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A comparison of MIDAS and bridge equations[☆]

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ABSTRACT

This paper compares two single-equation approaches from the recent nowcasting literature: mixed-data sampling (MIDAS) regressions and bridge equations. Both approaches are suitable for nowcasting low-frequency variables such as the quarterly GDP using higher-frequency business cycle indicators. Three differences between the approaches are identified: (1) MIDAS is a direct multi-step nowcasting tool, whereas bridge equations provide iterated forecasts; (2) the weighting of high-frequency predictor observations in MIDAS is based on functional lag polynomials, whereas the bridge equation weights are fixed partly by time aggregation; (3) for parameter estimation, the MIDAS equations consider current-quarter leads of high-frequency indicators, whereas bridge equations typically do not. To assist in discussing the differences between the approaches in isolation, intermediate specifications between MIDAS and bridge equations are provided. The alternative models are compared in an empirical application to nowcasting GDP growth in the Euro area, given a large set of business cycle indicators.

1. Introduction

In policy institutions such as central banks, nowcasting GDP growth is an important way of informing decision makers about the current state of the economy. Nowcasting models typically consider specific data irregularities: whereas GDP is sampled at a quarterly frequency and only with a considerable delay, many business cycle indicators are available at higher frequencies and in a more timely fashion; for example, monthly industrial production or high-frequency financial data. Policy analysts want to exploit this data for nowcasting in the most efficient way possible without a loss of information. Thus, methods for nowcasting should be able to tackle these data irregularities. This paper compares two single-equation approaches for nowcasting: (1) Mixed-data sampling (MIDAS) regressions and (2) bridge equations.

In MIDAS regressions, the observations of the low-frequency variable are related directly to lagged high-frequency observations of the predictors without time aggregation. If the differences in sampling frequencies are huge, functional lag polynomials are employed in order to ensure that the number of parameters to be estimated remains small. In this case, non-linear least squares (NLS) is used for parameter estimation, as outlined by Ghysels, Sinko, and Valkanov (2007). If the difference in sampling frequencies between the explained low-frequency variable and the high-frequency predictors is not too large (for example, given quarterly and monthly data), unrestricted linear polynomials have been considered in the literature as well, by Foroni, Marcellino, and Schumacher (2015). These polynomials can be estimated by ordinary least squares (OLS). Whereas MIDAS has been used initially for financial applications, by Ghysels, Santa-Clara, and Valkanov (2005, 2006) for example, it has been employed recently in many applications as a macroeconomic forecasting tool for quarterly GDP, starting with Clements and Galvão (2008, 2009). Recent contributions include those of Andreou, Ghysels, and Kourtellos (2013), Duarte

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(2014), Drechsel and Scheufele (2012a), Ferrara, Marsilli, and Ortega (2014), Foroni et al. (2015), and Kuzin, Marcellino, and Schumacher (2011), amongst others. Recent surveys include those by Andreou, Ghysels, and Kourtellos (2011) and Armesto, Engemann, and Owyang (2010).

Bridge equations are also dynamic, but the variables on both sides of the equation are low-frequency variables. In particular, for nowcasting the quarterly GDP, the explanatory variables on the right-hand side of the equation are quarterly lags of the predictor. These quarterly observations are typically obtained from time aggregation of the high-frequency observations of the predictor. The bridge equations can be estimated by ordinary least squares (OLS). To make nowcasts, the predictors are themselves predicted using an additional high-frequency model, such as an autoregressive (AR) model. The high-frequency forecasts from this model are then aggregated over time to the quarterly frequency and plugged into the bridge equation. Due to this simple estimation method and their transparency, bridge equations are used widely in policy organizations, and central banks in particular. Applications in the literature include those by Angelini, Camba-Mendez, Giannone, Reichlin, and Rünstler (2011), Baffigi, Golinelli, and Parigi (2004), Bulligan, Golinelli, and Parigi (2010), Bulligan, Marcellino, and Venditti (2015), Camacho, Perez-Quiros, and Poncela (2014), Diron (2008), Foroni and Marcellino (2013), Foroni and Marcellino (2014), Golinelli and Parigi (2007), Hahn and Skudelny (2008), Ingenito and Trehan (1996), and Rünstler et al. (2009), amongst others. Applications of bridge equations to nowcasting in central banks are documented by ECB (2008), Bundesbank (2013), and Bell, Co, Stone, and Wallis (2014) from the Bank of England.

