Measuring uncertainty for macroeconomic statistics

Keywords: official statistics, uncertainty, signal extraction

1. INTRODUCTION

Statistical offices and other public agencies producing statistics usually communicate a variety of official economic and social indicators in general as single values (normally corresponding to the central point estimate), without explicitly mentioning the associated inherent and unavoidable uncertainty. While the technical documentation associated with official data often acknowledges the possible presence of errors, little is done to communicate widely such features. While it is difficult to derive a valid scientific or professional explanation for this circumstance, Manski (2019) argues that one possible reason for this status quo lies in the partly political nature of official statistics. He argues that policy makers or other public agencies may be incentivised to express strong certitude in their communication rather than providing further information about the underlying and inherent uncertainty. However, conveying strong certitude about data or economic analysis can be harmful for the development of public policies in multiple ways. If policy makers incorrectly believe that existing statistical analyses provide an errorless description of the current state of the economy, they will not take into proper account the underlying uncertainty when taking their decisions. Moreover, communicating official statistics with strong certitude leads to further difficulties because of the way that third parties, especially media, distribute this information to a wider audience, namely by largely taking them at face value, which may lead to further miscommunication. On the other hand, official statisticians are worried by the possibility that showing that statistics are affected by uncertainty could lower their credibility. Furthermore, they consider that uncertainty, especially when it is relatively high, could confuse or even mislead policy makers and analysts. This explains, even if it does not justify completely, the traditional conservative position taken by official statistical agencies. Nowadays things are starting to move, even if slowly, and the attention to all aspects related to the uncertainty in official statistics is progressively growing up within statistical institutions. In such a promising context, also Eurostat has decided in 2019 to play an active role contributing to the measurement and communication of uncertainty in official statistics by launching a new research project within its methodological framework contract labeled ”COMmunicating UNcertainty In Key Official Statistics” (Comunikos) of which this paper presents part of the outcome. This paper aims at presenting an approach to provide quantitative measures of uncertainty associated to macroeconomic statistics using a sound and robust statistical methodology.

2. METHODS

The methodology is based on state space modelling. Such models provide a natural avenue since they permit the presence of unobserved variables that can proxy for the true process that statistical agencies and other policy-making bodies are trying to measure. Such models have an added benefit of allowing for the consideration of particular economic structures that can inform the quantification of conceptual uncertainties. The proposed model is a state space representation of the signal extraction problem following the work of Cunningham et al (2012). Using business surveys and other indirect measures, the model allows for an array of measures of each macroeconomic variable of interest. Then, for each variable of interest, the model comprises alternative indicators, a transition law and separate measurement equations describing the latest official estimates. The model is presented in a vector notation, assuming m variables of interest. However, we simplify estimation by assuming block-diagonal structure throughout the model so that the model can be estimated on a variable-by-variable basis for each of the m elements in turn. Let the m dimensional vector of variables of interest that are subject to data uncertainty at time t be denoted by yt , t = 1,…,T. The vector $\mathbf{y}_t$ contains the unobserved true value of the economic concept of interest. The model for the true data $\mathbf{y}_t$ is given by

$$\mathbf{y}_t = \mu + \sum \mathbf{A}_i \mathbf{y}_{t-i} + \varepsilon_t,$$

$\mathbf{A}_1, \ldots, \mathbf{A}_q$ are $m \times m$ matrices, $\mathbf{A}(L) = \mathbf{I}_m - \mathbf{A}_1 L - \ldots - \mathbf{A}_q L^q$ is a lag polynomial whose roots are outside the unit circle, μ is a vector of constants, $\varepsilon_t = (\varepsilon_{1t}, \ldots, \varepsilon_{mt})'$ and $E(\varepsilon_t \varepsilon_t') = \Sigma_\varepsilon$, where we denote the main diagonal of Σ_ε by $\sigma^2_\varepsilon = (\sigma^2_{\varepsilon 1}, \ldots, \sigma^2_{\varepsilon m})'$. We further assume that $\mathbf{A}_1, \ldots, \mathbf{A}_q$ are diagonal. Let $\mathbf{y}_t^{t+n}$ denote a noisy estimate of $\mathbf{y}_t$ published by the statistical agency at time $t + n$, where $n = 1, \ldots T - t$. The model for these published data is

$$\mathbf{y}_t^{t+n} = \mathbf{y}_t + \mathbf{c}^n + \mathbf{v}_t^{t+n}$$

where $\mathbf{c}^n$ is the bias in published data of maturity n and $\mathbf{v}_t^{t+n}$ the measurement error associated with the published estimate of $\mathbf{y}_t$ made at maturity n. One of the main building blocks of the model is the assumption that revisions improve estimates so that official published data become more accurate as they become more mature. Reflecting this assumption, both the bias in the published estimates and the variance of measurement errors are allowed to vary with the maturity of the estimate - as denoted by the n superscript. The constant term $\mathbf{c}^n$ is included in equation (2) to permit consideration of biases in the statistical agency's data set. Specifically, $\mathbf{c}^n$ can be modelled as

$$\mathbf{c}^n = \mathbf{c}^1 (1 + \lambda)^{n-1},$$

where $\mathbf{c}^1$ is the bias in published data of maturity $n = 1$ and λ describes the rate at which the bias decays as estimates become more mature $(-1 < \lambda < 0)$. This representation assumes that the bias tends monotonically to zero as the estimates become more mature. The measurement errors, $\mathbf{v}_t^{t+n}$, are assumed to be distributed normally with finite variance. Serial correlation in $\mathbf{v}_t^{t+n}$ is allowed. Concerning the estimation strategy, we mainly use maximum likelihood via the Kalman filter. Fore a more detailes description of model characteristics we refer to Kapetanios et al {3}. The proposed model is very flexible allowing for delivering either confidence intervals or posterior probability densities.

