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Fiscal Nowcasting

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The opinions expressed herein are those of the authors and do not necessarily reflect those of the European Central Bank, the Eurosystem or the Federal Reserve Bank of New York

Plan of the talk

i	Motivation
ii	Contribution
iii	Related literature
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v	The now-casting problem
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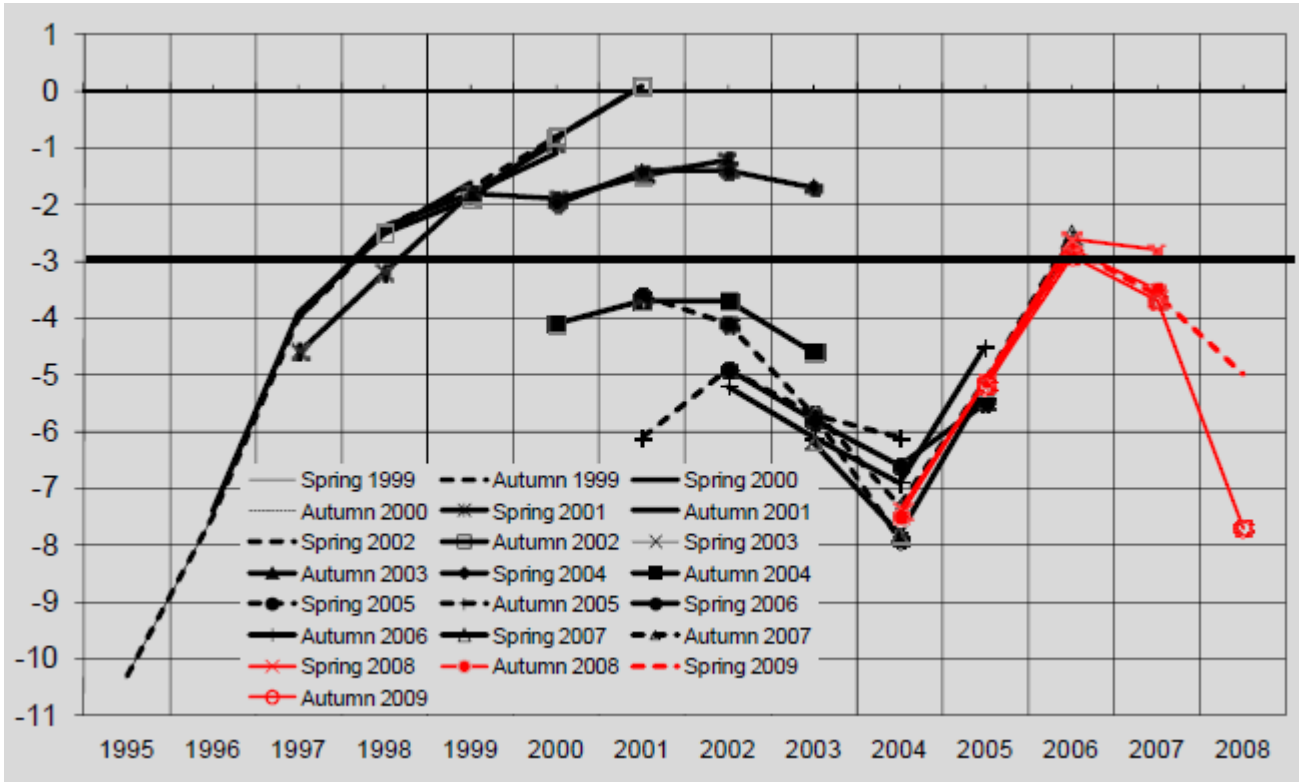
Motivation

- The government balance to GDP ratio is a synthetic indicator of state of public finances in one country, and it has a core role in the surveillance process (e.g., in the context of the EU fiscal framework)
- Timely monitoring the tendency of such ratio is of fundamental importance, especially for countries that exceeded the 3% of GDP.

The corrective arm of the Stability and Growth Pact (SGP) ensures that Member States adopt appropriate policy responses to correct excessive deficits by implementing the Excessive Deficit Procedure (EDP).

