An Agent-Based Integrated Assessment of Climate and Social Tipping Points

Most climate-economy models have focused exclusively on non-catastrophic damages, where accumulation of carbon in the atmosphere slows down economic growth. Recently, catastrophic events and climate tipping points have achieved an increasing attention in the literature. A climate tipping point is a critical value in the temperature or other environmental variable, after which it is crossed, the catastrophic event may occur. Such catastrophes can cause “large-scale discontinuities”, i.e. abrupt and persistent changes in the climate-economy system.

It has been shown that the inclusion of tipping points intensifies the economic impacts of climate change, resulting in about 50-70% higher estimates of economic damages compared to models with non-catastrophic damages only. The effect is even greater in the presence of multiple climate tipping points. Multiple tipping points occur if crossing the threshold of one tipping point increases the risk of crossing additional tipping points. For instance, Greenland Ice Sheet (GIS) meltdown increases the risk of Atlantic Overturning Circulation (AMOC) collapse.

Despite recent progress in modeling climate tipping points, current economy-climate models are still not well equipped to study multiple social tipping points. A social tipping point describes a critical number of adopters of a new technology, after which its further adoptions are driven by self-reinforcing positive feedback mechanisms. A number of social tipping interventions, which can help reduce carbon dioxide emissions have been identified in the literature, e.g. related to adoption of electric cars or renewable energy. However, current climate-economy are ill-equipped to study them quantitatively. This relates to the fact that their analysis is carried out at the high level of aggregation, i.e. by assuming a representative consumer and aggregate demand. This reduces the complexity of social impacts of climate change to total consumer spending. Yet, social tipping points can affect climate tipping by creating a network of users/adopters of technologies that have a high potential to reduce emissions.

In this project, we will develop models for integrated assessment of multiple social and climate tipping points using an agent-based modelling method. Agent-based models have been suggested as a new wave of climate change modelling. They offer a behavioural alternative to mainstream economic models. In particular, each aggregate equation in traditional economic models, e.g. describing capital accumulation or total consumer spending, is replaced by the network of interacting agents, namely: heterogeneous consumer, firms and investors. This allows for modelling diversity of behaviours, bounded rationality and social interactions. As a result, ABMs offer a better starting point for integrating social tipping points than traditional models.

Modelling social tipping points is important for the climate policy assessment. Such points can have synergic, complementary or antagonistic impacts on the carbon dioxide emissions, thus may slow down or accelerate climate tipping points. For instance, digitalization and electrification of transport, if adopted by a critical mass, would increase electricity use. This would require massive investments in renewable energy to support the low carbon transition. However, investments in renewable energy will be mineral intensive. As a result, the process may be undermined by the scarcity of rare metals and minerals, unless a critical mass of rare metals embodied in consumer products is recycled. The net effect of these mechanisms has not been assessed quantitatively, which we will do in this project. Our goal is to identify the positive social tipping cascades so as to avoid negative tipping cascades in climate.