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BREAKING THE SPACE DEBRIS DEADLOCK: A GAME-THEORETIC AND POLICY APPROACH

Abstract

The increasing accumulation of space debris in LEO presents a classic tragedy of the commons. While prevailing discourse emphasizes international cooperation for active debris removal (ADR), this study applies game theory analysis and comparative policy assessment to demonstrate why such cooperation remains economically irrational. States face strong incentives to delay investment in mitigation efforts, preferring to wait for others to act– a dynamic that exacerbates collective inaction. Using a game-theoretic approach, this paper models the strategic decision-making of spacefaring nations, revealing structural disincentives for players to act. Comparative analysis of existing space governance frameworks further illustrates the limitations of current international agreements towards compelling countries to participate. The findings suggest that a shift from a singular global governance model towards a polycentric system where multiple overlapping authorities and incentives operate could offer a more viable path forward. To address economic and regulatory hurdles, this study proposes a policy framework centered on a debris credit system, creating economic incentives by rewarding responsible behavior while also imposing costs on continued debris generation. This mechanism, combined with decentralized governance structures, could drive more long-term engagement from both states and private actors. By reassessing governance models beyond traditional multilateral agreements, this paper contributes to the ongoing debate on long-term space sustainability. While a polycentric approach with economic incentives offers a viable path forward, nations remain reluctant to invest first in debris removal, preferring instead to wait for others to take the initiative. This hesitation reinforces the lack of effective international collaboration, leaving space debris mitigation efforts stagnant.