Greece: budget balance across different vintages (% of GDP)



Source: Castro et al. (2013)

Timeliness and frequency

- The general **government budget balance** is an accrual quarterly variable and released with a considerable delay.

➢ For EU countries: budget balance released only on the first business day of the fourth month after the end of the reference quarter.

For example, the budget balance for the second quarter of 2017 will be released only at the beginning of October 2017.

➢ Problem of timeliness and sample frequency

➢ However: cash data for government revenue and expenditures (borrowing requirement) are available at the monthly frequency, and released more timely

Cash vs. accrual fiscal data

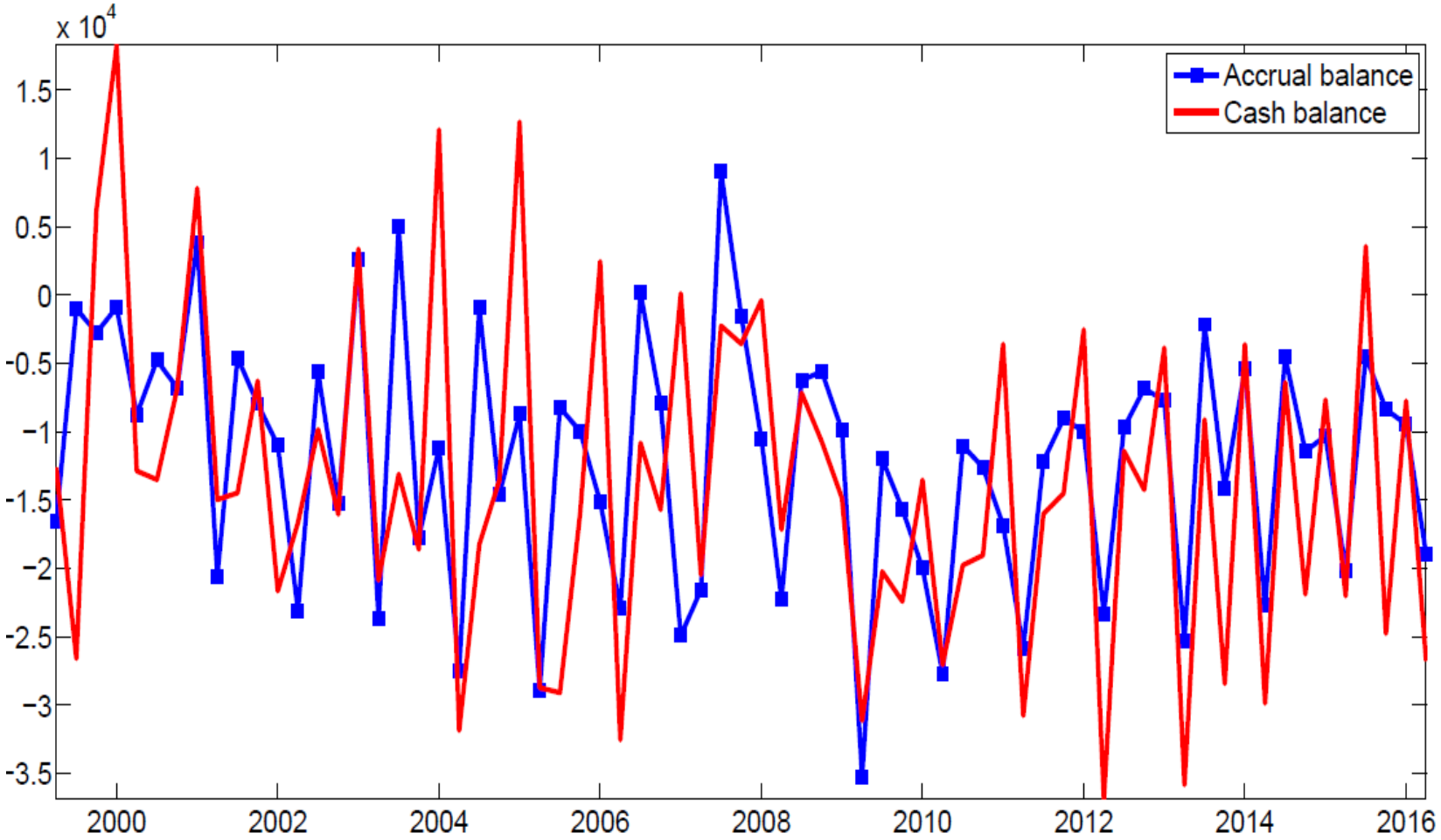
- Accrual accounting (fiscal surveillance): records revenues and expenses when they are incurred, regardless of when cash is received (or paid) by (or to) the government.

