Institute for Policy Integrity
NEW YORK UNIVERSITY SCHOOL OF LAW

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VIA ELECTRONIC SUBMISSION

Federal Communications Commission

Attn: Federal Communications Commission
Re: Reply Comments on Mitigation of Orbital Debris in the New Space Age
Docket No.: IB 18-313

The Institute for Policy Integrity at New York University School of Law[1] ("Policy Integrity") respectfully submits the following comments to the Federal Communications Commission (the "Commission") regarding possible market-based approaches to and regulatory impact analysis of orbital debris. Policy Integrity is a non-partisan think tank dedicated to improving the quality of government decision-making through scholarship in the fields of administrative law, economics, and public policy.

Our reply comments focus on (1) the use of economic approaches to create incentives for satellite operators "consistent with the public interest in limiting the growth of orbital debris," and (2) how the Commission should assess the benefits and costs of regulatory alternatives.[2] In addition to addressing these issues as raised by the Commission, we also respond to some of the comments that the Commission received during the initial comment period. Specifically, we note that the Commission should:

- Broadly consider market-based alternatives to traditional prescriptive regulation. In addition to bonding and insurance requirements, the Commission should evaluate the role that different liability rules, marketable permits or offsets, and regulatory fees could play in achieving its policy goals.
- Fully weigh the direct and indirect costs and benefits of any regulatory scheme in order to maximize total net benefits. The global nature of the orbital debris problem requires weighing costs and benefits on a global scale, and the Commission should at the very least adopt a broad conception of U.S. costs and benefits that

[1] This document does not purport to present New York University School of Law's views, if any.
[2] 84 Fed. Reg. 4742, 4751-52 (Feb. 19, 2019).

encompasses reduced spillover effects, foreign reciprocity, and the extraterritorial financial interests of U.S. citizens.

Background

On February 2, 2019, the Commission proposed to amend its rules related to satellite orbital debris mitigation, summarizing in a *Federal Register* notice the Proposed Rulemaking adopted by the Commission on November 15, 2018.[3] The Commission noted that the Proposed Rulemaking constituted "the first comprehensive look at [its] orbital debris rules since their adoption in 2004."[4] The Commission went on to cite significant technological developments and the persistent increase in the amount of orbital debris capable of inflicting damage to functional spacecraft as reasons for updating its rules.[5]

On April 5, 2019, Policy Integrity submitted initial comments touching upon two topics raised by the Commission: the prospect of using market-based regulatory alternatives to incentivize orbital debris mitigation, and the appropriate approach to weighing the costs and benefits of regulatory action.[6] We now expand upon these issues and encourage the Commission to consider a range of market-based alternatives and account for the full range of direct and indirect benefits in evaluating options.

I. The Commission Should Broadly Consider Market-Based Alternatives

Market-based alternatives to prescriptive regulation could help internalize the global externalities of orbital debris at the lowest possible cost, and the Commission should fully explore these ideas. Indeed, in the Commission's *Strategic Plan 2018-2022*, Performance Goal 4.1.2 promises to implement the principles of Executive Order 12,866.[7] Executive Order 12,866 § 1(b)(3) requires agencies to assess a broad range of economic incentives, including marketable permits.[8]

At present, factors such as unclear liability rules and lack of information may need to be addressed before certain market-based approaches to orbital debris could be fully and efficiently implemented. Therefore, to the extent the Commission concludes that market-based approaches hold the promise for a more efficient alternative to traditional regulatory interventions, the Commission should take active steps to remove these impediments and work toward the creation and implementation of economic incentives consistent with the policy goal of orbital debris reduction. In addition to reviewing its own experience with marketable permits in the context of electromagnetic spectrum auctions, the Commission

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[3] *Id*. at 4742-43.
[4] *Id.* at 4743.
[5] *Id.* at 4743-44.
[6] Policy Integrity, Comment Letter on Proposed Rule related to Mitigation of Orbital Debris in the New Space Age (Apr. 5, 2019), https://ecfsapi.fcc.gov/file/10405341403925/FCC%20Orbital%20Debris_Initial%20Comments_2019.4.3.pdf
[7] FEDERAL COMMUNICATIONS COMMISSION, STRATEGIC PLAN 2018-2022 at 13, https://docs.fcc.gov/public/attachments/DOC-349143A1.pdf.
[8] 58 Fed. Reg. 51,735 (Oct. 4, 1993); *see also* OFFICE OF MGMT. & BUDGET, EXEC. OFFICE OF THE PRESIDENT, OMB CIRCULAR A-4, REGULATORY ANALYSIS 8-9 (2003) [hereinafter CIRCULAR A-4] (encouraging agencies to consider marketable permits and offsets, as well as fees, penalties, subsidies, liability, bonds, insurance, or warranties.)

should consider the lessons that may be learned from other agencies' use of marketable permits and liability-based regulatory regimes to reach policy objectives.

Our comments focus on a range of market-based approaches that could be used as alternatives or supplements to prescriptive regulation. Specifically, we observe that:

- Marketable permits and offsets have succeeded in a variety of regulatory contexts, and merit consideration in the orbital debris context;
- Regulatory fees may incentivize debris reduction and create additional funding to further the Commission's policy objectives;
- Insurance may hold long-term potential to efficiently incentivize orbital debris mitigation; and
- The legal doctrine of market-share liability has proven effective under circumstances resembling those found in the orbital debris context.

The Commission should closely examine these and other market-based regulatory alternatives as it moves forward with the rulemaking process.

A. Marketable Permits and Offsets Have a Record of Success in Various Contexts, and the Commission Should Consider Using These Tools to Address Orbital Debris

Marketable permits and offsets allocate regulatory privileges and obligations efficiently by harnessing the incentives of rational economic actors.[9] Designing an effective regulatory system based around marketable permits or offsets requires gathering and evaluating enough information to verify that the proposed system would efficiently reduce risk and further policy objectives. Despite some upfront extra administrative costs to design and implement a market-based system, "[e]vidence suggests that marketable permits [and offsets] lower compliance costs, incentivize innovation, and may ease administrative burdens more than traditional regulation."[10] If applied to orbital debris, the resulting efficiencies of a well-designed market-based system could either reduce overall costs for a given level of debris reduction and mitigation, or could help the Commission justify more optimal targets for debris reduction and mitigation on cost-benefit grounds. By allowing the regulated community to take advantage of market-based flexibilities, the Commission could channel the resulting cost savings back towards policy objectives and increase net regulatory benefits compared to traditional approaches.[11]

Numerous federal, state, and local agencies have successfully made marketable permits and offsets the centerpiece of various regulatory regime by harnessing the efficiencies of the market to achieve policy objectives. The Commission itself adopted such an approach by using auctions to allocate electromagnetic spectrum rights and allowing some secondary

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[9] JASON A. SCHWARTZ, ADMIN. CONFERENCE OF THE U.S., MARKETABLE PERMITS: RECOMMENDATIONS ON APPLICATION AND MANAGEMENT 1 (2017) [hereinafter ACUS Report].
[10] ACUS Report, *supra* note 9, exec. summary at i.
[11] *Id*. at 51-52, 54.

trades of licenses. Not only did the Commission find that this process granted spectrum rights to those who would use those rights most effectively, but it also allowed the Commission to speed up the licensing process.[12] Another notable example of the successful use of marketable permits was the development of the emissions trading program to curb acid rain under the George H.W. Bush administration. This program not only allowed a relatively small EPA staff to ensure nearly 100 percent industry compliance, but it also prompted innovation and saved industry millions of dollars relative to traditional non-trading approaches.[13] Other examples of successful marketable permits programs include taxi cab medallion auctions, tradable fish catch shares, and wetland mitigation banks; other aerospace applications include some limited trading allowed for airport landing slots and an attempt at transferrable permits to reduce aircraft noise.[14]

A properly designed system of marketable permits or offsets may be a powerful tool for reducing orbital debris. The Commission should consider guidance recently issued by the Administrative Conference of the United States on best practices for adopting marketable permits programs,[15] and should also look to current domestic and international marketable permit arrangements to analyze how such a non-traditional regulatory scheme could be used to create market incentives for the mitigation and remediation of orbital debris.

