters in Panels A to B, and 30 quarters in Panels C to D. The columns labeled $h = 4^*$ and $h = 8^*$ show the results for the one-year-ahead and two-year-ahead, year-on-year predictions, respectively.

6 BVAR in Levels

As a final robustness check, we re-estimated the baseline BVAR with stochastic volatility in levels with the standard Minnesota prior. Tables 17 to 20 show the results for entropic tilting and soft conditioning for the baseline BVAR, where real GDP and HICP enter the model in log-levels instead of log-differences. We adopted the most common prior specification in this case, which is to shrink the coefficient of the first own-lag to one.

Table 17: Entropic tilting versus BVAR in levels: RMSFE

Forecast horizon	$h=1$	$h=2$	$h=3$	$h=4$	$h=5$	$h=6$	$h=7$	$h=8$	$h=4^*$	$h=8^*$
					Panel A. BVAR					
GDP	0.54	0.55	0.55	0.54	0.54	0.54	0.53	0.53	1.59	1.74
HICP	0.30	0.32	0.34	0.35	0.35	0.35	0.35	0.34	1.15	1.24
Unemployment	0.28	0.43	0.59	0.76	0.93	1.09	1.25	1.40	*N/A*	*N/A*
Euribor	0.39	0.74	1.05	1.32	1.57	1.79	1.99	2.16	*N/A*	*N/A*
					Panel B. Tilting GDP					
GDP	**0.82****	**0.92*****	**0.99**	1.05	1.08	1.08	1.08	1.03	**0.86****	1.10
HICP	1.01	1.01	1.01	1.00	1.01	1.02	1.03	1.03	1.01	1.03
Unemployment	**0.95**	**0.91***	**0.91*****	**0.92****	**0.93*****	**0.95****	**0.96**	**0.97**	*N/A*	*N/A*
Euribor	1.02	1.00	**0.99**	**0.99**	**0.99**	**1.00**	1.00	**1.00**	*N/A*	*N/A*
					Panel C. Tilting HICP					
GDP	1.01	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01
HICP	**0.81****	**0.83****	**0.79****	**0.80****	**0.81***	**0.82***	**0.83***	**0.84***	**0.73****	**0.76***
Unemployment	1.00	1.01	1.02	1.03	1.03	1.03	1.04	1.03	*N/A*	*N/A*
Euribor	**1.00**	1.01	1.02	1.03	1.04	1.04	1.03	1.02	*N/A*	*N/A*
					Panel D. Tilting Unemployment					
GDP	**0.95**	1.00	1.04	1.04	1.02	1.01	1.02	1.02	**1.00**	1.02
HICP	1.01	**0.99**	**0.99**	1.00	**1.00**	**1.00**	1.02	1.04	**0.99**	1.02
Unemployment	**0.97**	**0.95**	**0.94**	**0.94**	**0.94**	**0.93**	**0.92**	**0.91**	*N/A*	*N/A*
Euribor	**0.95**	**0.96**	**0.99**	1.03	1.04	1.05	1.05	1.04	*N/A*	*N/A*
					Panel E. Tilting GDP, HICP and Unemployment					
GDP	**0.84****	**0.93****	**0.99**	1.09	1.08	1.07	1.08	1.05	**0.87****	1.10
HICP	**0.83****	**0.85****	**0.81****	**0.82****	**0.81****	**0.82***	0.85	0.86	**0.73****	**0.77***
Unemployment	**0.95**	**0.92**	**0.92**	**0.94**	**0.94**	**0.94**	**0.92**	**0.91**	*N/A*	*N/A*
Euribor	**0.96**	**0.97**	**0.98**	1.01	1.02	1.03	1.02	**1.00**	*N/A*	*N/A*

Note: Panel A displays the raw BVAR in levels RMSFE. Panels B to E show the ratios of the RMSFE of the entropically tilted BVAR in levels to the raw BVAR in levels. Numbers in bold imply that the tilted BVAR in levels improves over the raw BVAR in levels. Asterisks *, ** and *** imply statistical significance of a two-sided Diebold and Mariano (1995) test of equal predictive ability at the 10%, 5%, 1% level. The variance is estimated using Bartlett kernel weights with bandwidth equal to the forecast horizon h. The evaluation sample size is $P = 72$ quarters. The columns $h = 4^*$ and $h = 8^*$ show the results for the one- and two-year-ahead, year-on-year predictions, respectively.

