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The Nowcasting Lab

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Abstract

The Nowcasting Lab is an automated code-database-website environment for GDP nowcasting. It generates nowcasts and one-quarter ahead forecasts for quarterly GDP growth of currently 12 European countries and the euro area using several nowcasting models and a large set of data. The projections are updated daily and are released on a website. The website also provides detailed additional information such as the outcomes of the different models, the forecast changes from day to day, the forecast impacts of new data and past projection errors. All information about the models, methods and data is made transparent. Applied forecasters can use the website as an extended arm for their work. The daily projections and the input data are stored in a real-time database. Researchers can use the database for real-time forecasting exercises.

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1 Introduction

Macroeconomic news generate a high level of public attention. When unexpected economic or political events occur, people want to know what this means for the state of the economy today and in the future. They want to know this as soon as possible, also because new events might occur already tomorrow. Unfortunately, the public does not directly benefit from the tremendous progress that has been made in macroeconomic research on nowcasting and short-term forecasting over the past 15 years. Research institutes, central banks, international organizations and financial sector companies mostly use their forecasting models internally. The resulting projections are usually published at a monthly, quarterly or half-yearly interval only. With few exceptions, no reference is made to which models were actually used.

In this paper, we document the Nowcasting Lab project, which delivers up-to-date GDP projections to the public. We project, in an automated process, the quarter-on-quarter GDP growth rate of the following countries: Germany, United Kingdom, France, Italy, Spain, the Netherlands, Switzerland, Poland, Sweden, Belgium, Austria and the euro area. The projections are updated three times a day. They are made for the current quarter (nowcast) and the upcoming quarter (one-step ahead forecast). We employ the following forecasting models: a mixed-frequency dynamic factor model following Bańbura et al. (2011), a mixed data sampling (MIDAS) model along the lines of Ghysels et al. (2007) and Clements and Galvão (2008), an unrestricted MIDAS model following Foroni et al. (2015) and a Bridge as described in, e.g., Schumacher (2006). These models are widely used by forecasting practioners and/or are well established in the nowcasting literature, which is why we chose them for the Nowcasting Lab. The models are fed with around 250 daily and monthly macroeconomic and financial time series

for each country. An initial variable selection is made via elastic net following Zou and Hastie (2005). Further, the forecast algorithm includes a forecast pooling following Timmermann (2006). The projections (pooled across all forecasting models and separately for each model) are made available on a website. The website also shows the update history, the impact of new data releases on the projections, past projection errors, forecast distributions, the contributions of different variable categories to the forecasts, uncertainty and risk measures, and other details. The information is presented in graphs, charts, and tables to make it easily digestible.

The Nowcasting Lab aims to be an interface between the academic forecasting research on the one side, and forecasting practioners as well as a wider public on the other. The overview section of the website is for analysts, decision makers, journalists and all those who want to have a quick look at the latest information on the current and future economic situation. The detail section of the website is for researchers, forecasting practitioners and analysts in, e.g., central banks, international organizations, research institutes, banks and other financial market companies. These persons usually have a great deal of knowledge about forecasting models and data, but they often lack the time to maintain up-to-date big data forecasting models for all the economies they monitor. The Nowcasting Lab supports their work.

Furthermore, the Nowcasting Lab aims to be a platform for empirical research on macroeconomic nowcasting and short-term forecasting models. The database collects new time series releases for the aformentioned countries each night and stores them in daily vintages. As a consequence of this updating process, we assemble a massive and ever increasing real-time database of daily, weekly and monthly macroeconomic time series. The daily GDP projections resulting from

the aforementioned models are also part of the real-time database. The database can be used for future research. In addition, since the Nowcasting Lab is coded in a modular form, new forecasting models can be easily integrated. Also, the environment can be extended to projecting other variables than GDP. Thus, the Nowcasting Lab is an ideal facility for testing new forecasting models in real time.

The remainder of this preliminary version of the paper presents the structure of the Nowcasting Lab.