- Cash accounting: receipts are recorded in the period they are received, and expenses are recorded in the period in which they are actually paid by the government.

Cash fiscal data

- Two business days after the end of, say, month *tm*, the EU governments publish its cash flow in month *tm*
  - *For example: cash data for September 2017 will be released in early October 2017.*
- The sum of the cash flows in the quarter do not exactly reflect the (accrual) budget balance of that quarter, due to different accounting methods and time lags.
- However, the cash flows reflect a large part of the items included in the budget balance data relevant for fiscal surveillance.

Italy: quarterly budget balance and cash borrowing requirement



This paper

- A new methodology, based on a mixed frequency vector autoregressive model (Schorfheide and Song, 2015; Brave Butters Justiniano 2016)
  - Reap the benefits of the timeliness in the releases of monthly cash data
  - Filter out the noise in the relationship with quarterly budget balance data induced by the different accounting procedures
- Exploiting both monthly and quarterly information:

  a *monthly* indicator of the *annual government balance*
- Apply this procedure to Italian data, but the aim is to build up an monitoring tool for all EA countries (and the US)

Literature review I

- Our paper at the intersection between the literature on **GDP nowcasting** and **fiscal forecasting**
- Literature on GDP nowcasting has developed very significantly over the last years.

➢ Giannone Reichlin Small (2008): evaluate impact that intra-monthly data releases have on the GDP growth nowcast.

➢ Kuzin Marcellino Schumacher (2011), Foroni and Marcellino (2014): compare the forecasting performance of MIDAS and MF-VAR models

➢ Banbura et al. (2013) survey the literature on economic nowcasting → models that formalize how market participants and policy makers read macroeconomic data releases in real-time.

➢ Schorfheide and Song (2015) and Brave et al. (2016): GDP nowcasting with mixed frequency BVARs

Literature review II

- The fiscal forecasting literature is quite limited

- Some papers highlight that intra-annual data are available with short time lags can be used to derive accurate forecasts for end-of-year fiscal outcomes (see e.g. Pérez, 2007; Pedregal and Pérez, 2008; Onorante et al., 2008).
- Based on MIDAS models, Asimakopoulos et al. (2012) assess the news content of quarterly fiscal data releases and their implications for the annual outturn.
- Hughes-Hallet et al (2010) focus on monthly cash data to construct early warnings indicators for future deficit.
- Carabotta and Claeys (2015): combine forecasts from both private and public agencies for Italy.

Related modelling approaches

- Our modeling approach is based on a mixed-frequency Bayesian VAR model: treat the low frequency variables as the result of aggregation of a high frequency latent process.
- This approach has been used in previous work, based on Maximum Likelihood (or under flat priors) estimation (see, e.g., Giannone et al., 2009; and by Kuzin et al., 2011).
- We follow more recent work which use informative priors (see, in particular, Schorfheide and Song, 2015, and Brave et al., 2016).

Contribution

- Nowcast del government budget entails a lot of "art" (and judgement) [IMF, ECB, EC, CBO…]
- Our attempt: turn it into 'science' as it was the case for GDP
- There is a lot of information (cash data, survey?) to be included into models, but little has been done so far…
- Question: a small scale model including cash variables is enough, or we cannot avoid to rely on judgement?