1. Weighing the Appropriateness of Marketable Permits in the Orbital Debris Context

Marketable permits are government-created licenses or obligations that allow the holder to engage in a certain type of activity.[16] These permits can be sold independent of other property interests in primary markets (e.g., a spectrum auction by the Commission), in secondary markets (i.e., any subsequent transfer after the initial grant), or both.[17]

Regulatory uses of marketable permits generally fit into two broad classifications: cap and trade or credit trading. In a cap-and-trade system, regulators establish an "absolute baseline" that caps the total amount of a given activity that can take place. This is controlled by limiting permit supply. Credit trading programs operate against a "relative baseline" (e.g., no net loss of wetlands in development projects); regulators allow the activity to take place only if the applicant can show that this relative baseline will remain unaffected through some kind of offset or remediation programs.[18]

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[12] About Auctions, Introduction, FCC.GOV (last updated Aug. 9, 2006), https://www.fcc.gov/auctions/about-auctions.
[13] ACUS Report, *supra* note 9, at 6, 31, 37.
[14] *Id.* at i.
[15] 82 Fed. Reg. 61,728, 61,730 (Dec. 29, 2017); *also available at* https://www.acus.gov/sites/default/files/documents/Recommendation%202017-4%20%28Marketable%20Permits%29.pdf.
[16] *Id.* at iv.
[17] *Id.* at 2.
[18] *Id.* at 3.

Aside from questions of legal authority,[19] there are two threshold questions that the Commission should consider in determining if marketable permits would be effective and appropriate for the regulation of orbital debris. First, are the risks created by orbital debris fungible? In other words, can the Commission's policy objectives be served only if every individual regulated actor takes specific steps to reduce its own debris, or would program goals still be met so long as any increased debris generation by one FCC-licensed satellite operator is offset by the efforts of another operator to mitigate an equal, fungible amount of debris or debris-related risk?[20] A system of marketable permits works on the assumption that the negative externality an agency wants to reduce is relatively fungible among actors and, therefore, regulatory goals are not compromised by allowing the trading of the permits among actors.[21]

Second, does the Commission have reason to believe that licensed satellite operators would experience a range of compliance costs in reducing orbital debris generation? In a market system, the variation of compliance costs across actors help to generate the supply of and demand for permits. While actors with lower compliance costs will be able to generate or free up credits or permits, actors with higher compliance costs will buy those permits if doing so is less costly than either non-compliance or incurring additional compliance costs.[22] In addition to evaluating current compliance costs, the Commission should also consider realistic but as yet unrealized technological innovations that would impact future compliance costs. Given the inherently high-tech nature of the space industry, the Commission may conclude that innovative debris reduction technologies would be developed if licensees were presented with the proper market incentives.[23]

2. Features of a Marketable Permit or Offset Scheme for Orbital Debris

If the Commission concludes that marketable permits and offsets could lead to efficient policy outcomes, the next steps are to identify an appropriate credit currency and market design that further the Commission's policy aims.

As the following discussion makes clear, the Commission would have to make a number of significant design choices if it decides to implement a system of marketable permits or offsets. These considerations should be driven by rigorous analysis of the orbital debris context in order to maximize the regime's net benefits. Whatever approach the Commission decides to take, it is important that the permitting system is predictable and has clear

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[19] A discussion of the Commission's legal authority to establish a system of marketable permits is beyond the scope of these reply comments. However, see *id.* at 14-23 for a discussion of how, often, explicit statutory authority is not required for an agency to establish a system of marketable permits or offsets.
[20] This question is distinct from determinations about what drives risk in the orbital debris context, e.g., size or other debris characteristics. Those issues of currency design for a marketable permit and offset program are discussed in greater detail below.
[21] ACUS Report, *supra* note 9, at 43.
[22] *Id.* at 29-30.
[23] *See id.* at 32-33.

liability rules.[24] Predictability will allow the regulated industry to adapt its market behavior to the regulatory scheme and may promote long-term investments in technologies that would enhance debris reduction.

i. Currency Design

"Currency" in the context of marketable permits refers to the fungible unit of risk that can be traded among regulated actors.[25] While effective currency design requires analysis of many facets of a regulated activity, there are three main components that should guide the Commission's analysis: the identification of a fungible unit of risk, the ability to quantify and verify reductions of that risk, and the regulator's policy objectives. Possible currency designs could include permits based on such factors as the number of debris items generated; the mass of debris; the lifespan of debris; the risk of collision; or some combination of these and other factors.

Identification of the appropriate currency unit to be traded in the space debris context is complicated by the fact that the *number* of objects in orbit is an indicator of current collision risk, while total *mass* in orbit is more indicative of future collision risk.[26] Therefore, while the currency must represent a fungible unit of risk, it may also reflect a policy decision by the Commission about the prevention of future versus current collisions.

The unit of the currency should be quantifiable, verifiable, and allow the Commission to efficiently monitor the activities of licensees. For example, if one licensee plans to reduce the number of debris items that its launches will generate and sell the associated debris-item-based permits to another licensee, the reduction in the number of items of debris must be either predictable before launch with some degree of accuracy or else measurable post-launch, and in either case the claimed reduction in debris would need to be monitored to ensure the number does not increase over time. A verifiable currency supported by clear liability rules for noncompliance ensures that the currency has value and that the program will achieve its policy objectives—in other words, to use the jargon of marketable permit programs, that the currency is "real."[27]

Finally, in designing the currency, the Commission may consider imposing certain trading ratios greater than 1:1 to the extent that risks are not perfectly fungible or if doing so helps further policy objectives. For example, in the above scenario, if the reduction in the number of items of debris cannot be predicted or measured with complete certainty, the licensee seeking to sell debris-item-based permits may be required to reduce two items of debris in order to generate a permit that would allow the licensee buying that permit to generate one item of debris (a 2:1 ratio); the trading ratio compensates for the uncertainty and helps

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[24] *Id.* at 56, 62.

[25] *See id.* at 47-48 (discussing type of and value considerations for permits).

[26] Darren McKnight & Donald Kessler, *We've Already Passed the Tipping Point for Orbital Debris: The Longer We Wait, the Tougher and More Expensive It Will Be to Safeguard Satellites*, IEEE SPECTRUM (Sept. 26, 2012), https://spectrum.ieee.org/aerospace/satellites/weve-already-passed-the-tipping-point-for-orbital-debris.

[27] ACUS Report, *supra* note 9, at 78-79.

ensure that, overall, the trading of permits is achieving the debris reduction targets. Similarly, to the extent that debris creation in Low Earth Atmosphere (LEO) and Geosynchronous Earth Orbit (GEO) create different levels of risk, the non-fungibility or uncertainty of the risk measure may be accounted for by imposing a trading ratio that makes risk generation more expensive in the environment where debris imposes greater costs.[28] Trading ratios could be used to incentivize active debris removal by granting a premium for active removal technologies.

ii. Market Structure

The choice of currency informs questions of market structure. Two common structures discussed earlier are cap and trade and credit trading. In a cap-and-trade system, the Commission would set an absolute cap on the number of permits that would be released into the market in a given time period and allow trading of these permits among satellite operators. In a credit trading system, the Commission would set a relative baseline, perhaps by setting minimum performance-based regulatory standards, and would allow additional credit trading so long as the total risks associated with orbital debris would not increase above that baseline. Firms with low compliance costs or otherwise capable of creating offsets by taking actions that went beyond their baseline requirements would be able to generate credits and trade them to firms with higher compliance costs. Offset credits can also be integrated into a cap-and-trade system. Both of the credit trading and cap-and-trade approaches have advantages and drawbacks that the Commission should evaluate.

While cap-and-trade programs have the virtue of creating more predictable outcomes by placing a hard limit on the amount of orbital debris generated by FCC-licensed launches,[29] the inherent complication in this approach is setting a cap that reflects the optimal level of debris generation. This would require weighing the costs and benefits of debris generation and finding a cap that generates the greatest net benefit.[30] This cost-benefit analysis could also yield different results if the Commission decides to coordinate with other agencies with jurisdiction over outer-space activities in setting a national cap. Anja Nakarada Pecujlic and Sarah Katharina Germann have suggested an initial cap at "seven categorized objects per launch" based on the average number of objects currently emitted per launch.[31] This number appears to be based on international figures and assumes a degree of international cooperation. However, it may nonetheless be a starting point for thinking about determining an efficient cap.

A credit-trading system would avoid some of the complications of setting a hard cap by adopting a relative baseline for how much additional orbital debris risk satellite operators

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[28] *See id.* at 48, 56.
[29] *See id*. at 50.
[30] See below for a further discussion of how the Commission should think about the cost-benefit calculation in the orbital debris context.
[31] Anja Nakarada Pecujlic & Sarah Katharina Germann, *Global Cap and Trade System for Space Debris: Putting a Price on Space Hazards*, 40 J. SPACE L.131, 141 (2016).

are allowed to create. For every increase in risk—measured by the currency unit(s)—operators would need to either create or purchase offset credits.[32] Possible baselines could include a zero net increase baseline, such that every risk of debris generation from every launch would require an offset,[33] or a baseline set to some traditional performance-based or design-based regulatory standards, such that operators that can cost-effectively exceed those minimal performance-based standards could generate and sell offset credits to licensees for whom compliance with even those minimal regulatory standards is very costly.

iii. Additional Design Considerations

There are some final design considerations that the Commission should consider. While some of these considerations (like non-additionality) arise in the design of any system of marketable permits, one consideration (accidental collision) is more specific to orbital debris.

