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To Whom It May Concern:

We are submitting **"Orbital-use fees could more than quadruple the value of the space industry"** to be considered as an article in *PNAS.*

The nascent commercial space industry is in a phase of rapid growth, but there is also concern about the growing debris field in low-Earth orbit. As the number of satellites in orbit has increased, so too has the quantity of debris, the collision risk to existing satellites, and the economic costs of these collisions. Without intervention, the debris field may soon reach a tipping point, called Kessler Syndrome, beyond which it becomes self-sustaining.

Public discussion of the space debris problem has so-far largely focused on technological solutions. However, the space debris problem is essentially a tragedy of the commons—a problem of incentives. Just as stocking a lake does not remove the incentive to overfish, space-debris-removal technologies do not remove the incentive for satellite operators to overpopulate the orbital commons.

We propose and model the effects of an internationally coordinated tax on satellites in orbit—an 'orbital-use fee'. Our calibrated, integrated model combines physical dynamics with satellite economics and projects that an optimal orbital-use fee would increase the long-run value of the industry by around 2.4 trillion USD—a more than four-fold increase. Further, we show that the costs of failing to address the tragedy of the commons in space escalate each year; and we show that technological solutions not only do not address this problem, they might make the problem costlier than inaction.

Historically, managers have often failed to address tragedies of the commons—such as global overfishing—until damages had already occurred on large scales for decades. In space, there is a rare opportunity to address the problem relatively early. We discuss how existing multinational externality pricing programs, such as the European Union's Emissions Trading System and the Parties to the Nauru Agreement Vessel Day Scheme, offer models that spacefaring countries could emulate in establishing an orbital-use fee.

Our article is very timely, and should be of interest to a wide audience of scientists, governments, media, and members of the public. The manuscript has undergone extensive

review and revision before submission. Waleed Abdalati (former Chief Scientist of NASA) provided a particularly thorough review.

We thank you for your consideration.

Sincerely,

Akhil Rao