Making sense of uncertainty in macroeconomic model

Impact paragraph

Since the Global Financial Crisis, there has been an increased interest in examining uncertainty and its impact on the economy. Empirical studies have shown that uncertainty diminishes economic outputs but macroeconomic models have difficulty in accurately capturing these effects, particularly during recessions. This can be partially attributed to the complex relationship between macroeconomic uncertainty and people's beliefs, as well as the technical limitations of solving and estimating macroeconomic models. This dissertation addresses these two issues, in order to improve our understanding of the economy under uncertainty and enhance the performance of macroeconomic models. The positive implications of this study will not only be felt across the economic literature but are also likely to inform policymakers and ultimately benefit society.

In Chapter 2, we study the effects of macroeconomic uncertainty on individual expectations of income and GDP growth using four panel datasets of professional forecasters and households. We quantify these expectations by the mean and subjective uncertainty of the forecast distributions provided by survey respondents. Our findings suggest that people become more pessimistic when macroeconomic uncertainty rises, but they can either be more uncertain or more certain about their beliefs. This chapter makes two main contributions to the existing literature. First, we contribute to the body of research on survey-based measures of subjective uncertainty in professional forecasters (Clements, 2014; Giordani & Söderlind, 2003; Glas & Hartmann, 2016; Manzan, 2021) and firms (Altig et al., 2020; Bachmann et al., 2021). We use both simple standard deviation and a fitted Beta distribution as done in Fermand et al. (2023) to measure subjective uncertainty in households. Second, we present direct evidence on the relationship between macroeco-

nomic uncertainty and individual expectations which are assumed in many macroeconomic models. This is significant since the effects of macroeconomic uncertainty on the economy are highly dependent on the mechanisms specific to the models.

Chapter 3 studies a real business cycle model featuring smooth ambiguity preferences based on Altug et al. (2020). The model can reproduce the effects of macroeconomic uncertainty on individual expectations as found in Chapter 2 and other empirical studies. We make two primary contributions to the existing literature. Firstly, while a substantial amount of macroeconomic models have been exploring uncertainty in the form of a time-varying volatility or risk (Born & Pfeifer, 2021; Fernández-Villaverde & Guerrón-Quintana, 2020; Lhuissier & Tripier, 2021), we incorporate uncertainty taking the form of ambiguity. This type of uncertainty has been used in business cycle models by, for example, Bianchi et al. (2018), Ilut and Schneider (2014, 2022) and Altug et al. (2020). We depart from these models as our representative household is uncertain whether the economy will be in recession or normal growth, and macroeconomic uncertainty has asymmetrical impacts on the two scenarios. Lastly, we provide an analytical framework which links the empirical findings to decision-making theories under uncertainty. This framework shows that the smooth ambiguity model can replicate the empirical stylized facts regarding the relationship between macroeconomic uncertainty and individual expectations. Moreover, ambiguity aversion plays an important role in shaping these relationships.

Chapter 4 brings the theoretical discussions in Chapter 3 to real world data. We show that the smooth ambiguity model can fit the output growth data of the U.S. and major European countries better than the benchmark model without uncertainty, especially in recessions. Our estimations also suggest that ambiguity aversion amplifies the effect of macroeconomic uncertainty through individual beliefs which is consistent with the findings in Chapters 2 and 3. This paper contributes to the literature in the techniques of solution and estimation, and the applications of smooth ambiguity models. First, to solve the model, we apply a parameterized expectation algorithm to preserve the nonlinearity in the transmission mechanism. This approach allows us to determine the expectations of the two scenarios without imposing an additional decision rule for each scenario. Second, while smooth ambiguity models have been utilized to fit financial asset returns (Collard et al., 2018; Gallant et al., 2019), their application to estimate macroeconomic variables

has been scarce. We estimate the model by employing nonlinear least squares, minimizing the distance between model-implied and actual output growth. We demonstrate that the level of ambiguity aversion is time-varying and associated with economic crises. To the best of our knowledge, this is the first study that has measured the level of ambiguity aversion utilizing macroeconomic data.

Throughout this dissertation, we gain a deeper understanding of how uncertainty can affect the economy and demonstrate that this can improve the performance of macroeconomic models, especially in times of recession. This can have important contributions to policymaking in three main ways. First, distinguishing the presence of ambiguity or risk can be beneficial in the policymaking process. For instance, Chapter 2 points to the fact that households and professional forecasters respond differently to macroeconomic uncertainty. One of the possible reasons for this could be that households are more exposed to uncertainty in the form of ambiguity, while professional forecasters may not be. This finding could help policymakers to better communicate and explain their decisions to the public, increasing accountability and transparency.

Second, a deeper comprehension of how crises influence individuals can enhance policy effectiveness. In Chapter 4, we find that ambiguity aversion of US representative households remained constant throughout the Dot-com crisis but structurally increased after the Global Financial crisis. This suggests that the expansionary policies which were effective during the Dot-com crisis could be inadequate to address the Global Financial Crisis since people had become more pessimistic on account of heightened ambiguity aversion. This kind of insight could be useful for policymakers in formulating policies more effectively.

Finally, Chapter 3 and 4 demonstrate that the smooth ambiguity model has the potential to be used as a forecasting tool in situations of high uncertainty. Forecasts are essential for monetary policy, as they can give information about future output growth, inflation and unemployment. Central bankers can then use this information to determine appropriate interest rates and other policies to help them achieve their targets.