Problems of "non-additionality" arise when a currency and market structure in effect allow actors to take advantage of credits or offsets based on activity that they would have engaged in even without regulatory intervention; marketable permit programs should only reward activity with a valuable permit if the activity is truly *additional* and would not have occurred but-for the existence of the market program.[34] In the context of cap and trade, non-additionality would result if the Commission set a cap that exceeds current debris mitigation practices. In the context of credit trading, it could mean, for example, granting a

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[32] *See* ACUS Report, *supra* note 9, at 3.

[33] As Jared Taylor has observed, "[s]pace debris is a byproduct of nearly every human activity in space." Jared B. Taylor, *Tragedy of the Space Commons: A Market Mechanism Solution to the Space Debris Problem*, 50 COLUM. J. TRANSNAT'L L. 253, 260 (2011). If the Commission finds this statement to be true on further study, then under a no-net-increase baseline, offsets would be necessary for every launch. This would raise issues concerning the current technical and legal limitations on orbital debris remediation. Remediation technologies remain in relatively early stages of development. *See* Timothy Nelson, *Regulating in the Void: In-orbit Collisions and Space Debris*, 40 J. SPACE L. 105, 113 (2016) (citing Michael W. Taylor, Trashing the Solar System One Planet at a Time: Earth's Orbital Debris Problem, 20 GEO. INT'L L. REV. 1, 43 (2007)) ("Unfortunately, wide-scale remediation efforts are neither technologically possible nor economically feasible."). While there is some evidence that a power-constrained ultraviolet laser system could be used to deorbit debris, such strategies are yet to be implemented. Al Anzaldua et al., *A Path to Commercial Orbital Debris Cleanup, Power-beaming, and Communication Utility, Using Technology Development Missions at the ISS*, THE SPACE REV. (Nov. 6, 2017), http://www.thespacereview.com/article/3363/1. Additionally, orbital debris is not considered abandoned property under current space law, and transferring "ownership of, and liability for, objects in space—even junk" remains difficult. James Duncan & Berin Szoka, *Beware of Space Junk*, FORBES (Dec. 19, 2009), https://www.forbes.com/2009/12/17/space-junk-environment-global-opinions-contributors-berin-szoka-james-dunstan.html#2ef0833f165d; *see also* Chelsea Muñoz-Patchen, Note, *Regulating the Space Commons: Treating Space Debris as Abandoned Property in Violation of the Outer Space Treaty*, 19 CHI. J. INT'L L. 233, 244-46 (2018). Change in this area of the law may be complicated by the numerous national security issues that recognizing abandonment rights may raise. *See* Nelson, *supra* note 33, at 114 n.42. While the Commission may have some legal authority to facilitate the removal of debris generated by its licensees, answering that question would require an analysis of the international space law regime.

[34] ACUS Report, *supra* note 9, at 55-58.

valuable offset credit for deorbiting a satellite that the operator was planning to deorbit anyway. In such situations, by failing to account for the effects of additionality, the regulatory system has failed to generate any benefits beyond those that would have occurred absent regulation.

Finally, insofar as a marketable permit regime focuses on intentional debris creation from launches, it may overlook large sources of orbital debris. For example, the inadvertent collision of two satellites in 2009 created more than 1,600 pieces of debris.[35] Would similar events count towards an operator's cap or require an offset? Upon further study, the Commission may find ways to account for accidental debris creation within a system of marketable permits or offsets, or it may find that such events are best addressed by other regulatory mechanisms.

3. Support for a Marketable Permit or Offset Scheme for Orbital Debris

A number of economists, NASA employees, and other experts have voiced support for marketable permits as a viable solution to orbital debris regulation. In addition to the specific examples detailed below, the Commission should consider the experiences of other federal, state, and international agencies in designing and implementing regulatory systems structured around marketable permits.[36]

i. Existing Proposals for a Cap-And-Trade System for Orbital Debris

While a number of commentators have expressed support for the idea of a cap-and-trade system for orbital debris generation,[37] one of the most developed schemes is found in the 2016 article "Global Cap and Trade System for Space Debris: Putting a Price on Space Hazards," by Anja Nakarada Pecujlic and Sarah Katharina Germann.[38] Based on the European Union's Emission Trading Systems, Pecujlic and Germann propose a cap for "active and intentional emission of space debris" on a per-launch basis, with both national and international caps in place.[39] Permits would be freely tradable, and both public and

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[35] Stephen J. Garber, *Incentives for Keeping Space Clean: Orbital Debris and Mitigation Waivers*, 41 J. SPACE L. 179, 183 (2017).
[36] ACUS Report, *supra* note 9, at 7-13 (describing regulatory initiatives of other state, federal, and international actors that made marketable permits the core of their regulatory program). While many of these examples come from the area of environmental and natural resource regulation, there is no reason why a marketable permit approach could not work in other contexts where actors generate fungible externalities.
[37] *See, e.g.*, Molly K. Macauley, *Regulation on the Final Frontier*, REGULATION, Vol. 26, No. 2 at 41 (2003) (discussing how issuing permits for debris generation that are tradable between both government and industry could be a flexible approach that would control debris without imposing prohibitive costs on space activity); Garber, *supra* note 35, at 194 (analogizing permits for debris generation to existing cap-and-trade schemes for atmospheric pollution).
[38] Anja Nakarada Pecujlic & Sarah Katharina Germann, *Global Cap and Trade System for Space Debris: Putting a Price on Space Hazards*, 40 J. SPACE L. 131 (2016).
[39] *Id.* at 140-41.

private entities engaging in launches would have to hold sufficient permits to cover their anticipated debris generation in orbit.[40]

To calculate the national and international caps, Pecujlic and Germann suggest starting with the average number of objects emitted per launch and reducing the number of permits issued per launch over time.[41] Liability for non-compliance could take the form of either monetary penalties or a possible reduction in future permit allocations. Money raised through government sale of permits or penalties could be reinvested in technology to enable debris remediation.[42] Additionally, a national cap would apply to the number of inactive payloads left in orbit, though the authors do not offer guidance on how that cap might be set.[43]

Jared Taylor also discusses the desirability of a cap-and-trade scheme for orbital debris reduction, noting that such a system could be supplemented by initiatives to incentivize debris removal by private actors. The mechanism he provides for doing so would be to grant firms offsets against future debris generation for the current removal of orbital debris.[44]

It is worth noting that the cap-and-trade designs in the literature discussed above either explicitly or implicitly envision a degree of international cooperation and coordination among spacefaring nations. However, there are precedents for establishing cap-and-trade systems aimed at global regulatory problems without universal participation. For example, though there is not yet a single global permit market aimed at efficiently addressing climate change, California has a statewide cap-and-trade program for greenhouse gas emissions and a growing number of Northeastern states have formed a coalition, the Regional Greenhouse Gas Initiative, to cap power plant emissions.[45]

ii. Existing Proposals for a Credit Trading System for Orbital Debris

The Commission should also consider the possibility of a credit trading program centered around granting offsets for either the development of debris remediation technologies or actual physical removal of debris.

While there are currently fewer proposals in the literature on credit-trading systems in the orbital debris context, the comment letter submitted by Duke's Science Regulation Lab suggests such an approach modeled off of the Food and Drug Administration's ("FDA's")

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[40] *Id.* at 142.
[41] *Id.* at 141.
[42] *Id.* at 143, 145.
[43] *Id.* at 141.
[44] Jared B. Taylor, *supra* note 33, at 276. See further discussion of offsets and the possibility of combining them with other marketable permit schemes below.
[45] ACUS Report, *supra* note 9, at 8; Herman K. Trabish, *How Big Can New England's Regional Cap-and-Trade Program Get?*, UTIL. DIVE, (May 1, 2018), https://www.utilitydive.com/news/how-big-can-new-englands-regional-cap-and-trade-program-get/522375/.

priority review voucher ("PRV") program.[46] FDA created the PRV system in 2007 in order to incentivize the study of rare and "neglected" tropical diseases.[47] After submitting a proposed treatment to the FDA, the drug's manufacturer may be granted a tradable permit that allows them to expedite the approval and distribution of both the newly discovered treatment and another drug.[48] As the Duke Science Regulation Lab notes, this model works in the pharmaceutical context because it allows pharmaceutical companies to expedite review of "blockbuster" drugs for which getting to market sooner can be a major factor in revenue production.[49] These vouchers have sold for millions of dollars.[50] The U.S Patent and Trademark Office is currently testing a similar expedited review approach for technologies developed in response to humanitarian crises.[51]

The workability of a similar scheme in the satellite-licensing context would require identification of a regulatory benefit that is as desirable as expedited review in the pharmaceutical context that could be extended to firms who develop tools for reducing and remediating orbital debris. The Duke Science Regulation Lab suggests priority launch approval and other regulatory clearances as possible candidates.[52] Another could be approval of certain satellite constellations or rights to priority use of certain desirable orbital slots.

