Macroeconomic Sustainability Scenarios for Europe

As technologies develop at exponential rates and societies change rapidly, it becomes increasingly important for policy makers to have a long-term vision of what the future might hold to steer the policy process rationally and take decisions at the right time and for the right reasons. Such a vision can be created through developing **scenarios** which seek to conceive alternative futures and their potential consequences for all three dimensions of sustainability, the environmental, the social and the economic dimension. Scenarios explore the future through "what if..." statements. They thereby help policy makers to become aware of and explore different development paths subject to the policies they chose. By portraying images of how Europe could look like in the future and how it might get there, scenarios can in an informed and structured way provoke critical thinking and in-depth reflections on the challenges and opportunities that lie ahead.

This being said, rational policy making also requires that the consequences of different policy options are assessed comprehensively. Given the long-term impact of many environmental policies and widespread path-dependence, for instance due to the long lifespan of transport, energy or housing infrastructures, such an assessment must take into account that the future is inherently uncertain and, therefore, cannot be predicted. This uncertainty concerns not only assumptions about important variables such as population trends or energy prices, but the political process itself. Thus political events both within the European Union and beyond its borders are likely to shape, if not constrain the political process and its outcomes. Given that scenarios do not intend to predict future events, but seek to devise plausible stories about how the future might unfold, scenarios can help to explore the consequences of uncertainty and surprise events. Concomitantly, since there are reasons to suggest that available policy options and political framework conditions are interdependent, both must be analysed and formulated together in order to ensure consistency.

Against this background and building on earlier work, the paper develops three possible scenarios for the European Union, referred to as "The Rebound", "Agitated Normality" and "Fortress Europe". These scenarios can be distinguished by different international contexts, but also different institutional, social and economic settings which are both likely to impact sustainability policies. All three scenarios are a follow-up of sorts to the 1999 European Commission report "Scenarios Europe 2010" which was widely acknowledged and distributed at the time and which devised a robust methodology for developing scenarios. Arguably, the scenarios in the 1999 report have not been invalidated by events during the last 15 years of so, and thus can still be used as a starting point in order to produce plausible political scenarios for Europe with a focus on beyond 2020 and a horizon of 2050.

When updating and reviewing the 1999 report by incorporating significant events that have shaped the world since 1999, a special focus was put on exploring the possible implications of these future scenarios on environmental policies. Thus it was checked for each scenario whether or not environmental policies would become easier, whether the scenario would be neutral with respect to such policies or whether environmental policies would be more difficult to devise and implement. On this basis, the scenarios then identify compatible policy options and analyse their impacts for important socioeconomic and environmental variables using **E3ME**, a macro-econometric model of the European Union.

E3ME is a computer-based econometric simulation model of the world's economic and energy systems and the environment. It was originally developed through the European Commission's research framework programmes and has been specifically adapted to simulate sustainability scenarios. The

model is owned by Cambridge Econometrics and has been licensed to the authors. The econometric and empirical grounding of the model makes it well-suited to represent performance in the short to medium terms, as well as providing long-term assessment up until 2050. It also means that the model is not reliant on the rigid assumptions common to other modelling approaches, such as Dynamic Stochastic General Equilibrium (DSGE) Models.

The current version of E3ME covers:

- Europe at Member State level (incl. Croatia)
- three other EU candidate countries, Norway and Switzerland
- 11 other major economies explicitly
- the rest of the world grouped into political regions

In addition, the model captures 69 sectors of which 38 comprise services.

Being based on three distinct modules for the economy, the energy system and environmental emissions, the model can calculate quantitative scenarios for a rich set of indicators and variables. To do so, the analyst can vary a wide range of policy variables such as taxes or government expenditures in conjunction with assumptions regarding e.g. energy prices or variations of population trends from Eurostat projections.

Economic variables and indicators include output (constant and current price bases), GVA at market prices and factor cost, investment and R&D spending, government final consumption (by category), exports and imports, employment, labour costs and an estimate of (real) income distribution (expenditure-based Gini-coefficient) etc. Many of these variables are available at sectoral level. In its **energy modelling**, E3ME can be described as top-down with a bottom-up submodel of the electricity supply sector. More specifically, the energy module in E3ME is constructed, estimated and solved for each energy user, each energy carrier (currently 12) and each region while the power sector in E3ME is represented using a framework for the dynamic selection and diffusion of innovations which contains a decision-making core for investors wanting to build new electrical capacity, facing several options.

The **emissions module** then calculates air pollution generated from end-use of different fuels and from primary use of fuels in the energy industries themselves, particularly electricity generation. Current emissions include carbon dioxide, sulphur dioxide, nitrogen oxides, carbon monoxide, methane and larger particulates. In addition the E3ME model simulates material consumption for each region of the model. At present the following material types are modelled: food and feed, forestry, construction minerals, industrial minerals, ferrous ores and non-ferrous ores.

Based on these specifications of the model and for each of the three aforementioned scenarios, a specific set of policies has been identified, implemented and simulated. Moreover, simulations have also been carried out for different population scenarios in order to assess the sensitivity of the global scenarios with respect to this crucial variable. Preliminary results indicate that changes in population trends exert significant impacts on simulation results and therefore on pathways towards sustainability in Europe.