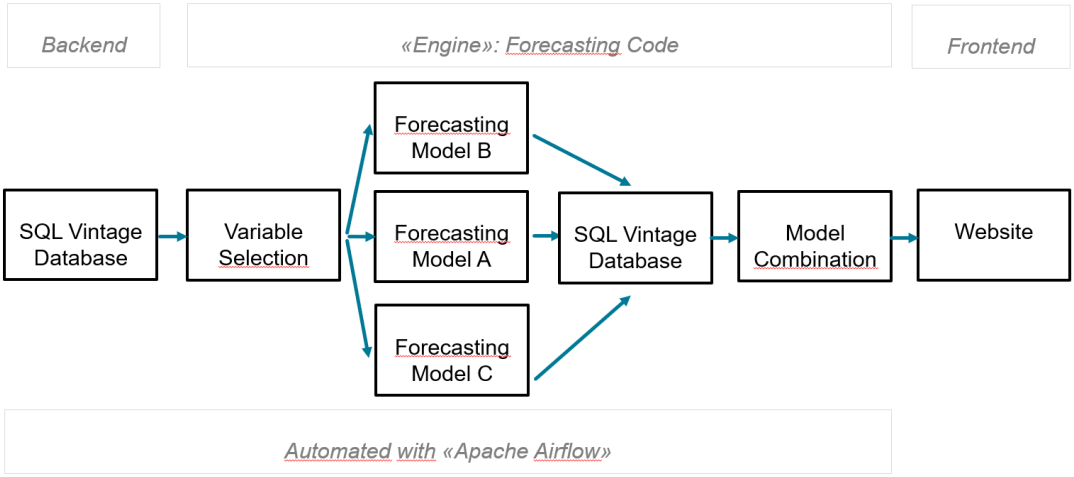
2 The Structure of the Nowcasting Lab

The Nowcasting Lab consists of three interrelated parts: the code that contains the forecasting models, the real-time database from which the forecast models are fed and into which the projection output is read, and the website that presents the projection output and various meta-information. In this section, we present the three parts. In addition, we describe the employed data, the interfaces between the parts and the overall automatic control provided by an Apache Airflow process. Figure 1 provides an initial overview of the entire Nowcasting Lab structure.

2.1 The Data

We compile a large set of daily, weekly, monthly and quarterly macroeconomic, sectoral and financial time series ("indicators"). We currently use around 3000 indicator series in total (or around 250 series by country). All data come from ourselves or from Macrobond, a meta-provider that compiles a wide range of data sources. By using a single data provider, we ensure an efficient and automatic data update process.

Figure 1: Structure of the Nowcasting Lab



Notes: The figure shows an overview of the Nowcasting Lab structure.

We boost the dataset by applying multiple transformations to all variables: level, month-on-month growth rate, 3-month-on-3-month growth rate, year-on-year growth rate, 1-month absolute change, 3-month absolute change and 1-year absolute change. The dataset is further doubled by including trend adjusted variants of all aforementioned transformations. The trend adjustment is done by subtracting the moving average over the past year from each time series observation. In turn, we sort out variables or variable transformations with presumably weak predictive content by applying the elastic net method following Zou and Hastie (2005).

2.2 The Forecasting Models

According to our reading of the literature, four classes of nowcasting models are nowadays standard both among forecasting practioners as well as in academic research.[1] The models classes are: mixed-frequency dynamic factor models (MF-DFMs), mixed-data sampling (MIDAS) models, Bridge equation models, and un-

[1] A fifth model class is the Bayesian mixed-frequency VAR, which is increasinly used for nowcasting.

restricted mixed-frequency models. The Nowcasting Lab implements four models, one of each class: the MF-DFM of Bańbura et al. (2011) in a single-factor version, the autoregressive single-predictor MIDAS model as described in Clements and Galvão (2008), the single-predictor Bridge equations model as described in Schumacher (2006), and the autoregressive single-predictor U-MIDAS of Foroni et al. (2015). The Nowcasting Lab is coded in a modular form. This makes it easy to integrate new forecasting models in the future.