Other designs for a credit trading system would rely on profit motivations rather than such regulatory benefits. For example, as explained above, a credit trading system could be developed relative to minimum performance-based or design-based standards for debris mitigation, such that licensees able to cost-effectively go above and beyond those minimum regulatory standards and reduce additional debris risks could generate credits to sell to licensees that would otherwise be facing higher compliance costs.

B. The Commission Should Consider Using Regulatory Fees to Incentivize Debris Reduction and Fund Activities that Further Policy Objectives

The Commission should consider the efficacy of fees as regulatory tools for combatting the orbital debris problem.[53] In theory, regulatory fees operate much like marketable permits, insofar as they encourage regulated actors to cap their own activities at the point at which the marginal cost of the activity, post-fee, outweighs its benefits.[54] However, when

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[46] Duke Science Regulation Lab, Comment Letter on Proposed Rule related to Mitigation of Orbital Debris in the New Space Age, 84 Fed. Reg. 4742, at 20 (Apr. 5, 2019), https://ecfsapi.fcc.gov/file/104060721622603/Orbital%20Debris%20Comment_DukeSciRegLab.pdf.
[47] *Id.* at 20.
[48] *Id.* at 20-21.
[49] *Id.* at 21.
[50] *Id.*
[51] *Id.* at 23.
[52] *Id.* at 21.
[53] *See* Exec. Order No. 12,866 § 1(b)(3) (recommending user fees along with marketable permits).
[54] ACUS Report, *supra* note 9, at 4.

regulatory fees meet reality, they may diverge from marketable permits in two ways. First, whereas a marketable permit system like a cap-and-trade program sets a predictable and enforceable cap on the total regulated activity, any *ex ante* predictions about the level of activity that entities subject to a given regulatory fee will actually undertake are not guaranteed to bear out in the real world for any number of reasons, thus introducing an element of uncertainty about the total amount of activity that will actually take place under the regulatory program.[55] But while regulatory outcomes may be more uncertain under a fee than under marketable permits, the total regulatory costs of fees are generally more predictable than the regulatory costs under the market fluctuations of permit prices.[56] The cost certainty of fees may allow regulated actors to structure their behavior more efficiently and make long-term investments in technologies that would lower their compliance costs.[57]

It is also important to note that the money generated from a regulatory fee (or a permit auction) can have additional benefits if the revenue can be directed at policy objectives, such as the research and development of debris-mediation technologies or the physical remediation of orbital debris. However, without specific Congressional authorization, any revenue collected by the Commission from a regulatory fee or permit auction, after covering administrative expenses from operating the regulatory program, may have to be deposited into the general treasury.[58]

1. Features of a Regulatory Fee Program

Successfully designing a regulatory fee scheme would require the Commission to determine both a verifiable unit of regulated activity that would trigger liability and an efficient fee level.

Much like the issue of currency design in the marketable permit context,[59] a first step for the Commission in crafting a regulatory fee would be to identify the underlying unit of risk creation that would drive fee liability. As discussed above, this choice in the orbital debris context is complicated by the fact that total objects in orbit is indicative of current collision risks while total mass in orbit is indicative of future collision risks.[60] In addition to being able to monitor and verify this unit, regulators must also be able to tie each unit of risk created back to the actor creating the risk so that the negative externality is internalized by the proper party.

This relates to issues of timing. While regulated actors could be required to pay the fee based on pre-launch disclosures about anticipated debris generation, the Commission may also explore the possibility of imposing a regulatory fee based on in-orbit debris creation,

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[55] *Id.*
[56] Jared B. Taylor, *supra* note 33, at 271-72.
[57] ACUS Report, *supra* note 9, at 4.
[58] ACUS Report at 42-43 (discussing the Miscellaneous Receipts Act, 31 U.S.C. § 3302 (2008)).
[59] *See supra* Part I.C.2.i.
[60] *See* McKnight & Kessler, *supra* note 26.

thus making the size of the fee dependent on the actual debris-creating activity rather than pre-launch estimates. Levying fees based on in-orbit activity would only be feasible, however, if the costs of monitoring such activity were not prohibitive and the available monitoring technology were accurate enough to ensure that the proper party pays the fee.[61]

The Commission would have to determine a cost-benefit justified fee level to be borne by regulated actors. This would require study of both current and anticipated debris-mitigation costs for regulated actors, as well as estimation of the cost of the risks created by unmitigated debris. Additionally, the Commission may also want to consider potential costs that such a fee could create by shifting launches outside the jurisdiction of the United States into countries that do not regulate orbital debris generation.[62]

As noted above for marketable permit programs, a discussion of the Commission's legal authority to institute a regulatory fee system is beyond the scope of these comments. However, it is important to note generally that *regulatory* fees can be structured to be legally distinct from taxes, which only Congress can authorize. A fee may be regulatory in nature and not a tax if, for example, its aim is not revenue generation but rather to motivate certain regulatory behaviors and achieve authorized policy objectives.[63]

2. Designing a System of Regulatory Fees

The available literature contains a variety of proposals both about how a system of regulatory fees could be implemented and to what ends the money collected could be put. In addition to the specific ideas below, the Commission should also consider the experiences of other federal and state agencies in designing regulatory regimes centered around regulatory fees.

i. Proposals for Designing a Fee Mechanism

While many have supported the idea of a regulatory fee on satellite launches as part of an effective orbital-debris-mitigation policy, few have elaborated on the mechanism for imposing such a fee or how the optimal level of taxation would be calculated. For example, both NASA historian Stephen J. Garber and satellite industry commenters D-Orbit have suggested the implementation of an "orbital use tax" and an "ecotax," respectively, without providing further detail.[64]

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[61] *See* Jonathan Baert Wiener, *Global Environmental Regulation: Instrument Choice in Legal Context*, 108 YALE L.J. 677, 718-19 (1999); *see also* Michael W. Taylor, *supra* note 33, at 12 (discussing the state of debris tracking technology).

[62] *See* Garber, *supra* note 35, at 195 (discussing the possibility of such incentives). However, note that such "leakage" problems are neither unique to market-based regulatory approaches, nor are such problems insurmountable.

[63] *See generally* ACUS Report, *supra* note 9, at 21-22 (citing cases and executive branch guidance on the issue of distinguishing constitutional regulatory fees from unconstitutional taxes).

[64] Garber, *supra* note 35, at 194; D-Orbit, Comment Letter on Proposed Rule related to Mitigation of Orbital Debris in the New Space Age, 84 Fed. Reg. 4742, at 4 (Dec. 1, 2019),

More developed ideas about how such a system might work can be found in articles by Molly K. Macauley and Jared Taylor. Styled as a penalty, Macauley essentially suggests a regulatory fee levied pre-launch based on a satellite's design features and its "debris generation potential."[65] While Taylor does not discuss whether such a fee would be levied pre-launch or in orbit, he similarly discusses tying the regulatory fee to some measurable unit of debris generation. Additionally, he suggests an idea much like an offset in a credit trading program, in which operators can earn "tax credits" by removing debris from orbit.[66]

Putting aside the complexity of determining an optimal fee level and the risk unit that would drive liability, the Commission may find that a regulatory fee levied pre-launch based on the characteristics of a satellite may be easily incorporated into the Commission's current system of pre-launch disclosures without significantly increasing oversight costs. However, as discussed above in the context of marketable permits, by focusing only on pre-launch activity the Commission may overlook other activities, whether intentional or unintentional, that generate debris.

ii. Accounting for the Use of Funds Generated by a Regulatory Fee

Many of the commentators who discuss the possibility of a fee or tax on launch activities suggest that the money be used in one way or another to remove debris from orbit. This recommendation is consistent with the advice offered by two NASA scientists in 2006 that "[o]nly remediation of the near-Earth environment—the removal of existing large objects from orbit—can prevent future problems for research in and commercialization of space."[67]

The literature contains a variety of different approaches to using the proceeds of this regulatory fee or tax for remediation efforts. Duncan and Szoka envision an "Orbital Debris Removal and Recycling Fund" out of which bounties would be paid for actually removing debris from orbit, thus incentivizing private investment in such technologies.[68] Garber suggests that the money collected through a regulatory tax could be used to directly fund research in debris mitigation technologies either in the public or the private sector.[69] However, as noted above, there are important caveats to how the Commission could redirect revenue to achieve remediation: for instance, there are a number of international legal issues connected to the remediation of orbital debris that may lie beyond the

https://ecfsapi.fcc.gov/file/120147310791/FCC%20Debris%20Reg%20Proposal%20D-Orbit%20Comment%20Letter%2004%20-%20CD.pdf. Insofar as Garber and D-Orbit might be referring to a flat fee levied on all domestic launches, it is worth noting that a 2009 article in Forbes suggests a similar approach of adding an additional licensing fee for all launches. *See* Duncan & Szoka, *supra* note 33.