Empirical analysis

- Focus: **end-of-the-year annual budget balance to GDP ratio**:

$$b_{ta} = \frac{\sum_{t=ta.Q1}^{ta.Q4} D_t}{\sum_{t=ta.Q1}^{ta.Q4} Y_t P_t},$$

- We specify a mixed-frequency VAR model that includes:

➢ **Quarterly data**: difference between government revenues and expenditures (D_t); real GDP (Y_t) and the GDP deflator (P_t). Sample: 1999Q1 to 2016Q3

➢ **Monthly data**: cash borrowing requirement for the general government (D_{tm}). Sample: January 1999 to December 2016

The now-casting problem

- Data availability for Italy in the dates of the now-cast production:

Date of now-cast	GDP	GDP Deflator	Budget balance	Cash balance
15-Jan	ta-1.Q3	ta-1.Q3	ta-1.Q3	ta-1.December
15-Feb	ta-1.Q3	ta-1.Q3	ta-1.Q3	ta.January
15-Mar	ta-1.Q4	ta-1.Q4	ta-1.Q3	ta.February
15-Apr	ta-1.Q4	ta-1.Q4	ta-1.Q4	ta.March
15-May	ta-1.Q4	ta-1.Q4	ta-1.Q4	ta.April
15-Jun	ta.Q1	ta.Q1	ta-1.Q4	ta.May
15-Jul	ta.Q1	ta.Q1	ta.Q1	ta.June
15-Aug	ta.Q1	ta.Q1	ta.Q1	ta.July
15-Sep	ta.Q2	ta.Q2	ta.Q1	ta.August
15-Oct	ta.Q2	ta.Q2	ta.Q2	ta.September
15-Nov	ta.Q2	ta.Q2	ta.Q2	ta.October
15-Dec	ta.Q3	ta.Q3	ta.Q2	ta.November

The now-casting problem

			GDP	GDP-DEFLATOR	BALANCE	CASH BALANCE
	2015	m1	NaN	NaN	NaN	-1361
	2015	m2	NaN	NaN	NaN	-10781
	2015	m3	405419	1.05	-15659	-17719
	2015	m4	NaN	NaN	NaN	-11521
	2015	m5	NaN	NaN	NaN	-5463
	2015	m6	404333	1.05	-11017	10592
	2015	m7	NaN	NaN	NaN	3480
	2015	m8	NaN	NaN	NaN	-7005
	2015	m9	404619	1.05	-6883	-18358
	2015	m10	NaN	NaN	NaN	-7335
	2015	m11	NaN	NaN	NaN	-5239
	2015	m12	407011	1.05	-21856	4923
	2016	m1	NaN	NaN	NaN	4679
	2016	m2	NaN	NaN	NaN	-8139
	2016	m3	407760	1.05	-7684	-18552
	2016	m4	NaN	NaN	NaN	-6752
	2016	m5	NaN	NaN	NaN	-4255
	2016	m6	409049	1.05	-5821	14588
	2016	m7	NaN	NaN	NaN	408
	2016	m8	NaN	NaN	NaN	-7302
	2016	m9	411371	1.06	**-35260**	-17864
	2016	m10	NaN	NaN	NaN	-2313
	2016	m11	NaN	NaN	NaN	-11673
15-Jan-17	2016	m12	NaN	NaN	NaN	**6243**

The now-casting problem

			GDP	GDP-DEFLATOR	BALANCE	CASH BALANCE
	2015	m1	NaN	NaN	NaN	-1361
	2015	m2	NaN	NaN	NaN	-10781
	2015	m3	405419	1.05	-15659	-17719
	2015	m4	NaN	NaN	NaN	-11521
	2015	m5	NaN	NaN	NaN	-5463
	2015	m6	404333	1.05	-11017	10592
	2015	m7	NaN	NaN	NaN	3480
	2015	m8	NaN	NaN	NaN	-7005
	2015	m9	404619	1.05	-6883	-18358
	2015	m10	NaN	NaN	NaN	-7335
	2015	m11	NaN	NaN	NaN	-5239
	2015	m12	407011	1.05	-21856	4923
	2016	m1	NaN	NaN	NaN	4679
	2016	m2	NaN	NaN	NaN	-8139
	2016	m3	407760	1.05	-7684	-18552
	2016	m4	NaN	NaN	NaN	-6752
	2016	m5	NaN	NaN	NaN	-4255
	2016	m6	409049	1.05	-5821	14588
	2016	m7	NaN	NaN	NaN	408
	2016	m8	NaN	NaN	NaN	-7302
	2016	m9	411371	1.06	-35260	-17864
	2016	m10	NaN	NaN	NaN	-2313
	2016	m11	NaN	NaN	NaN	-11673
	2016	m12	NaN	NaN	NaN	6243
15-Feb-17	2017	m1	NaN	NaN	NaN	**5474**

