ESM SEMINAR STOCHASTIC DSA SESSION – 30 NOVEMBER 2023

Session 2: Mapping risks to the Stochastic DSA fan charts

The session focused on the role of stochastic models in the debt sustainability framework, and in particular on how these models can complement scenario analysis by modelling uncertainty over the medium term. The session was chaired by Marialena Athanasopoulou and included interventions from Luca Zavalloni (European Stability Mechanism), Philipp Mohl (European Commission), Othman Bouabdallah (European Central Bank) and Manrique Saenz (International Monetary Fund).

The deterministic and stochastic projections are complementary. As part of their medium-term risk assessment, the European Commission stresses the baseline scenario, constructed under the European Commission economic forecasts and a no policy change assumption, through deterministic adverse scenarios and stochastic simulations. The EC's stochastic DSA model is based on a variance-covariance approach, which assumes around 2000 normally distributed shocks, under a no policy change assumption. The risk metrics derived from the fan chart generated by the stochastic simulations include the probability of debt not stabilising within 5 years and the width of the fan chart. The stochastic and deterministic approaches complement each other in terms of complexity, communication to the public, adaptability to the shocks and user expertise required. In the EC's framework the overall DSA risk classification is determined by considering signals from both the stochastic and deterministic simulations through a decision tree.

The ECB relies on the stochastic DSA as a realism check for the baseline projection. The stochastic DSA is one of the three building blocks of the current ECB's DSA framework. Stochastic simulations allow to account for a wider set of shocks and facilitate communication with the public as they provide a probabilistic rather than a clear-cut assessment on debt sustainability, which would require consensus on the target variable and thresholds. The stochastic DSA of the ECB is based on a BVAR model, which is preferred to a variance covariance approach capturing only the static correlation among shocks. The resulting debt-to-GDP fan chart is expected to serve as a realism check for the baseline projection, and is not subject to tilting. Three metrics are derived from the fan chart, namely width, the likelihood of debt not stabilising by T+5, and the probability of debt-to-GDP exceeding 90%. Stochastic simulations can also find application beyond the DSA framework, e.g. assessing the likelihood of a country to comply with the 3% deficit rule.

Experts should pay attention the sensitivity of the fan chart to the assumptions on debt drivers and the challenges of capturing large shocks. The IMF stochastic DSA fan chart is based on the baseline projections of debt drivers prepared by country teams and on random draws from a pool of historical shocks. The resulting historical fan chart is then compared against the baseline projection. If the baseline projection appears to be realistic with respect to the historical fan chart, the stochastic DSA fan chart is centred around the baseline. However, if the baseline projection is optimistic by historical standards, an asymmetric fan chart, accounting for greater downside risk, is produced. A risk index is constructed based on three metrics, including the probability of debt not stabilizating, the width of the fan chart and the terminal debt level interacting with an index of institutional quality. The assumptions on debt drivers play a key role not only in determining the baseline scenario, but also in the tilting of the historical fan chart. Stochastic DSA models may show limitations in capturing mean reversion after large temporary shocks.

The ESM Stochastic DSA: An asymmetric fan chart is generated by reconciling BVAR simulations with the baseline projection. The ESM's stochastic DSA model follows a two-step process. In the first step, stochastic simulations are derived for each debt driver from a BVAR model, based on the Villani 2009 approach, which allows to specify priors on the long term mean of the model. In the second step, while retaining the support of the distribution from the BVAR, the probability density of the unconditional forecasts obtained in the first step is shifted to ensure the mode of the distribution is centred around the baseline projection, by parametrizing a two-part normal distribution. This approach allows to generate a skewed fan chart for each debt driver, which assumes the baseline projection remains the most likely scenario while capturing the direction of risks suggested by historical correlations.

Preliminary back-testing results indicate good predictive power of market distress episodes. Using in-sample forecasts, the ESM's stochastic DSA model was back-tested over 16 Euro area countries from 2011 to 2020. Three metrics are derived from the fan charts, including width, the probability of debt stabilising at T+5 and the skewness multiplied by the terminal debt level. By defining crisis episodes as those where the spread exceeds 350 bps for at least a quarter, the predictive power of these metrics is tested through Receiver Operating Characteristic curves. A probit index based on the three identified metrics is found to have greater discriminatory power than the metrics in isolation. By calibrating thresholds on the policymaker's preferences over type 1 and type 2 errors, a three-zone risk classification can be derived from the probit index.