Climate Change and Asteroids: Optimal Policy for a Dangerous Universe

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15 June 2020

Climate Change is Not the Only Extinction Risk We Face

- Thinking about climate change in isolation yields 4 strategic imperatives that shape policy:
  - Do what it takes to eliminate the extinction risk that climate change creates;
  - If there is uncertainty over what it takes, do what it takes in the worst case scenario;
  - Do what it takes even if that hammers economic growth; and
  - Compensate people/countries for the adverse consequences of climate change;
- None of these imperatives hold if extinction risk is multi-dimensional;
  - If risk is multi-dimensional (as it is) and resources to deal with these risks are limited (as they are), then there are trade-offs. Doing whatever it takes for one risk in isolation is not optimal;
  - Economic growth matters because it creates resources to deal with other risks;
  - If resources are finite, limiting extinction risk is more important than compensating people/countries for the adverse consequences of climate change;

Outline

- Optimal Policy for Climate Change Alone
- Optimal Policy for a Dangerous Universe
- Optimal Policy vs. Actual Policy

Optimal Policy for Climate Change Alone

A Very Simple Model

- Country *A* faces an extinction risk (an infinite loss) from climate change;
- The probability of surviving is Λ, with

$$\Lambda = \frac{c}{C_{\text{Max}}}$$

where *c* is the amount that *A* spends to deal with the risk, and C_{Max} is the amount that eliminates the extinction risk;

- *A* has a budget of *B*, with $B = \kappa Y$, and Y is GDP;
- If *A* survives, then *A* gets utility of *U*[*Y* - *c*].
  - Inspired by Weitzman (2009), "On Modeling and Interpreting the Economics of Catastrophic Climate Change", *The Review of Economics and Statistics*
- What is the optimal policy?

Do What It Takes

- Since *A*'s probability of survival is

$$\Lambda = \frac{c}{C_{\text{Max}}}$$

  and the loss from not surviving is infinite, *A* sets $c = C_{Max}$ (or *A*'s maximum budget of *B*).

- If there is uncertainty over the value of C_{Max} (say C_{Max} equals either C_{High} or C_{Low}), *A* sets $c = C_{High}$ (because if not then *A* runs the risk of an infinite loss).

Do What It Takes Even if it Hammers Economic Growth

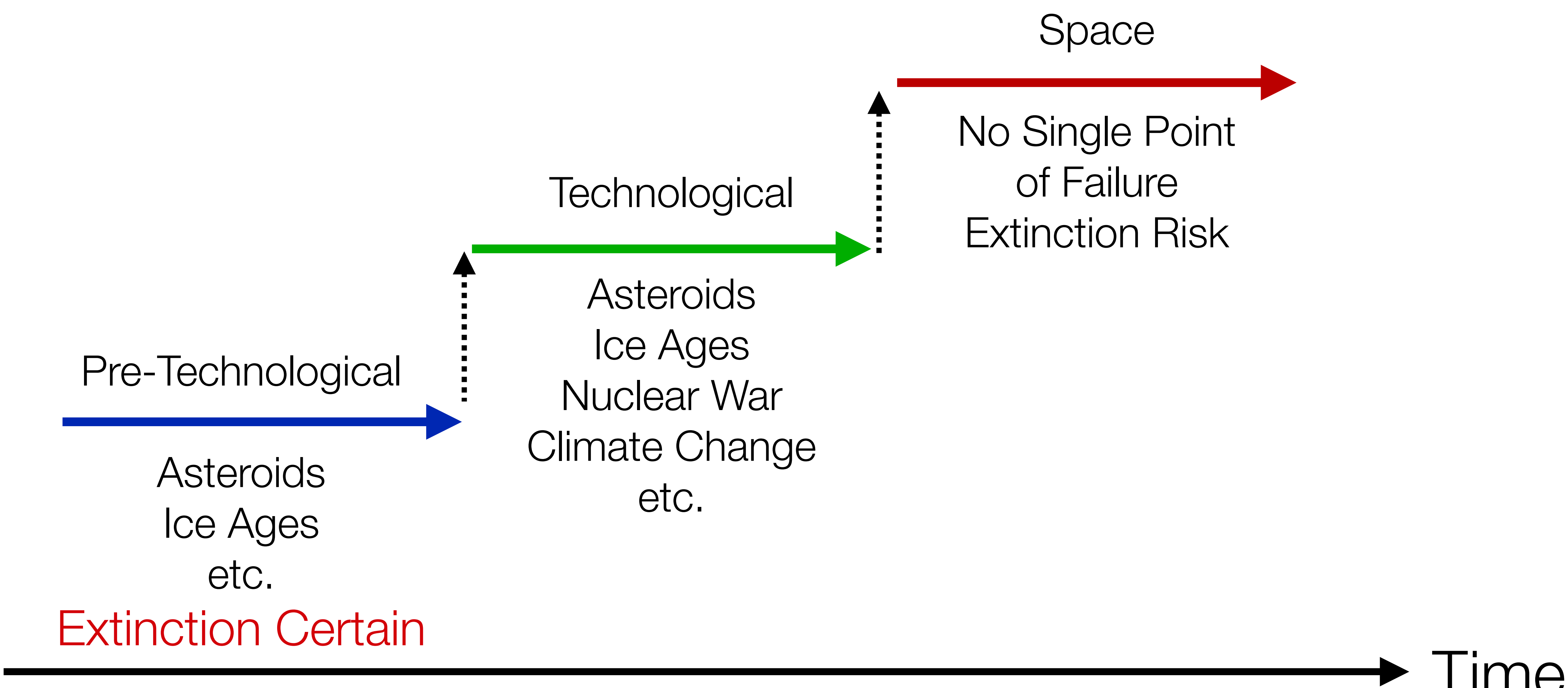
- Suppose that every dollar spent on dealing with climate change reduces Y due to its impact on growth;
- A still sets $c = C_{Max}$ anyway, because doing anything else increases the risk of an infinite loss;

Climate Justice

- Suppose that country *A*'s industrialization imposes negative externalities upon country *Z*, and an amount *J* will compensate *Z* for the consequences of the negative externality;
- *A* should pay *J* to *Z*;

Optimal Policy in a Dangerous Universe

Human Civilization



To eliminate the single point of failure risk inherent in living on one planet, human civilization needs to transition from the Pre-Technological Stage to the Space Stage.