[65] Macauley, *supra* note 37, at 41.

[66] Jared B. Taylor, *supra* note 33, at 275-76. Garber similarly discusses the idea of a tax credit based on debris remediation. Garber, *supra* note 35, at 195.

[67] J.C. Liou & N.L. Johnson, *Risks in Space from Orbiting Debris*, SCIENCE, Jan. 20, 2006, at 340.

[68] Duncan & Szoka, *supra* note 33.

[69] Garber, *supra* note 35, at 194-95.

Commission's jurisdiction, and perhaps more importantly, without additional Congressional authorization, the Commission may be somewhat constrained in designating revenue to certain policy objectives rather than to the general U.S. treasury.

C. The Commission Should Consider How Clearer Liability Standards and Regulation Can Foster the Development of an Effective Insurance Market

Well-functioning insurance markets create "surrogate regulation" under which insured parties are incentivized to adopt measures to reduce their premiums and insurers are incentivized to monitor risk.[70] In order for insurance markets to achieve optimal levels of safety, there must be clear rules concerning liability and other legal obligations.[71] Unfortunately, in its current form, the international legal framework governing space does not provide clear guidelines for orbital debris. Under the Liability Convention, a launching state is strictly liable for any damage caused by its space objects "on the surface of the earth or to aircraft in flight,"[72] but the state is liable for damage caused in orbit to other space objects only "if the damage is due to its fault or the fault of persons for whom it is responsible."[73] Considering that the vast majority of orbital debris is small and currently cannot usually be attributed to a particular country, the less stringent liability standard for objects in orbit stands out as particularly unhelpful for encouraging an effective insurance market.[74]

Moreover, although insurance policies that technically include coverage for orbital debris damage have existed for decades, quantification of this particular risk was almost entirely undeveloped at the turn of the century, as neither satellite operators nor the insurance community had any experience with orbital debris claims.[75] Other parties' initial comments assert that little progress has been made in the intervening years—citing interrelated obstacles such as a continued lack of information[76] and satellite operators' low demand for

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[70] Kenneth S. Abraham, *Environmental Liability and the Limits of Insurance*, 88 COLUM. L. REV. 942, 954 (1988).
[71] *Id.* at 949-50.
[72] G.A. Res. 2777 (XXVI), Convention on International Liability for Damage Caused by Space Objects, art. II (Nov. 29, 1971).
[73] *Id.* art. III; *see also* Lawrence D. Roberts, *Addressing the Problem of Orbital Space Debris: Combining International Regulatory and Liability Regimes*, 15 B.C. INT'L & COMP. L. REV. 51, 63 (1992) (remarking that "it is unclear how far the provision extends").
[74] *See* Joseph Kurt, Note, *Triumph of the Space Commons: Addressing the Impending Space Debris Crisis Without an International Treaty*, 40 WM. & MARY ENVTL. L. & POL'Y REV. 305, 307 (2015) (noting that out of the more than half million pieces of orbital space debris, about 16,000 are larger than 10cm in diameter and about 400,000 are between 1 and 10 cm in diameter); Marc G. Carns, *Consent Not Required: Making the Case that Consent is Not Required under Customary International Law for Removal of Outer Space Debris Smaller than 10cm^2*, 77 A.F. L. REV. 173, 176-77 (2017) (observing that debris smaller than 10cm^2, though dangerous, is "difficult, if not impossible, to track" and likely impossible to attribute to any state); *see also* Chelsea Muñoz-Patchen, Note, *Regulating the Space Commons: Treating Space Debris as Abandoned Property in Violation of the Outer Space Treaty*, 19 CHI. J. INT'L L. 233, 243 (2018) (referring to a "situation in which identifiable debris is involved in an accident and fault can be attributed under the Liability Convention" as "exceptional").
[75] Delbert D. Smith, *The Technical, Legal, and Business Risks of Orbital Debris*, 6 N.Y.U. ENVTL. L.J. 50, 64 (1997).
[76] Boeing Company, Comment Letter on Proposed Rule related to Mitigation of Orbital Debris in the New Space Age, 84 Fed. Reg. 4742, at 39 (Apr. 5, 2019), https://ecfsapi.fcc.gov/file/10405203725521/Boeing%20Orbital%20Debris%20NPRM%20Comments%204

insurance[77]—such that insurance may not prove effective at incentivizing debris mitigation in the near term.[78]

However, these conditions are not immutable. While market-based approaches like insurance may require different kinds of information than prescriptive regulation, the greater efficiencies promised by market-based approaches may make it worthwhile to invest in the pre-requisites for market-based approaches, such as establishing clearer liability rules and generating the information necessary to assess the risks of and track responsibility for specific debris. More effective debris regulation, aside from likely being necessary, can address the enumerated obstacles by clarifying liability rules and helping to generate more information.

Thus, the Commission should consider how new orbital debris regulations might be tailored so as to expedite the development of an effective insurance market. Insurers can engage in risk assessment based on either the past "loss experience" of the insured ("experience rating") or other objective features of the insured's business operations ("feature rating"); where the former creates incentives to reduce loss experience across the board, the latter creates incentives to adopt measures that bear on the specific evaluation criteria.[79] Over time, increased use of insurance would provide the industry with more data on loss experience, helping to align premium pricing with collision risks.[80] As for feature rating, the "Global NewSpace Operators" highlight efforts to develop a Space Sustainability

%205%202019%20final.pdf ("[A]lthough orbital debris is a significant and growing problem, the vast majority of orbital debris never results in any damage that could be the subject of a reimbursable insurance claim. Therefore, it would be very difficult to identify a correlation between the cost of such insurance and the scope of the efforts by the insured to avoid the generation of debris.").

[77] "Global NewSpace Operators," Comment Letter on Proposed Rule related to Mitigation of Orbital Debris in the New Space Age, 84 Fed. Reg. 4742, at 19 (Apr. 5, 2019), https://ecfsapi.fcc.gov/file/1040578949828/Global%20NewSpace%20Operators_FCC_NPRM.pdf ("Currently, only 5% of low-Earth orbiting satellites possess insurance. This is due to operators deciding they do not need insurance, are unable to secure insurance, or cannot afford insurance." (footnote omitted)); Secure World Foundation, Comment Letter on Proposed Rule related to Mitigation of Orbital Debris in the New Space Age, 84 Fed. Reg. 4742, at 8 (Apr. 5, 2019), https://ecfsapi.fcc.gov/file/1040564410702/Secure%20World%20Foundation%20IB%2018-313%20NPRM%20Comments.pdf ("Essentially, there is too much supply and not enough demand for insurers.").

[78] Secure World Foundation, *supra* note 77, at 8; *see also* "Global NewSpace Operators," *supra* note 77, at 19 ("[A]t the moment, collision risk is not adequately priced into third party liability insurance."); Commercial Smallsat Spectrum Management Association, Comment Letter on Proposed Rule related to Mitigation of Orbital Debris in the New Space Age, 84 Fed. Reg. 4742, at 21-22 (Apr. 5, 2019), https://ecfsapi.fcc.gov/file/104050921818816/CSSMA%20-%20Orbital%20Debris%20NPRM%20Comments%2020190405.pdf (citing VICTORIA A. SAMSON, ET AL., CAN THE SPACE INSURANCE INDUSTRY HELP INCENTIVIZE THE RESPONSIBLE USE OF SPACE? 2 (Oct. 2018), *available at* https://swfound.org/media/206275/iac-2018_manuscript_e342.pdf)

[79] Abraham, *supra* note 70, at 949-50.

[80] *See* "Global NewSpace Operators," *supra* note 77, at 19 (listing this as a prerequisite for incentivization of debris mitigation through insurance premiums).