The now-casting problem

		GDP	GDP-DEFLATOR	BALANCE	CASH BALANCE
	2015 m1	NaN	NaN	NaN	-1361
	2015 m2	NaN	NaN	NaN	-10781
	2015 m3	405419	1.05	-15659	-17719
	2015 m4	NaN	NaN	NaN	-11521
	2015 m5	NaN	NaN	NaN	-5463
	2015 m6	404333	1.05	-11017	10592
	2015 m7	NaN	NaN	NaN	3480
	2015 m8	NaN	NaN	NaN	-7005
	2015 m9	404619	1.05	-6883	-18358
	2015 m10	NaN	NaN	NaN	-7335
	2015 m11	NaN	NaN	NaN	-5239
	2015 m12	407011	1.05	-21856	4923
	2016 m1	NaN	NaN	NaN	4679
	2016 m2	NaN	NaN	NaN	-8139
	2016 m3	407760	1.05	-7684	-18552
	2016 m4	NaN	NaN	NaN	-6752
	2016 m5	NaN	NaN	NaN	-4255
	2016 m6	409049	1.05	-5821	14588
	2016 m7	NaN	NaN	NaN	408
	2016 m8	NaN	NaN	NaN	-7302
	2016 m9	411371	1.06	-35260	-17864
	2016 m10	NaN	NaN	NaN	-2313
	2016 m11	NaN	NaN	NaN	-11673
	2016 m12	**413365**	**1.06**	NaN	6243
	2017 m1	NaN	NaN	NaN	5474
15-Mar-17	2017 m2	NaN	NaN	NaN	**-10701**

The now-casting problem

		GDP	GDP-DEFLATOR	BALANCE	CASH BALANCE
	2015 m1	NaN	NaN	NaN	-1361
	2015 m2	NaN	NaN	NaN	-10781
	2015 m3	405419	1.05	-15659	-17719
	2015 m4	NaN	NaN	NaN	-11521
	2015 m5	NaN	NaN	NaN	-5463
	2015 m6	404333	1.05	-11017	10592
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	2015 m11	NaN	NaN	NaN	-5239
	2015 m12	407011	1.05	-21856	4923
	2016 m1	NaN	NaN	NaN	4679
	2016 m2	NaN	NaN	NaN	-8139
	2016 m3	407760	1.05	-7684	-18552
	2016 m4	NaN	NaN	NaN	-6752
	2016 m5	NaN	NaN	NaN	-4255
	2016 m6	409049	1.05	-5821	14588
	2016 m7	NaN	NaN	NaN	408
	2016 m8	NaN	NaN	NaN	-7302
	2016 m9	411371	1.06	-35260	-17864
	2016 m10	NaN	NaN	NaN	-2313
	2016 m11	NaN	NaN	NaN	-11673
	2016 m12	413365	1.06	**-12452**	6243
	2017 m1	NaN	NaN	NaN	5474
	2017 m2	NaN	NaN	NaN	-10701
15-Apr-17	2017 m3	NaN	NaN	NaN	**-21534**

The now-casting problem

		GDP	GDP-DEFLATOR	BALANCE	CASH BALANCE
	2015 m1	NaN	NaN	NaN	-1361
	2015 m2	NaN	NaN	NaN	-10781
	2015 m3	405419	1.05	-15659	-17719
	2015 m4	NaN	NaN	NaN	-11521
	2015 m5	NaN	NaN	NaN	-5463
	2015 m6	404333	1.05	-11017	10592
	2015 m7	NaN	NaN	NaN	3480
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	2016 m10	NaN	NaN	NaN	-2313
	2016 m11	NaN	NaN	NaN	-11673
	2016 m12	413365	1.06	-12452	6243
	2017 m1	NaN	NaN	NaN	5474
	2017 m2	NaN	NaN	NaN	-10701
15-Apr-17	2017 m3	NaN	NaN	NaN	-21534
	2017 m4	?	?	?	?
	2017 m5	?	?	?	?
	2017 m6	?	?	?	?
	2017 m7	?	?	?	?
	2017 m8	?	?	?	?
	2017 m9	?	?	?	?
	2017 m10	?	?	?	?
	2017 m11	?	?	?	?
	2017 m12	?	?	?	?