Table 18: Entropic tilting versus BVAR in levels: CRPS

Forecast horizon	$h=1$	$h=2$	$h=3$	$h=4$	$h=5$	$h=6$	$h=7$	$h=8$	$h=4^*$	$h=8^*$
	Panel A. BVAR									
GDP	0.25	0.26	0.26	0.26	0.26	0.27	0.26	0.26	0.81	0.97
HICP	0.17	0.18	0.20	0.20	0.20	0.20	0.20	0.20	0.70	0.76
Unemployment	0.17	0.25	0.36	0.49	0.61	0.73	0.85	0.97	*N/A*	*N/A*
Euribor	0.19	0.38	0.56	0.74	0.90	1.04	1.16	1.26	*N/A*	*N/A*
	Panel B. Tilting GDP									
GDP	**0.82*****	**0.89*****	**0.96**	1.01	1.03	1.03	1.03	1.00	**0.85****	1.09
HICP	1.01	1.01	1.01	1.01	1.02	1.03	1.04	1.04	1.02	1.06*
Unemployment	**0.96**	**0.93****	**0.91*****	**0.91*****	**0.92*****	**0.94*****	**0.95***	**0.97**	*N/A*	*N/A*
Euribor	1.03	1.02	1.01	1.01	1.01	1.01	1.01	1.01	*N/A*	*N/A*
	Panel C. Tilting HICP									
GDP	1.02	1.02	1.01	1.00	1.01	1.00	1.01	1.01	1.02	1.01
HICP	**0.81*****	**0.82****	**0.79****	**0.80****	**0.80***	**0.81***	**0.81***	**0.82***	**0.72****	**0.75****
Unemployment	1.01	1.03	1.05	1.05	1.05	1.05*	1.05*	1.05*	*N/A*	*N/A*
Euribor	1.00	1.02	1.02	1.03	1.04	1.04	1.04	1.04	*N/A*	*N/A*
	Panel D. Tilting Unemployment									
GDP	**0.96**	1.01	1.02	1.02	1.02	**0.99**	1.01	1.01	**0.98**	**0.97**
HICP	**1.00**	**0.98**	**0.98**	**1.00**	**0.99**	**0.99**	1.01	1.02	**0.97**	1.01
Unemployment	**0.97**	**0.97**	**0.93**	**0.90**	**0.88**	**0.86**	**0.84**	**0.83***	*N/A*	*N/A*
Euribor	**0.97**	**0.97**	**0.98**	1.01	1.02	1.02	1.03	1.03	*N/A*	*N/A*
	Panel E. Tilting GDP, HICP and Unemployment									
GDP	**0.84*****	**0.91****	**0.95**	1.04	1.03	1.03	1.03	1.01	**0.86****	1.08
HICP	**0.83*****	**0.84****	**0.81****	**0.81****	**0.80****	**0.81***	**0.85***	**0.85**	**0.72****	**0.76***
Unemployment	**0.95**	**0.95**	**0.91**	**0.89**	**0.87**	**0.86**	**0.85**	**0.84***	*N/A*	*N/A*
Euribor	**0.99**	**0.98**	**0.99**	1.01	1.02	1.03	1.02	1.02	*N/A*	*N/A*

Note: Panel A displays the raw BVAR in levels CRPS. Panels B to E show the ratios of the CRPS of the entropically tilted BVAR in levels to the raw BVAR in levels. Numbers in bold imply that the tilted BVAR in levels improves over the raw BVAR in levels. Asterisks *, ** and *** imply statistical significance of a two-sided Diebold and Mariano (1995) test of equal predictive ability at the 10%, 5%, 1% level. The variance is estimated using Bartlett kernel weights with bandwidth equal to the forecast horizon h. The evaluation sample size is $P = 72$ quarters. The columns $h = 4^*$ and $h = 8^*$ show the results for the one- and two-year-ahead, year-on-year predictions, respectively.