Rating project, which would supply a market standard to help insurers evaluate "different types of operations that are higher or lower in risk."[81]

D. The Commission Should Consider Whether Market-Share Liability Can Play a Role in Incentivizing Debris Mitigation and Removal

The legal doctrine of market-share liability is designed to afford relief in situations "where multiple parties contribute to a dangerous situation, but where it is virtually impossible to tie a particular party to the harm caused."[82] The doctrine was first developed by the Supreme Court of California in *Sindell v. Abbott Laboratories*, a case in which the plaintiffs sought damages against the manufacturers of diethylstilbestrol ("DES"), a drug that was marketed to pregnant women and had the capacity to cause cancer in their daughters at least a decade later.[83] The court observed that with only two exceptions, similar cases across the country had been decided in favor of DES manufacturers due to plaintiffs' failures to prove causation by identifying the manufacturer of the particular drug prescribed to their mothers,[84] despite the fact that DES was a "fungible" good.[85] The court proceeded to embrace market-share liability, which allowed for the apportionment of liability among the defendants so long as those defendants collectively represented a "substantial share" of the appropriate market. Each defendant would be responsible for a proportion of the judgment corresponding to its approximate share of the market, unless it proved that it could not have manufactured the injury-causing product.[86]

The orbital debris context features a number of similarities to the situation considered in *Sindell*: under most circumstances, it would currently be extremely challenging to prove causation in the case of damage inflicted by orbital debris;[87] debris is relatively fungible; and there is reasonably accurate information regarding space operators' general share of responsibility for existing orbital debris on a proportional basis.[88] Observing that several commentators have advocated for applying market-share liability to provide compensation for loss,[89] legal scholar Chelsea Muñoz-Patchen points out that the doctrine could provide the framework for a regulatory scheme, with a dedicated U.N. fund to reimburse parties for the costs of cleanup activities[90] and liability apportioned "on an ongoing or periodic basis to reflect new developments."[91] Notably, applying market-share liability in the orbital

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[81] *Id.* at 19-20.
[82] Muñoz-Patchen, *supra* note 74, at 256.
[83] 607 P.2d 924, 925 (Cal. 1980).
[84] *Id.* at 927-28.
[85] *Id.* at 936.
[86] *Id.* at 937.
[87] *See supra* note 74 and accompanying text.
[88] *See* Muñoz-Patchen, *supra* note 74, at 256-57; *see also* Mark J. Sundahl, Note, *Unidentified Orbital Debris: The Case for a Market-Share Liability Regime*, 24 HASTINGS INT'L & COMP. L. REV. 125, 144-46 (2000).
[89] *See* Sundahl, *supra* note 88, at 143-52 (2000); Peter T. Limperis, Note, *Orbital Debris and the Spacefaring Nations: International Law Methods for Prevention and Reduction of Debris, and Liability Regimes for Damage Caused by Debris*, 15 ARIZ. J. INT'L & COMP. L. 319, 339–41 (1998).
[90] Muñoz-Patchen, *supra* note 74, at 255-56.
[91] *Id.* at 258.

debris context would create incentives to both reduce debris production and remove existing debris.[92]

The United States, Russia, and China are by far the most responsible for existing orbital debris.[93] Because U.S. entities are responsible for a large share of existing orbital debris, the United States would bear a large share of the costs of a proportional liability scheme; however, U.S. entities would also enjoy a large share of the benefits.[94] In addition to historically being the most active in space, perhaps unsurprisingly, the United States, Russia, and China stand to suffer the most harm from collisions in the near future. As of November 2018, those three countries (or entities based within those three countries) owned or operated nearly two-thirds of all active satellites in orbit: 1257 of 1957.[95] With 830 satellites, the United States alone is responsible for over 40 percent of the total figure,[96] meaning that the United States is uniquely exposed to the risks posed by foreign or unattributed debris.

Though certain aspects of the orbital debris problem recommend market-share liability as a possible solution, the doctrine is not without its challenges.[97] For one, several courts have so far refused to follow the California Supreme Court in accepting market-share liability, and efforts to extend application of the doctrine to other domains have met with only moderate success.[98] In the orbital debris context, a robust market-share liability regime would require buy-in from at least a healthy majority of spacefaring nations: the Commission, therefore, would need to work with the State Department and the U.S. Ambassador to the United Nation to coordinate the participation of other key countries in such a scheme. Participating countries could deny recovery to any state that refuses to join the system and be held liable for its respective share of orbital debris, but without participation of a sufficient number of countries, the system will not create strong enough incentives to reduce and remove debris. Even if the Commission does not pursue applying market-share liability to the problem of orbital debris, it should consider what lessons can be drawn from the doctrine.

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[92] Sundahl, *supra* note 88, at 147-48.
[93] Dave Mosher & Samantha Lee, *More than 14,000 Hunks of Dangerous Space Junk Are Hurtling Around Earth — Here's Who Put It All up There*, BUS. INSIDER (Mar. 29, 2018, 9:29 AM), https://www.businessinsider.com/space-junk-debris-amount-statistics-countries-2018-3 (citing data provided by the Space Surveillance Network).
[94] *See* Muñoz-Patchen, *supra* note 74, at 257; Sundahl, *supra* note 88, at 147.
[95] *See* Johnny Wood, *The Countries with the Most Satellites in Space*, WORLD ECON. F. (Mar. 4, 2019), https://www.weforum.org/agenda/2019/03/chart-of-the-day-the-countries-with-the-most-satellites-in-space/ (citing data provided by the Union of Concerned Scientists' Satellite Database).
[96] *See id.*
[97] Additional critiques have been offered by Michael W. Taylor, *supra* note 33, at 51-52 (explaining that, unlike in the DES cases, "[u]nder the law governing the use of space, all rights and responsibilities flow through states," thereby making spacefaring states both claimants and respondents and reducing their recovery in any suit; also noting that basing liability on responsibility for "known and trackable" debris overlooks complicating variables, potentially generating unfair results; and observing that the regime makes no allowance for harm caused by natural orbital debris).
[98] Sundahl, *supra* note 88, at 142-43.

II. The Commission Should Assess Net Benefits by Fully Weighing Direct and Indirect Effects

The Commission cites the Communications Act of 1934, as amended, as creating the legal basis for amending its rules concerning orbital debris.[99] Notably, the relevant statutory provisions counsel the Commission to act in the public interest.[100]

In order to best serve the public interest in the context of space debris, the Commission should begin by acknowledging that orbital debris creates a special kind of global externality, such that regulations to reduce orbital debris will generate benefits beyond direct benefits to U.S. space operations. The Commission should fully weigh all direct and indirect effects and should select the regulatory alternatives that maximize total net benefits. As the Commission suggests, regulations with net benefits will appropriately advance public interests and should be adopted even if there are some near-term regulatory costs.[101]

Because the problem of space debris is an emblematic tragedy of the global commons, in conducting a regulatory impact analysis, the Commission should analyze costs and benefits on a global scale, knowing that the United States is in a strong position to induce other countries to adopt the same approach. Even when considering specific impacts to U.S. interests, the Commission should make sure to account for:

- the benefits to the United States of avoided negative spillover effects;
- the benefits to the United States of reciprocal foreign actions; and
- the extraterritorial interests of U.S. citizens.

A. Because Orbital Debris Constitutes a Tragedy of the Global Commons, the United States Should Evaluate the Issue on a Global Scale and Encourage Other Countries to Follow Suit

The "tragedy of the commons" refers to situations that encourage the inefficient use of a shared resource from which no one can be excluded; without intervention, the fact that individuals can benefit from the resource without having to fully internalize the associated costs ultimately destroys the productive use of the resource.[102]

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[99] 84 Fed. Reg. 4742, 4752.

[100] *See, e.g.*, 47 U.S.C. § 151 (establishing a purpose of "mak[ing] available, so far as possible, to all the people of the United States . . . a rapid, efficient, nationwide, and world-wide wire and radio communication service"); *id.* § 303 (describing the general powers and duties of the Commission and instructing it to act "as public convenience, interest, or necessity requires"); *id.* § 307 (instructing the Commission to consider "public convenience, interest, or necessity" in granting broadcasting licenses); *id.* § 309(j)(3)(a) (directing the Commission to promote, *inter alia*, "the development and rapid deployment of new technologies, products and services for the benefit of the public" in its administration of a competitive license bidding system).

[101] *See* 84 Fed. Reg. 4742, 4751.

[102] *See* Garrett Hardin, *The Tragedy of the Commons*, 162 SCIENCE 1243 (1968) ("[E]ach pursuing [only its] own best interest . . . in a commons brings ruin to all.").

The primary international treaty governing space has designated space as a global commons from which no country can be excluded[103] and over which no country should assert ownership.[104] Multiple commentators have recognized that this regime makes outer space susceptible to the tragedy of the commons, including with regard to space debris: because spacefaring countries enjoy the full benefits of their satellites and spacecraft but do not fully internalize the costs of the debris produced by space activity, countries lack a strong incentive to limit or reduce this debris.[105] Multiple initial comments submitted in this rulemaking also readily acknowledged the global scope of the orbital debris problem and the potential international impact of the proposed regulations.[106] In space as elsewhere, the conditions inherent to a commons can lead to inefficient decisions.[107] An optimal economic impact analysis should seek to reveal such inefficiencies and inform decision-makers about the best options for efficiently internalizing the externalities.