Methodology

- We assume that the *levels* of our *N* (=4) variables (collected in the *N*-dimensional vector X_{tm}) are described by the following monthly vector autoregressive process with p (=13) lags:

$$X_{tm} = A_0 + A_1 X_{tm} + \ldots + A_p X_{tm-p} + e_{tm}$$

where A_p is the *N*N* matrix collecting the coefficients of the p-th lag and e_{tm} is a normally distributed multivariate white noise error with covariance matrix $\sum$.

Methodology

- The rich dynamics we want to allow for in our VAR model imply that we face an issue of over-fitting, owing to the large number of parameters (the so-called "curse of dimensionality").

- We address this issue by shrinking the model's coefficients toward those of the naïve and parsimonious random walk with drift model, $X_{i,tm} = \delta_i + X_{i,tm-1} + u_{i,tm}$ (De Mol et al. (2008) and Banbura et al. (2010))

Prior specification

- For Σ, the covariance matrix of the residuals, we use an inverted Wishart with scale parameter given by a diagonal matrix Ψ and d=N+2 degrees of freedom.
- For the constant A_0 term, we use a flat prior.
- For the autoregressive coefficients (A_1 … A_p), we use the Minnesota prior, as originally proposed by Litterman (1980).
- As regards the Minnesota prior, conditional on the covariance matrix of the residuals, the prior distribution of the autoregressive coefficients is normal with:

$E(A_1) = I_N$ while $E(A_2) = \ldots = E(A_p) = 0_{N,N}$
$Cov[(A_s)_{ij},(A_r)_{hm}|\Sigma] = \lambda^2\Sigma_{ih}/(s^2\Psi_{ii})$ if m=j and r=s, zero otherwise.

- We set the value for λ to 0.2, as it suggested in Sims and Zha (1998).

Algorithm

- We tackle the issue of missing data by setting up a recursive procedure that:

  1. Balances the database by providing a draw of the missing data *conditional* on a draw from the posterior of the model parameters;

  2. Provides another draw of the parameters conditional on the previous draw of the variables.

Algorithm

- Recursive algorithm for the panel available in month t_m and forecast horizon *h*:

1. Initialization: $\mathbf{X(0)_{tm}}$ is obtained by interpolating the unbalanced panel by means of standard univariate non-parametric interpolation techniques.

2. First draw of the parameters from their posterior distribution, conditional on initialization of the variables: $\mathbf{A(1)_0}$ ... $\mathbf{A(1)_p}$.