Forecast horizon	$h = 1$	$h = 2$	$h = 3$	$h = 4$	$h = 5$	$h = 6$	$h = 7$	$h = 8$	$h = 4^*$	$h = 8^*$
					Panel A. BVAR					
GDP	0.54	0.55	0.55	0.54	0.54	0.54	0.53	0.53	1.59	1.74
HICP	0.30	0.32	0.34	0.35	0.35	0.35	0.35	0.34	1.15	1.24
Unemployment	0.28	0.43	0.59	0.76	0.93	1.09	1.25	1.40	*N/A*	*N/A*
Euribor	0.39	0.74	1.05	1.32	1.57	1.79	1.99	2.16	*N/A*	*N/A*
					Panel B. Soft Conditioning GDP					
GDP	**0.89****	**0.94****	**0.98**	1.02	1.04	1.05	1.05	1.03*	**0.92****	1.06
HICP	1.00	1.00	1.00	1.00	1.01	1.01	1.02	1.01	1.00	1.01
Unemployment	**0.97**	**0.96**	**0.95***	**0.96*****	**0.97****	**0.97*****	**0.98**	**0.99**	*N/A*	*N/A*
Euribor	1.01	1.00	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	*N/A*	*N/A*
					Panel C. Soft Conditioning HICP					
GDP	1.01	1.00	1.00	1.00	1.01**	1.01**	1.01*	1.01	1.00	1.01**
HICP	**0.89****	**0.90****	**0.88****	**0.88****	**0.88***	**0.88***	**0.88***	**0.89****	**0.85****	**0.85***
Unemployment	1.00	1.01	1.01	1.01*	1.02*	1.02*	1.02	1.02	*N/A*	*N/A*
Euribor	1.01	1.01	1.02	1.02	1.02	1.01	1.01	**1.00**	*N/A*	*N/A*
					Panel D. Soft Conditioning Unemployment					
GDP	**0.99**	**0.99**	1.01	1.00	1.00	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
HICP	**0.99**	**0.99**	**0.99**	**0.99**	**0.99**	**0.99**	**0.99**	1.00	**0.98**	**0.99**
Unemployment	**0.99**	**0.99**	**0.98**	**0.98**	**0.98**	**0.98**	**0.97**	**0.97****	*N/A*	*N/A*
Euribor	1.01	1.01	1.02*	1.02**	1.02*	1.02	1.02	1.01	*N/A*	*N/A*
					Panel E. Soft Conditioning GDP, HICP and Unemployment					
GDP	**0.89***	**0.94****	**0.98***	1.02	1.04	1.05	1.05	1.03*	**0.92****	1.06
HICP	**0.90****	**0.90***	**0.89****	**0.89***	**0.89***	**0.89***	**0.90***	**0.90**	**0.85****	**0.86****
Unemployment	**0.98**	**0.96**	**0.96**	**0.97**	**0.97**	**0.98**	**0.98**	**0.98**	*N/A*	*N/A*
Euribor	1.02	1.02	1.02	1.02	1.02	1.02	1.01	**1.00**	*N/A*	*N/A*

Note: Panel A displays the raw BVAR in levels RMSFE. Panels B to E show the ratios of the RMSFE of the soft conditioned BVAR in levels to the raw BVAR in levels. Numbers in bold imply that the soft conditioned BVAR in levels improves over the raw BVAR in levels. Asterisks *, ** and *** imply statistical significance of a two-sided Diebold and Mariano (1995) test of equal predictive ability at the 10%, 5%, 1% level. The variance is estimated using Bartlett kernel weights with bandwidth equal to the forecast horizon h. The evaluation sample size is $P = 72$ quarters. The columns $h = 4^*$ and $h = 8^*$ show the results for the one- and two-year-ahead, year-on-year predictions, respectively.