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[103] G.A. Res. 2222 (XXI), Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, art. I (Dec. 19, 1966) ("The exploration and use of outer space . . . shall be the province of all mankind."). The treaty proceeds to establish that "Outer space . . . shall be free for exploration and use by all States . . . and there shall be free access to all areas of celestial bodies." *Id.*

[104] *Id.* art. II ("Outer space . . . is not subject to national appropriation.").

[105] *See* Jared B. Taylor, *supra* note 33, at 260; *see also, e.g.*, Muñoz-Patchen, *supra* note 74, at 243-44; Brian Beck, *The Next, Small, Step for Mankind: Fixing the Inadequacies of the International Space Law Treaty Regime to Accommodate the Modern Space Flight Industry*, 19 ALB. L.J. SCI. & TECH. 1, 27 (2009).

[106] *E.g.*, European External Action Service, Comment Letter on Proposed Rule related to Mitigation of Orbital Debris in the New Space Age, 84 Fed. Reg. 4742, at 1 (Apr. 5, 2019), https://ecfsapi.fcc.gov/file/10404212777082/20190402%20EEAS%20comments%20on%20FFC%20proposal.pdf (encouraging the Commission to pursue regulations with a mind for "foster[ing] a global approach to the global challenge of space debris"); Josef Koller (on behalf of the Aerospace Corporation), Comment Letter on Proposed Rule related to Mitigation of Orbital Debris in the New Space Age, 84 Fed. Reg. 4742, at 2 (Apr. 5, 2019), https://ecfsapi.fcc.gov/file/10307212587227/OTR-2019-00270%20-%20COMMENTS%20OF%20THE%20AEROSPACE%20CORPORATION%20In%20the%20Matters%20of%20Mitigation%20of%20Orbital%20Debris%20in%20the%20New%20Space%20Age%2C%20%20B%20Docket%20No.%2018-313%2C%20Before%20the%20%20FEDERAL%20COMMUNICATIONS%20COMMISSION.pdf ("Since all users of space share the orbital debris environment, these rules have the potential to affect the entire community and have implications for future space operations domestically and internationally."); "Global NewSpace Operators," *supra* note 77, at 20 ("We also recognize that orbital debris affects all stakeholders in space, not just one nation. There needs to be international consensus on what constitutes safe and responsible behavior in space otherwise such rulemaking efforts will not be as effective."); Lockheed Martin, Comment Letter on Proposed Rule related to Mitigation of Orbital Debris in the New Space Age, 84 Fed. Reg. 4742, at 4 (Apr. 5, 2019), https://ecfsapi.fcc.gov/file/10405091397740/LM%20Comments%20IB%20Docket%2018-313%20FILED.pdf (acknowledging that "the space domain is a globally shared environment, thus international collaboration with other spacefaring nations and their stakeholders' 'buy-in' to a U.S.-led approach is ultimately another critical element to success").

[107] *See, e.g.*, Joel D. Scheraga, *Establishing Property Rights in Outer Space*, 6 CATO J. 889, 894-95 (1987) (observing that increased congestion corresponds to increased collision risk and concluding that "[e]ach individual country acting alone, in its own self-interest, will not make socially correct decisions"); Muñoz-Patchen, *supra* note 74, at 243-44 (remarking that there is "no obligation for spacefaring nations to internalize their own space debris externalities, so too much debris is created").

The Commission, as an independent agency, is not subject to the guidance on regulatory impact analyses issued by the Office of Management and Budget in *Circular A-4*, but the recommendations contained therein are widely considered to represent best practices for economic analysis. While *Circular A-4* suggests that most assessments of regulatory costs and benefits should focus on U.S. effects,[108] it cautions agencies that special cases call for different emphases:

> [Y]ou cannot conduct a good regulatory analysis according to a formula. Conducting high-quality analysis requires competent professional judgment. *Different regulations may call for different emphases* in the analysis, *depending on the nature and complexity* of the regulatory issues and the sensitivity of the benefit and cost estimates to the key assumptions.[109]

Orbital debris calls for precisely such a different emphasis. In order to protect against a global tragedy of the commons that could irreparably damage all countries, including the United States, every nation should ideally set policy according to the global costs of orbital debris.[110] Space is a common resource that is freely available to all countries, but the creation of debris by any one country imposes harms on not only that country, but also the rest of the world. Conversely, debris mitigation benefits all countries, not only the country engaging in the mitigation. Thus, the United States stands to benefit if it can encourage all other countries to consider the global externalities of their orbital debris and reduce their debris accordingly.

In light of the commanding presence of the United States on the international stage and in space in particular, game theory predicts that viable strategies for the United States to encourage other countries to think globally in designing their space debris policy is for the United States to do the same and then leverage some combination of lead-by-example, coalition-building, and "tit-for-tat" dynamics.

Under a number of scenarios and assumptions, leading by example with unilateral action could successfully foster international cooperation on orbital debris. For example, in the "coordination" strategic model, parties realize mutual welfare gains by pursuing mutually consistent strategies. A classic version is when two drivers meet on a narrow road: only when both swerve in the same relative direction (e.g., both to their own right) can they avoid crashing. Applying this model in the orbital debris context, remediation by one major actor can boost the incentive for others to also remediate. Good faith signals can build credibility and trust with other nations, increasing their perceptions that a cooperative outcome is likely and, in turn, inducing cooperation.[111] Accounting for the global costs and benefits of U.S. orbital debris regulation could provide a good faith signal that the United

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[108] *See* CIRCULAR A-4 at 15.
[109] *Id.* at 3 (emphases added).
[110] *See* Hardin, *supra* note 102.
[111] *See, e.g.*, Kenneth Clark & Martin Sefton, *Repetition and Signaling: Experimental Evidence from Games with Efficient Equilibria*, 70 ECON. LETTERS 357, 361 (2001).

States cares about the welfare of other countries, paving the way for other governments to follow suit. Because the United States is the premier actor in space,[112] these beneficial reciprocal results are especially plausible.[113]

A U.S. regulatory approach that accounts for the global effects of space debris carries an even greater likelihood of generating beneficial reciprocity where the United States actively recruits support from other countries as part of a coalition-building strategy. A stable coalition of key actors possesses a greater capacity to lead by example through joint initial commitments to act, and a critical mass can tip the scales toward a global agreement.[114] Initial comments from this rulemaking proceeding support coalition-building as a viable strategy in the context of orbital debris regulation.[115]

A tit-for-tat strategy promotes cooperation under conditions that allow for repeat, dynamic negotiations over time, as opposed to a one-shot model.[116] This strategy entails matching whatever action a counterparty took most recently: if the counterparty cooperated, then you cooperate; if the counterparty defected, you punish the defection by also defecting. Experiments suggest that tit-for-tat is a very robust strategy in most multi-period negotiations.[117] Thus, whether the United States pursues unilateral action or a coalition-building approach in a push to assess orbital debris regulation on a global scale, it can motivate cooperation from other countries by deploying a tit-for-tat strategy. However, if the United States were to consider only direct U.S. effects and ignore global externalities in settings its regulation, other countries would be likely to retaliate by also ignoring how their orbital debris creates risks and costs for the United States, and U.S. interests in space would suffer as a result. The potential for such a powerful tit-for-tat dynamic cautions strongly in favor of taking a global perspective on the costs and benefits of regulatory actions to address the tragedy of orbital debris risks in the global commons of outer space.

B. Effects to Foreign Space Operations May Bear Directly or Indirectly on U.S. Interests and Should Be Counted Among Regulatory Costs and Benefits

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[112] *See* supra notes 93-96 and accompanying text.
[113] *See generally* Anu Bradford, *The Brussels Effect*, 107 NW. U.L. REV. 1 (2012) (taking the European Union as a case study for how states boasting a leading market presence and regulatory expertise in a given field can drive global regulations in that field).
[114] *See* Martha Finnemore & Kathryn Sikkink, *International Norm Dynamics and Political Change*, 52 INT'L ORG. 887, 895 (1998) (observing that norm emergence and broad norm acceptance "are divided by a threshold or 'tipping' point, at which a critical mass of relevant state actors adopt the norm").
[115] *See* European External Action Service, *supra* note 106, at 1 (conveying the "readiness" of the EEAS and the European Commission to "work with the U.S. government").
[116] The "prisoner's dilemma" is an example of a one-shot model. The classic version involves two criminal co-conspirators being questioned by police in separate rooms, where each ends up implicating the other since their physical separation prevents them from collaboratively making a mutually beneficial agreement to both stay silent.
[117] *See* ROBERT AXELROD, THE EVOLUTION OF COOPERATION 10-11 (1984) (discussing repeated prisoner's dilemma games).