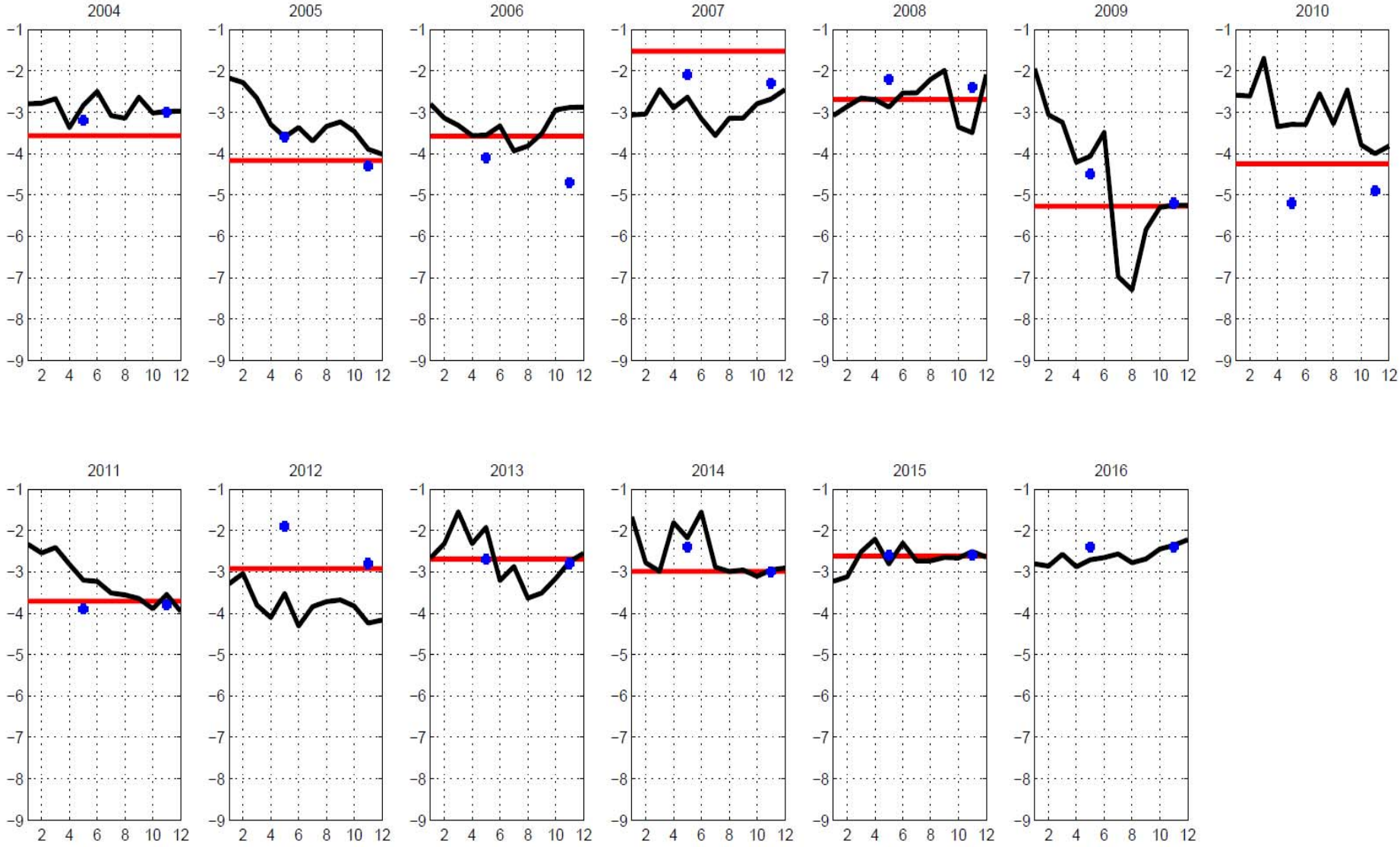
3. First draw of the past, present and future of the variables from the distribution of their conditional expectation, conditional on $A(1)_0$ ... $A(1)_p$: $\mathbf{X(1)_0}$... $\mathbf{X(1)_{tm}}$... $\mathbf{X(1)_{tm+h}}$ by means of the simulation smoother of Carter and Kohn (1994).

4. Second draw of parameters from their posterior distribution, conditional on previous draw of the variables conditional on $X(1)_0$... $X(1)_{tm}$: $\mathbf{A(2)_0}$ ... $\mathbf{A(2)_p}$.