Following common practice in the literature, we refrain from (U-)MIDAS models and Bridge equation models with multiple predictor variables. Instead, we include always only one predictor variable at a time into a model and then pool the forecasts stemming from all individual models using a forecast combinations approach. Specifically, we a apply a two-step weighted averaging forecast combinations procedure based on the mean square forecast error performance of the past four quarters as described in Kuzin et al. (2013) (see also Stock and Watson, 2004). First, forecasts stemming from all individual-predictor models are pooled separately for the MIDAS model type, the Bridge equation model type and the U-MIDAS model type, respectively. Second, the resulting pooled forecasts are pooled again in the same manner over all four models types (MIDAS, Bridge, U-MIDAS and DFM) to get an overall forecast.[2]

2.3 The Real-Time Database

For data storage, we use a PostgreSQL database, an open-source relational database management system. The database is equipped with a vintage data system to store real-time data. All time series that we use to produce the forecasts are

[2]The single-factor MF-DFM generates one forecast and, hence, does not necessiate forecasting pooling. Consequently, the forecast stemming from this model enters only in the second pooling step.

stored in the real-time database, along with meta-information such as when the series were updated. Previous data states are kept in the vintage data system. This allows to replicate the data state that a forecaster had at each day since the beginning of the data collection, both in terms of data availability and data revisions. Thus, a large and ever increasing real-time database for daily, weekly, monthly and quarterly macroeconomic, sectoral and financial time series is created over time.

To allow reproducibility of the forecasts, in addition to the daily input data storage, the codes used to generate the forecasts will be stored on a GitLab repository. This makes is possible to reproduce old predictions even if the working models have been adjusted over time. Last, the forecast output gets also stored in the vintage database. Past forecasts can thus be evaluated quickly and easily, for example to better assess the forecast quality of particular model specifications or predictor variables and to optimize future models.

2.4 The Website

The website `www.nowcastinglab.com` presents, for several European countries and the euro area, quarter-on-quarter GDP growth forecasts for the current quarter (nowcast) and the upcoming quarter (one-step ahead forecast) as well as various additional information.[3] The following countries are currently included: Germany, United Kingdom, France, Italy, Spain, the Netherlands, Switzerland, Poland, Sweden, Belgium, Austria and the euro area. A direct linkage of the website with the database ensures that forecast updates appear immediately on the website (see Section 2.5). The website is divided into two parts, which will be discussed in turn.

[3]The website is also available unter `www.nowcasting-lab.com`, `www.nowcasting-lab.ch` and `www.nowcastinglab.ch`.

The overview part of the website provides a quick overview. It presents in graphical form the current GDP projection for the aformentioned countries (see Figure 2). A drop-down menu allows to select the target period of the projection, i.e. either the nowcast or the one-quarter ahead forecast. The user can also select old target periods, i.e. quarters for which GDP has already been published. She can thus inquire the forecast updating process and the eventual forecast error for past GDP releases. The overview part further includes a graph showing the update history of a country's current GDP projection, where the country can be selected by another drop-down menu.

The user can choose on the overview page for which country and for which target period she wants to open a detail page (see Figure 3). Any number of detail pages can be opened side by side. The detail page is for forecast practioners, analysts and researchers. It contains the following elements:

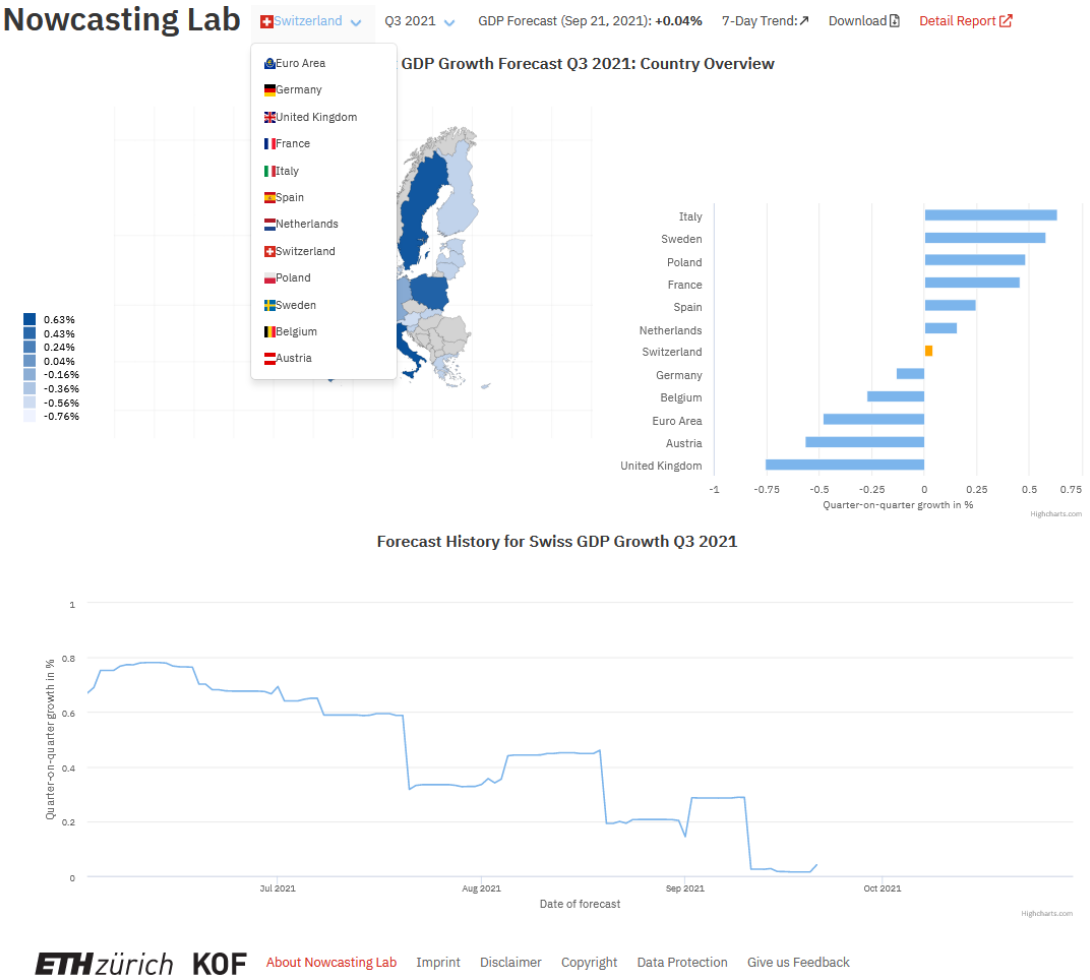
1. Headline elements showing the current projection along with a precision measure (mean squared forecast error of the last 12 periods), a forecast interval, and a measure of upside/downside risk (Pearson skewness measure).

2. A time series plot showing how the projection has evolved from day to day since the start of the projection 6 months before the GDP release.

3. A stacked bar chart showing either the forecast contributions or the forecast impacts (i.e. the changes in contributions from the previous day) of different variable categories. A switch allows to change from the contribution chart to the impact chart and vice versa.

4. A histogram showing the frequency distribution of the projections across all individual predictor variables. Pooling of the individual forecasts then