Table 20: Soft Conditioning versus BVAR in levels: CRPS

Forecast horizon	$h=1$	$h=2$	$h=3$	$h=4$	$h=5$	$h=6$	$h=7$	$h=8$	$h=4^*$	$h=8^*$
				Panel A. BVAR						
GDP	0.25	0.26	0.26	0.26	0.26	0.27	0.26	0.26	0.81	0.97
HICP	0.17	0.18	0.20	0.20	0.20	0.20	0.20	0.20	0.70	0.76
Unemployment	0.17	0.25	0.36	0.49	0.61	0.73	0.85	0.97	*N/A*	*N/A*
Euribor	0.19	0.38	0.56	0.74	0.90	1.04	1.16	1.26	*N/A*	*N/A*
				Panel B. Soft Conditioning GDP						
GDP	**0.89****	**0.92****	**0.96****	**0.99**	1.01	1.02	1.02	1.01	**0.94**	1.10
HICP	1.01	1.01	1.01	1.01	1.01	1.02	1.03	1.02	1.02*	1.04*
Unemployment	**1.00**	**0.99**	**0.98**	**0.98**	**0.99**	**1.00**	1.01	1.02	*N/A*	*N/A*
Euribor	1.01	1.02	1.02	1.02	1.01	1.01	1.01	1.01	*N/A*	*N/A*
				Panel C. Soft Conditioning HICP						
GDP	1.01	1.00	**1.00**	0.99	**1.00**	1.00	1.00	1.01	1.01	1.02**
HICP	**0.90***	**0.90***	**0.89***	**0.89***	**0.89***	**0.89***	**0.89***	**0.89*****	**0.89***	**0.90***
Unemployment	1.02*	1.03*	1.04**	1.04**	1.04**	1.04***	1.04***	1.04**	*N/A*	*N/A*
Euribor	1.00	1.02	1.03	1.03	1.03	1.02	1.02	1.01	*N/A*	*N/A*
				Panel D. Soft Conditioning Unemployment						
GDP	**0.99**	**0.99**	**0.99**	**0.99**	**0.98**	**0.98***	**0.98**	**0.98**	1.00	**0.99**
HICP	**0.99**	**0.98**	**0.99**	**0.99**	**0.99**	**0.99**	**1.00**	**1.00**	**0.98**	1.00
Unemployment	1.01	1.01	1.00	1.01	1.01	1.01	1.01	1.00	*N/A*	*N/A*
Euribor	1.01	1.01	1.02*	1.02*	1.02*	1.02	1.02	1.01	*N/A*	*N/A*
				Panel E. Soft Conditioning GDP, HICP and Unemployment						
GDP	**0.89*****	**0.92*****	**0.95****	**0.99**	1.01	1.01	1.02	1.01	**0.95**	1.10*
HICP	**0.91***	**0.91**	**0.90***	**0.90***	**0.91**	**0.91***	**0.92**	**0.91**	**0.90*****	**0.93**
Unemployment	1.02	1.02	1.01	1.02	1.02	1.03	1.03	1.04*	*N/A*	*N/A*
Euribor	1.02	1.04	1.05	1.05	1.05	1.04	1.04	1.02	*N/A*	*N/A*

Note: Panel A displays the raw BVAR in levels CRPS. Panels B to E show the ratios of the CRPS of the soft conditioned BVAR in levels to the raw BVAR in levels. Numbers in bold imply that the soft conditioned BVAR in levels improves over the raw BVAR in levels. Asterisks *, ** and *** imply statistical significance of a two-sided Diebold and Mariano (1995) test of equal predictive ability at the 10%, 5%, 1% level. The variance is estimated using Bartlett kernel weights with bandwidth equal to the forecast horizon h. The evaluation sample size is $P = 72$ quarters. The columns $h = 4^*$ and $h = 8^*$ show the results for the one- and two-year-ahead, year-on-year predictions, respectively.

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