

Draft of Personal Problem

15.879 Class – Spring 2025

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What is the effect of an entrepreneurial ecosystem on global warming?

Entrepreneurial ecosystems have dual climate impacts. Positively, they drive low-carbon innovation through renewable energy startups (solar, wind, hydropower), smart building systems, electric vehicles, and circular economy models that reduce waste and resource use. However, these ecosystems often exacerbate environmental harm by prioritizing unchecked growth. Advanced entrepreneurial ecosystems like some in U.S. exhibit unsustainable ecological footprints—their sum is equivalent to three planets' resources—due to tech manufacturing demands and energy-intensive scalability. For example, the digital economy's carbon footprint now exceeds global trucking emissions. Then, the net impact hinges on policy alignment: climate-focused regulations and circular practices can steer innovation toward mitigation, while growth-centric models deepen ecological overshoot.

Fundamental source of inertia:

- **Direct impact of the ecosystem:** the sum of the emissions generated by the ecosystem's actors: universities, big firms, risk capitals, government, and entrepreneurs. A first approximation could be the modeling of the people's density with the average consumption for desk activities (entrepreneurial activities are related to tuition, coaching, and meetings). The more challenging part is to connect the knowledge density with the environmental emission. (if, in an ecosystem where there is a nuclear reactor, startups have access to this type of technology, but this ecosystem could have more emissions than others).
- **Indirect impact of the startups generated in the ecosystem.** This is a sort of Scope 3 for the ecosystem. The first outcome of an entrepreneurial ecosystem is the generated startups, so it is important to consider the impact they produce on the environment. For this purpose, an interesting metric was developed by the project frame ([Project Frame Methodology for Early-Stage GHG Impact Assessment — Frame](#)). This metric is based on the consideration of the net impact of the startups on a baseline scenario (emissions without that startup). The final score is a value greater than zero if the net impact of the business unit of the startup is negative and less than zero if the net impact of the business unit of the startup is positive.
- **Imitation effects:** the more a new technology is a breakthrough, the more it will be imitated by other Firms (e.g., Generative AI: ChatGPT launched the open platform, and the big firms a few months later launched their similar platform). These effects could be modeled as an additional diffusion of the startup's business unit in the case of particular innovative technology.

Combining the first two and possibly the imitation effects, the goal of the model is to understand in which condition the ecosystem could have an overall positive impact (a reduction of the baseline emission). It could help to see the startups as a coflow, modeling the brown startups and the green startups separately or adding other categorizations of startups (for example, for each sector). These categories could have proper life parameters through the different stages (death rate and investments through the several seed phases).

Commented [HR1]: This is a very complex problem and not one that would fit in its entirety into the scope of the assignment for modeling you will be working on. You will need to simplify, but may have many different options about where to focus on.

For example you could try to keep the very broad boundary of the problem and come up with a very aggregate but broad model, something along the lines of (simplified) world dynamics model with a stock for economic capital (or per person capital), another for energy consumption per unit of capital, and two for startups contributing to growth rate of the capital and energy efficiency (i.e. reduction rates of energy consumption per unit of capital). The allocation of entrepreneurial activity to one vs. The other startup type would control the relative strengths of the two pathways, and could in the second iteration of the model become endogenous, i.e. responding to current pressures on total energy consumption, e.g. coming from climate change feedbacks. I am not saying this is the right choice necessarily: it is a very aggregate model, requiring some novel formulations and will remain rather abstract, so harder to model.

Another idea may be modeling a single startup's impact (along the Frame project): the startup chooses what area to focus on: efficiency or growth, and how ambitious to be (e.g. shooting for reducing emissions by 90% in a sector, or shooting for increasing productivity by 50%; some technologies allow for both). That choice informs the likelihood of success (the more ambitious, the less likely), but also the attractiveness for adopting companies (i.e. the rate and maximum level of adoption should they be successful). With those adoption rates settled, the net impact can be calculated in comparing what different choices will imply for overall emissions (note that you will need to translate productivity into excess production, which can increase emissions absent enhancements in energy intensity of production process).

Finally, the model could help to explore how different policies for the allocation of resources in green and brown technology could impact the potential impact of the entrepreneurial ecosystem.

Additional sources of inertia that could be modeled:

- The gap between when investments in infrastructure are made and when they actually benefit businesses or the environment, as infrastructure projects typically require significant time before delivering results.
- Nature of green innovations, categorized by the "5 R" framework (Refuse, Reduce, Reuse, Recycle, Rot). Different types of innovations within this framework vary in how quickly and effectively they produce environmental improvements, thus creating varying mechanisms in how to achieve sustainability goals.

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