To comply with Circular A-4's instructions to analyze at least all significant effects that accrue to U.S. citizens, agencies must look beyond U.S. borders.[118] Circular A-4 instructs agencies to estimate all important "opportunity costs," meaning "what individuals are willing to forgo to enjoy a particular benefit."[119] U.S. individuals are willing to forgo money to enjoy benefits or avoid costs from effects of orbital debris that occur beyond U.S. borders, and all such significant effects must be captured. These effects include the benefits of avoided negative spillover effects, the benefits of reciprocal foreign actions, and any impacts on the extraterritorial interests of U.S. citizens.

1. Benefits of Avoided Negative Spillover Effects

A full accounting of the direct and indirect effects of the proposed debris regulations should include the benefits of reduced spillover effects—that is, orbital debris harms that affect the United States even if the first incidence of the harm falls to non-U.S. space operations. The "Kessler Syndrome" or "cascade effect" follows from the fundamental premise that the collision of orbital debris with other space objects creates further debris, which in turn threatens to trigger a disastrous chain reaction of collisions that "could potentially close some of the more popular orbits, which provide valuable and relied-upon services to people around the world."[120] While estimates vary as to when the Kessler Syndrome could occur,[121] orbital debris still poses a considerable risk in the meantime. Given the high speeds at which it whizzes through space, orbital debris need not be large to generate catastrophic damage: fragments of ten centimeters or more in diameter are likely to completely destroy a functioning satellite in a collision, and smaller pieces can inflict severe damage.[122]

As discussed above, the United States is uniquely exposed to the risks posed by foreign or unattributed debris.[123] Because of the cascading risks to other satellites from collisions triggered by orbital debris, risks that initially fall most directly on non-U.S. space operations may quickly spillover and directly affect U.S. space operations as well. While not all orbital debris damages will necessarily spill back to affect the United States, many will, and reductions of this risk should be counted as benefits in any regulatory impact analysis.

Communications systems and other industries served by satellite operations may also feature certain network effects such that, even without the direct threat of cascading

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[118] *See* CIRCULAR A-4 at 15.
[119] *Id.* at 18.
[120] Agatha Akers, *To Infinity and Beyond: Orbital Space Debris and How to Clean It Up*, 33 U. LA VERNE L. REV. 285, 294 (2012) (further noting that according to the hypothesis, "even if humans add no additional debris to the Earth's orbit, the amount of orbital debris could still grow exponentially, based on the amount that already exists"); *see also* Kurt, *supra* note 74, at 309.
[121] *See, e.g.*, Muñoz-Patchen, *supra* note 74, at 241 (observing that while the National Research Council predicted that the Kessler Syndrome could occur within twenty years, the NASA scientist who theorized the phenomenon believes it may be a century away).
[122] Kurt, *supra* note 74, at 307.
[123] *See supra* notes 95-96 and accompanying text.

collisions destroying U.S. space assets, impacts to non-U.S. operations could spill over and directly affect U.S. interests. Any such spillover effects must also be accounted for.

2. Benefits of Reciprocal Foreign Actions

Any additional regulatory actions taken by the United States to control its orbital debris may induce other spacefaring nations to adopt reciprocal regulations; because such instances of foreign reciprocity would prove advantageous to U.S. space interests, they should be counted as benefits in any regulatory impact analysis. Established practice supports this approach. Circular A-4 requires that the "same standards of information and analysis quality that apply to direct benefits and costs should be applied to ancillary benefits and countervailing risks," such that any analysis of space debris regulations should include indirect effects from reciprocal foreign actions.[124]

Past administrations have recognized that U.S. agencies' analytical and regulatory choices can influence the actions of foreign countries, which in turn affect U.S. citizens.[125] And as discussed above, regulatory actions by the United States could trigger lead-by-example, coalition-building, and "tit-for-tat" dynamics to produce beneficial foreign reciprocity,[126] and the Commission should count these indirect effects.

3. Impacts on the Extraterritorial Interests of U.S. Citizens

Finally, the Commission should account for the fact that U.S. citizens and private businesses may have investments in foreign satellite companies or other foreign industries that heavily rely on satellites, such as telecommunications. Benefits to the United States from reducing the risks to these foreign space operations should thus count in any regulatory impact analysis.

For example, SES S.A. is a global communications company headquartered in Luxembourg,[127] and the company owns or operates dozens of satellites that are registered through the United Kingdom or Luxembourg and that were launched from sites like the Baikonur Cosmodrome in Kazakhstan or the Guiana Space Center in South America.[128] SES

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[124] CIRCULAR A-4 at 26.

[125] For instance, in addressing the analogous problem of ozone-depleting substances, the FDA under the George W. Bush administration remarked that U.S. health gains "could be magnified if other countries follow suit and further reduce emissions." Use of Ozone-Depleting Substances; Removal of Essential-Use Designations, 69 Fed. Reg. 33,602, 33,612 (June 16, 2004). In weighing the benefits of the proposed policy, the FDA proceeded to consider how "other Parties could attempt to delay their own control measures" in response to an FDA delay of action, which would carry "adverse environmental and human health consequences." *Id.* at 33,614; Use of Ozone-Depleting Substances; Removal of Essential-Use Designations, 72 Fed. Reg. 32,030, 32,044 (June 11, 2007).

[126] *See supra* notes 111-117 and accompanying text.

[127] https://www.bloomberg.com/profile/company/SESG:FP.

[128] *See* Union of Concerned Scientists, UCS Satellite Database (listing the nearly 2000 operational satellites currently in orbit, including launches through November 30, 2018), https://www.ucsusa.org/nuclear-weapons/space-weapons/satellite-database

S.A. is a publicly traded company, and major shareholders include U.S.-based mutual funds like Vanguard and Oppenheimer.[129] Thus, any damage to SES S.A.-owned satellites caused by orbital debris will directly impact U.S. investors.

According to the Satellite Industry Association's 2017 Annual Report, American firms generated approximately 44 percent of the annual revenues of the global satellite industry between 2012 and 2016.[130] While the United States has significant market share and is widely acknowledged as a leader in outer space, there are significant opportunities for American individuals and businesses to acquire ownership, use, and other interests in foreign satellite companies.

The same observation applies to the space industry as a whole. Already a multi-billion-dollar industry, Bank of America and Merrill Lynch expect that it will continue to grow in the coming years. In fall 2017, they issued a report to alert clients to the domestic and international long-term investment opportunities in various sectors of the space industry, including aerospace and defense, satellites, and insurance.[131] The desire to invest in space is global, and "space startups are aggressively pursued" by investors.[132] In addition to direct investment in the space industry, Americans may also have investments in foreign telecommunications companies that rely heavily on satellites;[133] moreover, the implementation of 5G technology in the near future will likely drive investment in both domestic and international telecommunications companies as well as companies adjacent to that industry, such as tower operators and chip manufacturers.[134] Including the effects of U.S. regulations on foreign space operations will therefore enable the Commission to consider a more accurate range of costs and benefits that matter to U.S. citizens and companies investing abroad.

Conclusion

Like many of the other parties that have submitted comments, Policy Integrity is pleased to see the Commission reevaluating its rules concerning the important issue of orbital space debris. To efficiently internalize the global externalities of orbital debris, the Commission should further explore market-based regulatory alternatives such as marketable permits and offsets, insurance, market-share liability, and regulatory fees. In conducting a regulatory impact analysis of any orbital debris policies, the Commission should fully weigh all direct and indirect regulatory effects, ideally by weighing costs and benefits on a global scale. In particular, the Commission should recognize that effects to foreign space operations may still directly or indirectly affect the United States, including the benefits of

[129] https://finance.yahoo.com/quote/SESG.PA/holders?p=SESG.PA
[130] SATELLITE INDUSTRY ASSOCIATION, STATE OF THE SATELLITE INDUSTRY REPORT 6 (2017).
[131] BANK OF AMERICA AND MERRILL LYNCH, TO INFINITY AND BEYOND—GLOBAL SPACE PRIMER 6-7 (2017).
[132] Greg Autry, Opinion, *Commercial Space Startups Should be Wary of Some Foreign Investors*, SPACE NEWS (Sept. 29, 2018), https://spacenews.com/op-ed-commercial-space-startups-should-be-wary-of-some-foreign-investment/.
[133] SATELLITE INDUSTRY ASSOCIATION, *supra* note 130, at 8 (finding that 35% of satellites in orbit were used in commercial communications).
[134] Paul R. La Monica, *The Real 5G Winners: Tower Companies*, CNN BUS. (Feb. 26, 2019, 11:02 AM), https://www.cnn.com/2019/02/26/investing/5g-tower-stocks/index.html.

avoided negative spillover effects, the benefits of reciprocal foreign actions, and the impacts on the extraterritorial interests of U.S. citizens. An open-ended approach to the global problem of orbital space debris will allow the Commission to select the regulatory alternatives that best maximizes total net benefits.

Respectfully,
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