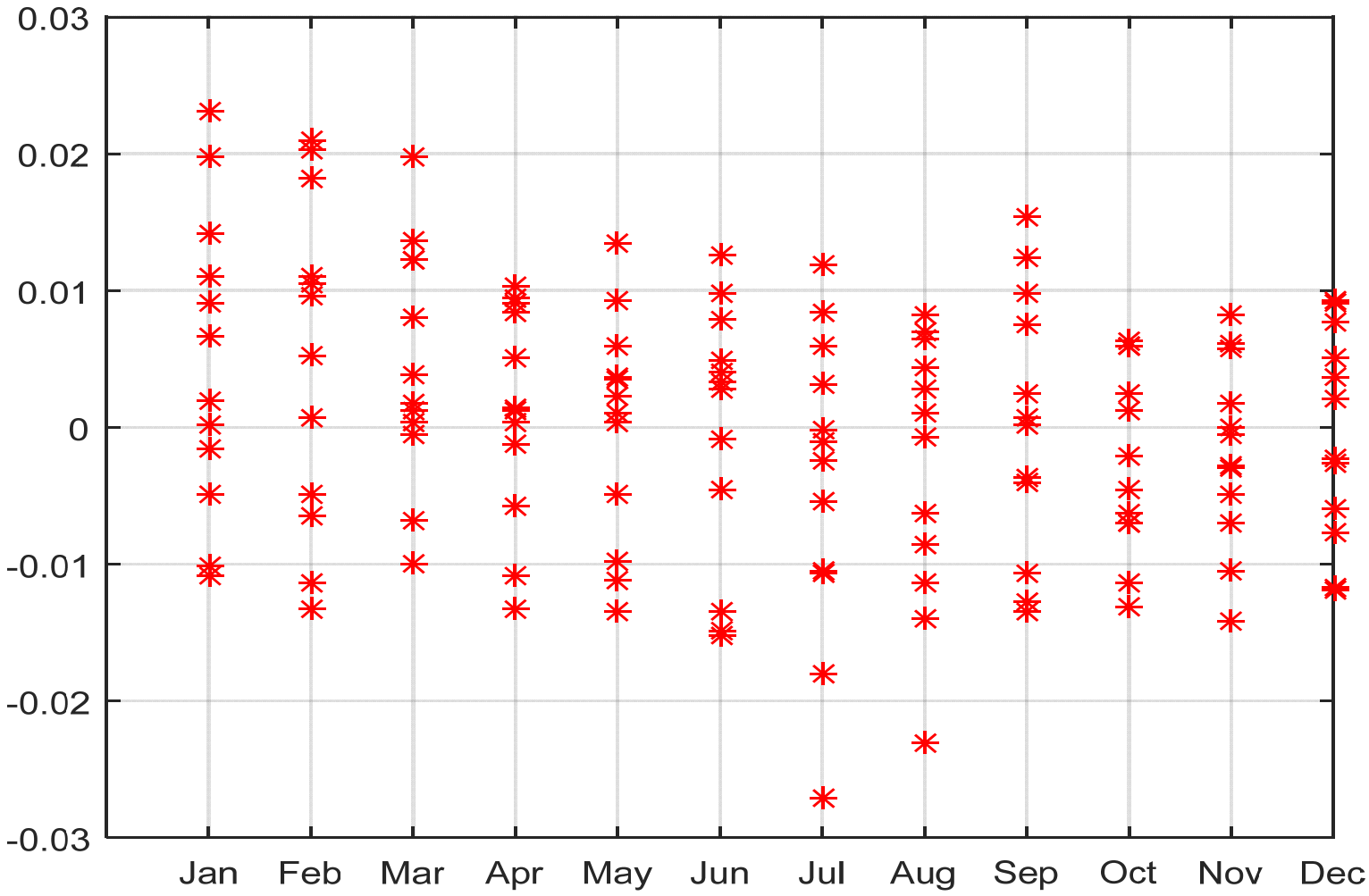
5. Second draw of the past, present and future of the variables from the distribution of their conditional expectation, conditional on $A(2)_0$ ... $A(2)_p$: $\mathbf{X(2)_0}$... $\mathbf{X(2)_{tm}}$... $\mathbf{X(2)_{tm+h}}$ by means of the simulation smoother of Carter and Kohn (1994).

6. Iterate 4 and 5 *M* times.

Results



Forecast errors over the 12 months



Conclusions

- This paper describes a methodology to extract information from monthly cash data in order to now-cast the annual budget balance ratio to GDP.
- The methodology we propose is able to handle both staggered data releases and missing data in the estimation sample in a unified framework and its outcome is the predictive distribution of the budget balance ratio.
- Our empirical application, in this paper, is on Italian data. We provide quite an accurate account of the Italian budget balance to GDP ratio, which allows us to conclude that our model is able to successfully extract information from the noisy cash flow data.

Ongoing work

- Apply to other countries (e.g. EA big-5 and the US)
- Evaluation of density forecasts; extend evaluation also to forecasts and back-casts
- Extension of the cross-section of data in order to improve forecast accuracy (for example, including monthly surveys to better forecast GDP)
- Perform a truly real-time exercise and forecast comparison (IMF, EC, OECD).

Thank you

Greece: planned vs. realized budget balance (% of GDP)