3. RESULTS

3.1. The data

Our application is based on a dataset containing data for 5 key macroeconomic indicators: Harmonized Index of Consumer Prices (HICP), Industrial Production index (IPI) Retail Trade Volume Index (RTI), Unemployment Rate (UR) and Gross Domestic Product in volume (GDP) for the Euroarea and its 4 major countries: Germany, France, Italy and Spain. Data start in 2000 with vintages available from March 2018 to March 2019 (13 vintages or releases). Then, we have created a quarterly dataset taking for each monthly variable the average of the 3 months of a given quarter. Data were further transformed in quarterly growth rates except for the UR, which was transformed into a quarterly difference.

3.2. Some findings

As a first consideration, the HICP is almost never revised while the RTI is the most often revised indicator among those considered. Over the 2000-2018 sample, the data for GDP show the mean growth rate to have been highest for Spain and lowest for Italy, with the growth rate for the Euroarea, Germany and France being in between, and quite similar to each other. The data for France have the lowest volatility over the period, with the data for the other countries up to twice as volatile. The data for all countries show a skew to the downside, reflecting the great recession, with the downside skew greatest for Germany, and smallest for Spain. Out of the monthly series, IP and RTI are shown to be somewhat more volatile than GDP, even when considered at the quarterly frequency. In broad terms, the patterns across the countries are similar to what is observed for GDP, with the exception of the volatility of RTI growth, which turns out to be higher in the case of Spain than for the other countries. In contrast to GDP growth, which has been positive on average over the 2000-2018 sample for all countries, the growth rates of IP and RTI have not been positive on average for all the countries. IP growth has been negative on average over the sample for Italy, Spain and France, and RTI growth for Italy and Spain, what might be an indication of a shift in activity from industry and retail trade to other parts of the service sector. The UR, finally, has declined on average over the sample in the cases of Germany and the Euroarea, increasing for the cases of Italy and Spain, and unchanged for France. As GDP growth, the changes in the UR are shown to have the lowest volatility over the sample in the case of France. The highest volatility is recorded in the case of Spain, even though the volatility of real GDP growth for that country has been the lowest across the countries.

In terms of revisions, the data suggest that the average revision is of the same order of magnitude for the (quarterly) growth rate of real GDP and RTI, while revisions to the IPI growth rate have tended to be somewhat larger on average, at least for the Euroarea, Germany and France. The volatility of the revisions is quite similar across the countries, with exceptions to the upside for IPI for Italy and Spain, and RTI for Germany. When applying our modelling strategy, due to the limited number of releases we set the initial error variance to 1, the parameter beta in serial correlation to -0.2 implying an AR(1) process for v(t+1). Initial bias in the statistical agency's data set and bias decay were both set to zero, as based on an earlier study by Cunningham et al {2} for UK data. We have experimented with the decay parameter delta, setting it to -0.01 and 0.05 and with the correlation of the measurement errors with the underlying state of the economy. The correlation was set to -0.5; 0 and 0.5 in turn. The results show that delta=-0.05 and rho=-0.5 perform best in describing the revisions in inflation, GDP for all countries and retail trade for all countries but Spain as measured by Mean Squared Error of the final release and the filtered estimate. For industrial production the same combination of variables performs best for Germany and Italy, while for the remaining three countries moving to a slower decay of delta=-0.01 provides better results. In the case of unemployment the no correlation case for delta=-0.05 works best for all countries but Spain for which delta=-0.01. What is interesting to note about those results is that with respect to the correlation of the measurement error, the best-performing specification is the same (rho=-0.5) for the variables expressed as growth rates - GDP, IP and RTI - and another (rho=0.0) for the UR, expressed as a simple difference, and irrespective of the decay parameter (whether delta=-0.05 or -0.01). This supports the notion that variables tend to display different patterns of data uncertainty, and therefore require different treatment for data uncertainty, depending on whether they are stationary or trending.

4. CONCLUSIONS

This short paper synthetically describes a model for measuring uncertainty in macroeconomic statistics together with some empirical results.

REFERENCES

[1] Charles F Manski. Communicating uncertainty in policy analysis. Proceedings of the National Academy of Sciences, 116(16):7634–7641, 2019.

[2] A. Cunningham, J. Eklund, C. Jeffery, G. Kapetanios, and V. Labhard. A state space approach to extracting the signal from uncertain data. Journal of Business and Economic Statistics, 30:173–180, 2012.

[3] G. Kapetanios, M. Marcellino, Felix Kempfs, g. L. mazzi, Jana Eklund Vincent Labhard Measuring and communicating uncertainty: status of the art and perspectives. Statistical working paper collection Eurostat 2020 forthcoming