In this paper, the relationship between MIDAS and bridge equations as nowcasting tools is investigated in detail. In the literature, a few comparisons of the two approaches can be found, see for example Foroni and Marcellino (2013). This paper expands on this body of literature by providing analytical results to explain the differences between MIDAS and bridge equations. This is possible because MIDAS and bridge equations both belong to the class of distributed-lag models extended to mixed-frequency data. Three conceptual differences between the two model classes are established. (1) In the applications cited above, MIDAS is a direct multi-step forecasting tool, whereas bridge equations are mostly based on iterated multi-step forecasts from an additional high-frequency model; see Bhansali (2002) for a discussion of direct versus iterative forecasting. (2) MIDAS employs an empirical weighting of high-frequency predictor observations, often based on functional lag polynomials, whereas bridge equations are based partly on fixed weights stemming from statistical time-aggregation rules. The different weighting schemes also imply different estimation methods, namely OLS for bridge equations and unrestricted MIDAS polynomials, but NLS for MIDAS equations based on non-linear functional lag polynomials. (3) Finally, MIDAS can consider current-quarter observations of the high-frequency indicator in the mixed-frequency equation, whereas bridge equations typically contain only contemporaneous or lagged observations of the indicator.

To assess the influences of each of these differences, an intermediate model between MIDAS and bridge equations, called iterative MIDAS (MIDAS-IT), is derived. This approach differs from the bridge equation only in its use of a different weighting scheme for the high-frequency observations on the right-hand side, and from standard MIDAS in its iterative solution of the model for nowcasting. Further model variants arise from different assumptions regarding leading terms of the indicators. Highlighting the differences between the approaches could help practitioners in making modelling decisions in a class of regression-based models for nowcasting with mixed-frequency data that have been discussed mostly in isolation in the recent literature.

To illustrate the differences between MIDAS and bridge equations, the two are compared in an empirical nowcasting exercise for Euro area GDP, where the evaluation period covers the years following the Great Recession. The predictor set comprises a large number of monthly indicators. Different specifications of MIDAS and bridge equations with single indicators are evaluated.

The paper proceeds as follows: Section 2 describes the MIDAS and bridge equations and how they can be used for nowcasting. Section 3 provides the analytical comparison of MIDAS and bridge equations, and discusses alternative models that link the two core approaches. In Section 4, the results of the empirical nowcasting exercise are discussed. Section 5 concludes.

2. MIDAS and bridge equations for nowcasting

The focus in this paper is on quarterly GDP growth, which is denoted as y_t, where t is the quarterly time index $t = 1, 2, \dots, T_y$, with T_y being the final quarter for which GDP data are available. The aim is to nowcast or forecast the GDP for period $T_y + h$, yielding a value for y_{T_y+h} with horizon $h = 1, \dots, H$ quarters.

In this context, nowcasting means that, in a particular calendar month, GDP for the current quarter is not observed. It can even be the case that GDP is available only with a delay of two quarters. In April, for example, the Euro area GDP is only available for the fourth quarter of the previous year, and a nowcast for the second quarter GDP requires $h = 2$. Typically, the GDP figure for the first quarter is published in mid-May. Thus, if a decision-maker requests an estimate of the current, namely second, quarter GDP in April, the horizon has to be set sufficiently large. Further information and details on nowcasting procedures can be found in the survey by Banbura, Giannone, and Reichlin (2011).

In this paper, for simplicity, it is assumed that the information set for now- and forecasting includes one stationary monthly indicator x_t^M in addition to the available GDP observations. The time index for monthly observations is defined as a fraction of the low-frequency quarter according to $t = 1 - 2/3, 1 - 1/3, 1, 2 - 2/3, \dots, T_x - 1/3, T_x$, where T_x is the final month for which the indicator is available, as per Clements and Galvão (2008) and Ghysels et al. (2007). Usually, $T_x \geq T_y$ holds, as monthly observations for many relevant macroeconomic indicators are available earlier than GDP observations for the current quarter. We