RESEARCH STATEMENT

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I am an economist with research interests in climate change, game theory and mechanism design. Methodologically, my research relies on both theory and data analysis to answer policy-related questions in qualitative and quantitative senses. In this research statement, I will summarize my contribution to a long-term collaborative research project called the Climate Action Gaming Experiment (CAGE). I will also briefly discuss the future work that is planned for the CAGE research project.

"Global Green Deal: International Cooperation on Net-Zero Carbon Emission" with Chenghao Ding and Clifford Singer (Job market paper)

In this paper, I synthesize some of the preceding progresses in the CAGE project including Chenghao's work on the physical balance model, Prof. Singer's work on the economic impact model and my own work on a piecewise-linear dynamic climate game. The purpose is to develop and estimate an integrated model of climate and the economy that can be used to conduct policy analysis in an internally coherent framework. This model is designed to connect two literatures: the literature on integrated modeling of climate change and the game-theoretic literature on international climate cooperation. The first typically focuses on the global prospective. While it provides insights on the appropriate global targets for climate change mitigation, it does not address the question whether those targets can be achieved by countries acting strategically. The latter studies the incentives and strategic behavior of countries but typically relies on simplified models that cannot be used to study the impact on climate.

Inspired by the European Union and China's recent announcements to become climate-neutral by mid-century, we use this computable model and numerical simulations to study international cooperation among sixteen geographic regions on achieving net-zero global carbon emission. An important assumption that simplifies the simulation exercise is that we let the emission reduction burden be distributed in a way such that all regions have equalized marginal emission reduction cost. This assumption is justified by my work on the dynamic climate game. In that work, I show that under some mild technical assumptions we can construct a market in which all regions' marginal reduction cost will become equalized through trading reduction burden with others.

Through simulations, we find that achieving net-zero emission by mid-century reduces global social welfare loss by up to 35%, accounting for the emission reduction cost. However, the economic benefit of free-riding may entice each region to quit the cooperation at low emission reduction rates. A similar observation is also made in my work on the dynamic climate game in which I formally demonstrate this point by comparing the global optimal outcome to a simple subgame perfect equilibrium under the assumption that the climate dynamic and climate change impacts are piecewise linear. Under the same assumption, I have also shown that effectiveness of using trigger strategies to sustain cooperation may be compromised when regions' climate change impacts are

highly heterogenous. We also test that result in this paper. We demonstrate that trigger strategies are not effective in stabilizing the cooperation and would quickly lead the world to the punishment phase. We also demonstrate that a global transfer-payment program could sustain cooperation, but the budget of the program would be in deficit until the middle of next century. These results suggest that global effort on achieving net-zero carbon emission by mid-century is desirable, but the required international cooperation may be difficult to sustain.

"Strategic Options of Solar Radiation Management" with Clifford Singer (In progress)

We study strategic options by the use of solar radiation management (SRM) techniques. These techniques have relatively inexpensive direct costs and have the potential to quickly control the global mean temperature increase. Based on results from the previously described paper, it may be difficult to achieve net-zero carbon emission by mid-century. This has a particularly large and negative consequence on African regions. Given that the direct cost is comparatively inexpensive, African regions will thus have sufficient incentives to use SRM to control the global climate. Based on the preliminary results, we find that the strategic options of using SRM in the context of international climate cooperation depend on the perceived indirect costs and risks. In contrast to other integrated assessment models, our model allows us to decouple the dynamics and economic impacts of atmospheric CO_2 concentration and global mean temperature. This feature allows us to analyze SRM and compare it to carbon emission reduction within the same framework, which to our knowledge has not be done yet in the literature. This paper will also contribute to the expanding literature that studies SRM in a strategic context.

Plans for Future Research

My research agenda in the near future is to continue the work on the CAGE research project. First, I will revisit my work on the dynamic climate game based on the empirical observations from the job market paper. In particular, I plan to study how effective transfer payments may be in a more general framework. Second, I will continue to work with Prof. Singer on devising a systematic random-sampling approach for the integrated model to test how our results stand based on reasonable probabilistic estimate of the model components and parameters. Lastly, based on my work on estimating emission reduction costs, it is likely that there is asymmetric information regarding reduction costs. I plan to study the implication of this information structure among regions on international climate cooperation using the mechanism design approach.