Unfortunately, that means that human civilization must past through the very dangerous Technological Stage (ability to destroy earth goes up but we are still stuck on it).

Nuclear war?

- At the height of the Cold War, the probability of a US/Soviet nuclear exchange was about 1% per year;
  - Barrett, Baum, and Hostetler (2013), “Analyzing and Reducing the Risks of Inadvertent Nuclear War between the United States and Russia”, *Science and Global Security*
  - Lewis, Williams, Pelopidas, and Aghlani (2014), “Too Close for Comfort: Cases of Near Nuclear Use and Options for Policy”, *Chatham House Report*

Extinction Risk

- *A* has a total budget of *B* for dealing with extinction risks, and can devote resources to:
  - Dealing with climate change (c) — each \$1 spent on dealing with climate change costs Δ, $\Delta > 1$, due to the impact of climate change policy on economic growth;
  - Getting into Space (Θ);
  - Compensating other countries for adverse consequences of climate change (J);

$$B = \Delta c + \Theta + J$$

- It costs S to get into Space, so the amount of time it takes to get into Space is:

$$T = \frac{S}{\Theta} = \frac{S}{B - \Delta c - J}$$

- So, survival probability can be written as

$$\Lambda = \left(\frac{c\eta}{C_{Max}}\right)^{\frac{S}{B - c\Delta - J}}$$

where η is the prob of surviving non-climate risks;

$$\frac{c\eta}{C_{Max}} = \text{Prob of Surviving each period}$$

$$\frac{S}{B - \Delta c - J} = \text{Number of periods before we enter Space age.}$$

Key Trade-Off

1) Higher *c* increases probability of surviving in any given period; but

2) Higher c lengthens the number of periods we need to survive before getting into Space.

And Trade-offs Must Be Made

- We could spend in excess of $50 Trillion on dealing with climate change by 2050;
  - Morgan Stanley Research (2019), “Decarbonization: The Race to Net Zero”
- If we are spending that kind of money, we could have a large self-sustaining human population in space by the end of this century;
  - Zurbin (2019), *The Case for Space: How the Revolution in Spaceflight Opens Up A Future of Limitless Possibility*
- But it will not be possible to do go all in on reducing climate change risk and establish a self-sustaining human population in space this century;

New Imperative: Balance Risks

- If we never get into Space, humanity is doomed. So, the optimal policy strikes a balance between limiting climate change risk and getting into space as quickly as possible;
- If dealing with climate change becomes more expensive (higher C_{Max}), the optimal response is to shift towards getting into space more quickly;

New Imperative: Growth Matters

- The length of time it takes to get into space is

$$\frac{S}{B - \Delta c - J}$$

- If dealing with climate change impacts economic growth (Δ), then dealing with climate change risk creates a negative externality by increasing the amount of time it will take to get into Space;
- In that case, the optimal response is focus less on climate change and more on getting into Space;

Climate Justice Is a Second Order Issue

- The combined amount that A spends on getting into Space and on climate change risk is: $B - J$;
- The more *A* spends on *J*, the less *A* spends on dealing with extinction risks;
- Spending on *J* does not reduce the probability of an infinite loss;
- So, *J* should equal 0;
  - Unless, that is, additional resources will not reduce climate change risk or increase the speed of getting into Space;
  - Given resource constraints, that is unlikely to be the case.

Optimal Policy vs Actual Policy

Climate Justice: US and EU

- It is pretty clear that isn't going to be any substantial transfer of wealth from industrialized countries to developing countries in response to climate change;
    - After Kyoto, it looked like the industrialized/developing country divide was going to be at the heart of climate policy;
    - But, the Paris Agreement explicitly excludes liability and compensation in the context of responding to the loss and damage that climate change inflicts upon developing countries;
        - Falkner (2019), "The unavoidability of justice — and order — in international climate politics: From Kyoto to Paris and beyond", *British Journal of Politics and International Relations*
- Industrialized countries may not be clear and explicit on this point (because these things are written by diplomats rather than economists), but, basically, the EU and the US are setting J equal to 0;
    - This is the result my analysis supports.

Dealing with Multi-Dimensional Extinction Risk: US vs EU

- The EU has done a slightly better job at reducing carbon emissions than the US;
  - 1.7% per year for EU vs 1.5% per year for US between 2007 and 2017;
  - BP Statistical Review of World Energy, 2019
- But the US has done much much more for space:
  - The Trump administration is laying the legal foundations for the commercial exploitation of space;
    - On 6 April, 2020, Trump issued an executive order to encourage and support the recovery and use of space resources;
  - The Trump administration is supporting a vibrant private sector space industry;
    - SpaceX successfully put astronauts in orbit on May 30th, the first private sector firm to do so;
- From my perspective, the US has the better policy balance;

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