Figure 2: Overview Part of the Nowcasting Lab Website



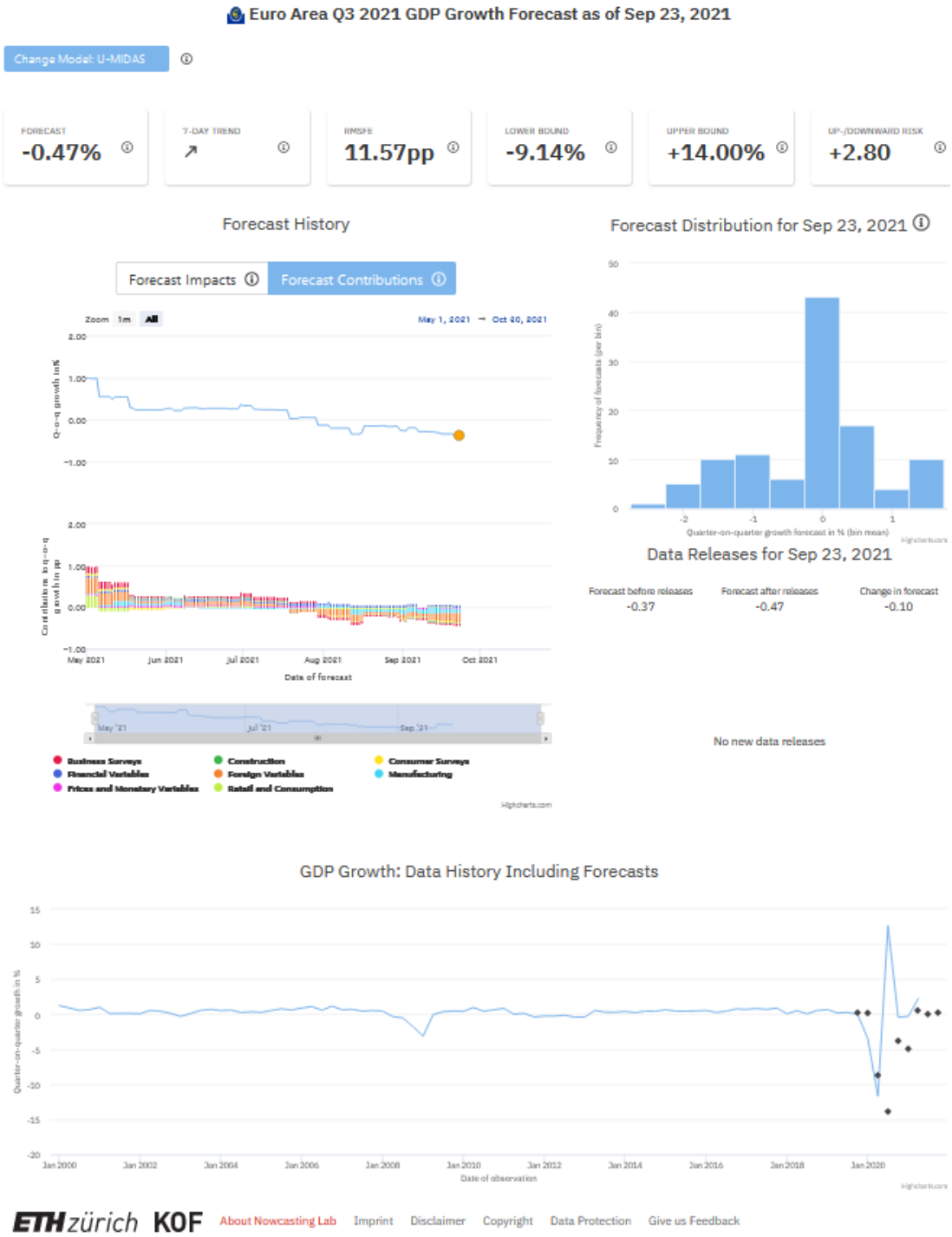
Notes: The figure shows the overview part of the website `www.nowcastinglab.com`.

yields the overall forecast (see Section 2.2).

5. A release calendar that shows the new data releases for each day and displays their impact on the projection. By clicking on a data release a popout window opens, which provides a careful description of the series (title, variable description, variable category, original source, release date, reference period, unit, current value, and previous value).

6. A graph showing the historical GDP development as well as the current and past projections for the selected country.

Figure 3: Detail Part of the Nowcasting Lab Website



Notes: The figure shows the detail part of the website `www.nowcastinglab.com`.

Importantly, the detail page includes a switch button where the user can select either one of the four model types (DFM, MIDAS, Bridge, U-MIDAS) or the pooled projections across all models types. The six aforementioned elements are displayed for the selected model type or, if selected, for the pooled projections. This feature allows to compare the projections of the different models.

2.5 Automated Workflow Managament

The entire code-database-website environment is managed by an Apache Airflow system. It automatically checks for new data releases three times a day. It is also possible to issue inbetween-updates manually. This feature is useful when important data releases occur and one wants to know their impact on GDP projections immediately. Once a new data release is detected, three consecutive steps are executed: the real-time PostgreSQL database is enlarged by a new data vintage, the full forecasting algorithm is executed and the updated projections are written into the new vintage of the database. Each time the website is accessed by a user, it loads always the most actual vintage from the database. Thus, the user can see projection updates shortly after a new data release.

2.6 Interfaces

The real-time PostgreSQL database, the forecasting algorithm and the website communicate with each other via interfaces.[4] These interfaces are themselves managed by the Apache Airflow system. The raw data and accompanying meta-information are loaded from the database into the forecasting algorithm via SQL queries. The output of the forecast algorithm is then written back to the database in form of tables. These tables contain the necessary information for the different parts (graphs, figures etc.) of the website. The communication between the

[4]The forecasting algorithm is written in Matlab and is stored on a separate server at ETH Zurich.

website and the database is fully automatic, using Application Programming Interfaces (APIs). Whenever a user retrieves the website, the latest state of the database is delivered to the website in machine-usable form via the APIs.

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